REPORT S2-S06-RW-1

Naturalistic Driving Study: Technical Coordination and Quality Control

SHRP2 SAFETY RESEARCH

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

TRANSPORTATION RESEARCH BOARD 2015 EXECUTIVE COMMITTEE*

OFFICERS

CHAIR: **Daniel Sperling,** *Professor of Civil Engineering and Environmental Science and Policy; Director, Institute of Transportation Studies, University of California, Davis*
VICE CHAIR: **James M. Crites,** *Executive Vice President of Operations, Dallas–Fort Worth International Airport, Texas*
Executive Director: Neil J. Pedersen, *Transportation Research Board*

MEMBERS

Victoria A. Arroyo, *Executive Director, Georgetown Climate Center; Assistant Dean, Centers and Institutes; and Professor and Director, Environmental Law Program, Georgetown University Law Center, Washington, D.C.*
Scott E. Bennett, *Director, Arkansas State Highway and Transportation Department, Little Rock*
Deborah H. Butler, *Executive Vice President, Planning, and CIO, Norfolk Southern Corporation, Norfolk, Virginia (Past Chair, 2013)*
Malcolm Dougherty, *Director, California Department of Transportation, Sacramento*
A. Stewart Fotheringham, *Professor, School of Geographical Sciences and Urban Planning, University of Arizona, Tempe*
John S. Halikowski, *Director, Arizona Department of Transportation, Phoenix*
Michael W. Hancock, *Secretary, Kentucky Transportation Cabinet, Frankfort*
Susan Hanson, *Distinguished University Professor Emerita, School of Geography, Clark University, Worcester, Massachusetts*
Steve Heminger, *Executive Director, Metropolitan Transportation Commission, Oakland, California*
Chris T. Hendrickson, *Professor, Carnegie Mellon University, Pittsburgh, Pennsylvania*
Jeffrey D. Holt, *Managing Director, Bank of Montreal Capital Markets, and Chairman, Utah Transportation Commission, Huntsville, Utah*
Geraldine Knatz, *Professor, Sol Price School of Public Policy, Viterbi School of Engineering, University of Southern California, Los Angeles*
Michael P. Lewis, *Director, Rhode Island Department of Transportation, Providence*
Joan McDonald, *Commissioner, New York State Department of Transportation, Albany*
Abbas Mohaddes, *President and CEO, Iteris, Inc., Santa Ana, California*
Donald A. Osterberg, *Senior Vice President, Safety and Security, Schneider National, Inc., Green Bay, Wisconsin*
Sandra Rosenbloom, *Professor, University of Texas, Austin (Past Chair, 2012)*
Henry G. (Gerry) Schwartz, Jr., *Chairman (retired), Jacobs/Sverdrup Civil, Inc., St. Louis, Missouri*
Kumares C. Sinha, *Olson Distinguished Professor of Civil Engineering, Purdue University, West Lafayette, Indiana*
Kirk T. Steudle, *Director, Michigan Department of Transportation, Lansing (Past Chair, 2014)*
Gary C. Thomas, *President and Executive Director, Dallas Area Rapid Transit, Dallas, Texas*
Paul Trombino III, *Director, Iowa Department of Transportation, Ames*
Phillip A. Washington, *General Manager, Denver Regional Council of Governments, Denver, Colorado*

EX OFFICIO MEMBERS

Thomas P. Bostick *(Lt. General, U.S. Army), Chief of Engineers and Commanding General, U.S. Army Corps of Engineers, Washington, D.C.*
Timothy P. Butters, *Acting Administrator, Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation*
Alison Jane Conway, *Assistant Professor, Department of Civil Engineering, City College of New York, New York, and Chair, TRB Young Members Council*
T. F. Scott Darling III, *Acting Administrator and Chief Counsel, Federal Motor Carrier Safety Administration, U.S. Department of Transportation*
Sarah Feinberg, *Acting Administrator, Federal Railroad Administration, U.S. Department of Transportation*
David J. Friedman, *Acting Administrator, National Highway Traffic Safety Administration, U.S. Department of Transportation*
LeRoy Gishi, *Chief, Division of Transportation, Bureau of Indian Affairs, U.S. Department of the Interior, Washington, D.C.*
John T. Gray II, *Senior Vice President, Policy and Economics, Association of American Railroads, Washington, D.C.*
Michael P. Huerta, *Administrator, Federal Aviation Administration, U.S. Department of Transportation*
Paul N. Jaenichen, Sr., *Administrator, Maritime Administration, U.S. Department of Transportation*
Therese W. McMillan, *Acting Administrator, Federal Transit Administration, U.S. Department of Transportation*
Michael P. Melaniphy, *President and CEO, American Public Transportation Association, Washington, D.C.*
Gregory G. Nadeau, *Acting Administrator, Federal Highway Administration, U.S. Department of Transportation*
Peter M. Rogoff, *Acting Under Secretary for Transportation Policy, Office of the Secretary, U.S. Department of Transportation*
Mark R. Rosekind, *Administrator, National Highway Traffic Safety Administration, U.S. Department of Transportation*
Craig A. Rutland, *U.S. Air Force Pavement Engineer, Air Force Civil Engineer Center, Tyndall Air Force Base, Florida*
Barry R. Wallerstein, *Executive Officer, South Coast Air Quality Management District, Diamond Bar, California*
Gregory D. Winfree, *Assistant Secretary for Research and Technology, Office of the Secretary, U.S. Department of Transportation*
Frederick G. (Bud) Wright, *Executive Director, American Association of State Highway and Transportation Officials, Washington, D.C.*
Paul F. Zukunft, *Adm., U.S. Coast Guard, Commandant, U.S. Coast Guard, U.S. Department of Homeland Security*

* Membership as of February 2015.

The Second
STRATEGIC HIGHWAY RESEARCH PROGRAM

Naturalistic Driving Study: Technical Coordination and Quality Control

THOMAS A. DINGUS
JONATHAN M. HANKEY
JONATHAN F. ANTIN
SUZANNE E. LEE
LISA EICHELBERGER
KELLY E. STULCE
DOUG MCGRAW
MIGUEL PEREZ
LOREN STOWE
Virginia Tech Transportation Institute
Blacksburg, Virginia

TRANSPORTATION RESEARCH BOARD
WASHINGTON, D.C.
2015
www.TRB.org

Subject Areas

Data and Information Technology
Highways
Operations and Traffic Management
Safety and Human Factors
Vehicles and Equipment

The Second Strategic Highway Research Program

America's highway system is critical to meeting the mobility and economic needs of local communities, regions, and the nation. Developments in research and technology—such as advanced materials, communications technology, new data collection technologies, and human factors science—offer a new opportunity to improve the safety and reliability of this important national resource. Breakthrough resolution of significant transportation problems, however, requires concentrated resources over a short time frame. Reflecting this need, the second Strategic Highway Research Program (SHRP 2) has an intense, large-scale focus, integrates multiple fields of research and technology, and is fundamentally different from the broad, mission-oriented, discipline-based research programs that have been the mainstay of the highway research industry for half a century.

The need for SHRP 2 was identified in *TRB Special Report 260: Strategic Highway Research: Saving Lives, Reducing Congestion, Improving Quality of Life,* published in 2001 and based on a study sponsored by Congress through the Transportation Equity Act for the 21st Century (TEA-21). SHRP 2, modeled after the first Strategic Highway Research Program, is a focused, time-constrained, management-driven program designed to complement existing highway research programs. SHRP 2 focuses on applied research in four areas: Safety, to prevent or reduce the severity of highway crashes by understanding driver behavior; Renewal, to address the aging infrastructure through rapid design and construction methods that cause minimal disruptions and produce lasting facilities; Reliability, to reduce congestion through incident reduction, management, response, and mitigation; and Capacity, to integrate mobility, economic, environmental, and community needs in the planning and designing of new transportation capacity.

SHRP 2 was authorized in August 2005 as part of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The program is managed by the Transportation Research Board (TRB) on behalf of the National Research Council (NRC). SHRP 2 is conducted under a memorandum of understanding among the American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), and the National Academy of Sciences, parent organization of TRB and NRC. The program provides for competitive, merit-based selection of research contractors; independent research project oversight; and dissemination of research results.

SHRP 2 Report S2-S06-RW-1

ISBN: 978-0-309-27401-2

Copyright Information

Note: SHRP 2 report numbers convey the program, focus area, project number, and publication format. Report numbers ending in "w" are published as web documents only.

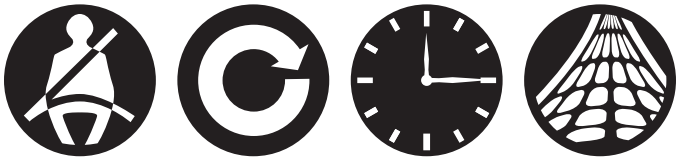
Notice

The project that is the subject of this report was a part of the second Strategic Highway Research Program, conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical committee and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

The Transportation Research Board of the National Academies, the National Research Council, and the sponsors of the second Strategic Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of the report.



SHRP 2 Reports

Available by subscription and through the TRB online bookstore:

www.TRB.org/bookstore

Contact the TRB Business Office:
202-334-3213

More information about SHRP 2:

www.TRB.org/SHRP2

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. C. D. (Dan) Mote, Jr., is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Victor J. Dzau is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. C. D. (Dan) Mote, Jr., are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

SHRP 2 STAFF

Ann M. Brach, *Director*
Stephen J. Andrle, *Deputy Director*
Cynthia Allen, *Editor*
Kenneth Campbell, *Chief Program Officer, Safety*
Jared Cazel, *Editorial Assistant*
JoAnn Coleman, *Senior Program Assistant, Capacity and Reliability*
Eduardo Cusicanqui, *Financial Officer*
Richard Deering, *Special Consultant, Safety Data Phase 1 Planning*
Shantia Douglas, *Senior Financial Assistant*
Charles Fay, *Senior Program Officer, Safety*
Carol Ford, *Senior Program Assistant, Renewal and Safety*
James Hedlund, *Special Consultant, Safety Coordination*
Alyssa Hernandez, *Reports Coordinator*
Ralph Hessian, *Special Consultant, Capacity and Reliability*
Andy Horosko, *Special Consultant, Safety Field Data Collection*
William Hyman, *Senior Program Officer, Reliability*
Linda Mason, *Communications Officer*
David Plazak, *Senior Program Officer, Capacity and Reliability*
Rachel Taylor, *Senior Editorial Assistant*
Dean Trackman, *Managing Editor*
Connie Woldu, *Administrative Coordinator*

ACKNOWLEDGMENTS

This work was sponsored by the Federal Highway Administration in cooperation with the American Association of State Highway and Transportation Officials. It was conducted in the second Strategic Highway Research Program (SHRP 2), which is administered by the Transportation Research Board of the National Academies. The project was managed by Kenneth L. Campbell, SHRP 2 Chief Program Officer, Safety.

The research reported in this document was performed under SHRP 2 Project S06: Technical Coordination and Quality Control, by the Virginia Tech Transportation Institute (VTTI) at Virginia Polytechnic Institute and State University. VTTI was the prime contractor for this study.

Thomas Dingus, Director of VTTI, served as principal investigator for this study. Jonathan M. Hankey, Senior Associate Director for Research and Development at VTTI, served as associate principal investigator and as VTTI's chief liaison with project sponsors and advisory boards. Jon Antin, Director of VTTI's Center for Vulnerable Road User Safety, served as the study's co-principal investigator and coordinator of VTTI's day-to-day study operations. Suzanne Lee, Director of Research Compliance and Data Access at VTTI, guided the study activities in support of the protection of human subjects and actively maintained the privacy of the data generated.

SHRP 2 staff provided invaluable leadership and guidance. VTTI appreciates and acknowledges the following: Ann M. Brach, Director, SHRP 2; Kenneth L. Campbell, Chief Program Officer for Safety Research; James H. Hedlund, Special Consultant for Safety Coordination; Andrew T. Horosko, Special Consultant for Safety Research; Walter J. Diewald, Senior Program Officer for Safety Research; and Charles R. Fay, Senior Program Officer for Safety Research. Collectively, their leadership has contributed to a stronger, more balanced research project, the results of which will yield invaluable information to the transportation research community for years to come.

Several others at VTTI contributed throughout the course of the SHRP 2 Naturalistic Driving Study (NDS) and with the preparation of this report. Special acknowledgment is extended to Elizabeth G. Eichelberger, Project Coordinator for the SHRP 2 NDS; Kelly E. Stulce, Project Assistant; Loren Stowe, Senior Research Associate; Doug McGraw, Senior Database Administrator; Clark Gaylord, Chief Information Officer; and Miguel Perez, Director of the Center for Data Reduction and Analysis Support.

Additional Virginia Tech and Coordination Contractor staff provided valuable contributions to support the NDS study. The technical expertise of the following individuals provided a strong foundation for accomplishing a naturalistic study of this magnitude. While this is not an exhaustive list of the individuals responsible for supporting the study, the key contributors listed here each played a significant role: Andrew Petersen, Craig Bucher, Brian Leeson, Carl Cospel, M. Jared Bryson, Julie Jermeland, Fang Huang, David Mellichamp, Jeff Taylor, Scott Aust, Hardware Electronics Laboratory staff; Jeff Baxter, Chad Graham, Robert Schnitz, Phil Lambert, Sally Waldon, Brian Daily, Tracy McElroy, Jonathan Barry, Ryan Johnson, Richard Zimmerman, Dean Iverson, Sondra Iverson, Zeb Bowden, Julie McClafferty, Brunilda Swannell, Data Reduction and Quality Assessment staff; Deborah Boles, Mary W. Hodge, Mikki Huff, Jennifer Coe, Jessamine Kane-Wisely, April Gray, Michael Buckley, Vikki Fitchett, Brian Wotring, Whitney Atkins, Tyler Lewis, Nelson Gunter, John Paul Plummer, Nicholas Britten, Julie Cook, Melissa Hulse, Jeremy Sudweeks, Kim Shelton, Shane McLaughlin, Kitty Boone, Randall Madison, Devi Mishra, Joel Kady, Michael Mollenhauer, Tammy Russell, Carri Behal, Scott Stone,

Alex Bier, Jon Lillestolen, Jean Paul Talledo-Villela, Steve Bears, Matthew Moeller, Matt Perez, Reginald Bryson, Andrew Karpa, Kenny Smith, Travis Graham, Travis Doerzaph, Greg Brown, Pascha Gerni, Catherine Strickland, David Moore, Kathy C. Smith, Terry Grubb, and Susan Willis-Walton.

Site contractor liaisons, assessment personnel, and installation staff also warrant special recognition. Their cooperation and commitment to following the NDS study protocols contributed greatly to the successful data collection effort. This listing is in no way exhaustive but recognizes those individuals whose daily efforts served to preserve the integrity of the data collection activities:

- From CUBRC: Alan Blatt, John Pierowicz, Maile Miller, Robert Bilz, Jason Pelz, and the remaining intake, assessment, and installation staff;
- From University of South Florida: Pei-Sung Lin, Achilleas Kourtellis, Chanyoung Lee, Matthew Wafford, Matthew Wills, and the remaining intake, assessment, and installation staff;
- From Battelle Memorial Institute: Christian Richard, Jim Brown, Monica Lichty, David Gold, and the remaining intake, assessment, and installation staff;
- From Westat: James Jenness, Martha Wilaby, Melanie Moore, Rick Huey, Brian Clark, Jon Hinrichs, and the remaining intake, assessment, and installation staff;
- From Indiana University: David Good, Nora Czar, Michelle Hoover, Alex Alexeev, and the remaining intake, assessment, and installation staff; and
- From Pennsylvania State University: Paul Jovanis, Phil Garvey, Betsy Jeschke, Robin Tallon, Zolton Rado, Billy Johns, and the remaining intake, assessment, and installation staff.

FOREWORD

Kenneth L. Campbell, *SHRP 2 Chief Program Officer, Safety*

This report describes the technical coordination and quality control carried out by the Virginia Tech Transportation Institute (VTTI) for the SHRP 2 Naturalistic Driving Study (NDS). This project encompassed procurement of the data acquisition system (DAS) and all associated installation and driver assessment equipment; coordination of human subjects protections; participant recruitment; training and coordination of the six site contractors that carried out participant enrollment, instrumentation, and data retrieval; data management; data processing; and quality control. From October 2010 through November 2013, the study collected continuous driving information on more than 3,000 light-vehicle drivers, covering about 50 million miles of driving in the six study sites. In this report, potential users of the SHRP 2 NDS data or findings will find a summary of data collection methods and procedures, instrumentation, quality control, and project management.

The objective of the SHRP 2 NDS is to reduce traffic injuries and fatalities by preventing collisions or reducing the severity of them. The SHRP 2 NDS is the first large-scale study focused on collision prevention (as opposed to injury prevention once a collision occurs) since the Indiana Tri-Level Study (*Tri-Level Study of the Causes of Traffic Accidents: Final Report,* DOT HS-805 085, U.S. Department of Transportation, May 1979). Vehicle use was recorded continuously during the SHRP 2 NDS. Information on vehicle travel, or exposure, can be extracted at the same level of detail as for safety-related events, such as crashes and near crashes. Hence, the SHRP 2 NDS is the first large-scale study to support detailed estimates of collision risk. Moreover, crashes are a leading cause of nonrecurring congestion, so collision prevention has added benefits in terms of reduced delay, fuel consumption, and emissions. The NDS provides objective information on the role of driver behavior and performance in traffic collisions and on the interrelationship of the driver with vehicle, roadway, and environmental factors.

The SHRP 2 Safety research program was carried out under the guidance of the Safety Technical Coordinating Committee (TCC), which was composed of volunteer experts. The Safety TCC developed and approved all project descriptions and budgets and met semiannually to review progress and approve any program modifications. The Oversight Committee approved all budget allocations and contract awards. Assistance was provided by expert task groups, which developed requests for proposals, evaluated proposals and recommended contractors, and provided guidance on many issues, such as data access policies and procedures. The decisions and recommendations of the governing committees were implemented by SHRP 2 staff as they carried out day-to-day management of the research projects.

CONTENTS

Executive Summary

Introduction

The Virginia Tech Transportation Institute (VTTI) served as the Coordination Contractor for the SHRP 2 Naturalistic Driving Study (NDS). In this role, VTTI led the implementation of the framework, which had been developed in the foregoing study design project described by Antin et al. (2011). The ambitious goal of the effort documented in this report was to collect and archive the largest store of naturalistic driving data ever attempted. The scope of this study ranks among the largest and most comprehensive of any driving-based research study conducted to date, facilitated by recent advances in camera and sensor technologies along with similar advances in the collection, movement, and secure storage of "big" data.

The overarching objective was to coordinate and oversee participant- and vehicle-based operations managed by six different groups of site contractors at six unique and geographically distributed data collection sites. The final set of selected sites and the manner in which the 1,950 data acquisition system (DAS) units were allocated to each one is illustrated in Figure ES.1. The sites were managed by the following site contractors:

- Buffalo, New York: CUBRC, Inc.;
- Tampa, Florida: Center for Urban Transportation Research—University of South Florida (CUTR-USF);
- Seattle, Washington: Battelle Memorial Institute (Battelle);
- Durham, North Carolina: Westat;
- Bloomington: Indiana University; and
- State College: Pennsylvania State University.

The desired results included the collection of not only the naturalistic driving data but a variety of associated participant, vehicle, and crash-related data as well. Collected data were stored securely in a manner that protected the rights and privacy of the more than 3,000 participants enrolled in the study.

The major task efforts fell into six key categories: human subjects protection, DAS management, system integration, supporting activities for the site contractor efforts, quality control and oversight, and reporting. The first two are detailed here; see Chapter 1 for more about all six categories.

Human Subjects Protections

Categories of Participants

There were two types of participants: (1) *Primary participants* were the main focus of the study, and recruitment efforts focused on getting the targeted mix in the various age group and gender

Figure ES.1. Site locations and nominal DAS allocations of 1,950 total units.

categories. Primary participants consented to have data collected from their main vehicle whenever it was driven during their participation in the study. They also underwent a broad set of functional assessments. Note that primary participants who were minors at the time of study enrollment provided *assent* to participate, but *consent* for their participation was provided by a parent. (2) *Secondary participants* were other adults who *regularly* drove a primary participant's instrumented vehicle *and* granted consent to have their data analyzed. These drivers were asked to provide a reference image for driver identification purposes, and they were asked to fill in two brief surveys. For example, a spouse may have chosen to grant consent to become a secondary participant, but a hotel valet would not qualify.

Both categories of participants were compensated, with secondary participants receiving a more modest compensation for their less-demanding role in the study. Any other driver of the vehicle was not considered to be a participant, and any data collected during trips when such individuals were driving have been expunged from the data set.

Certificate of Confidentiality

A Certificate of Confidentiality was secured from the National Institute of Mental Health (NIMH) for the SHRP 2 NDS. The Certificate of Confidentiality protects personally identifying data collected during the approved data collection period (i.e., from fall 2010 through the end of 2013). The certificate helps researchers protect the privacy of participant data against compulsory legal demands (e.g., court orders and subpoenas) that seek the name or other identifying characteristics of a research subject. This protection was crucial in that it gave prospective participants confidence that the data collected would not be used against them; without such protection in place, it is felt that recruitment would have been a much more daunting exercise. The protections provided by the Certificate of Confidentiality extend for the life of the data.

Design of the DAS

To comply with the requirements of in-vehicle performance, ease of handling, and ease of installation, the DAS was a comprehensive custom design. The DAS incorporated six primary components: NextGen main unit, head unit (HU), network box, radar, radar interface box (RIB), and solid-state data drive (Figure ES.2). The NextGen main unit housed the computing engine for the system, the electronics for which were encased in a rugged plastic enclosure with room for the solid-state drive (SSD) on which data were initially stored. DAS components were installed as indicated in Figure ES.3. A total of 2,085 DAS kits was purchased for the SHRP 2

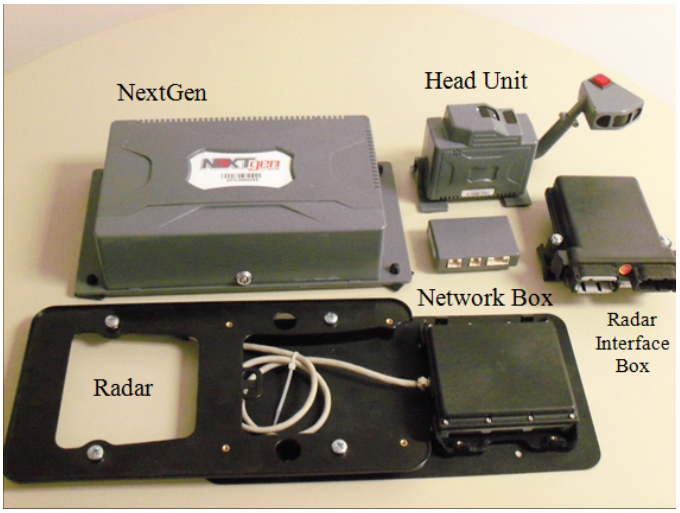


Figure ES.2. DAS kit components (from upper left and moving clockwise: NextGen main unit, head unit, network box, RIB, and radar assembly).

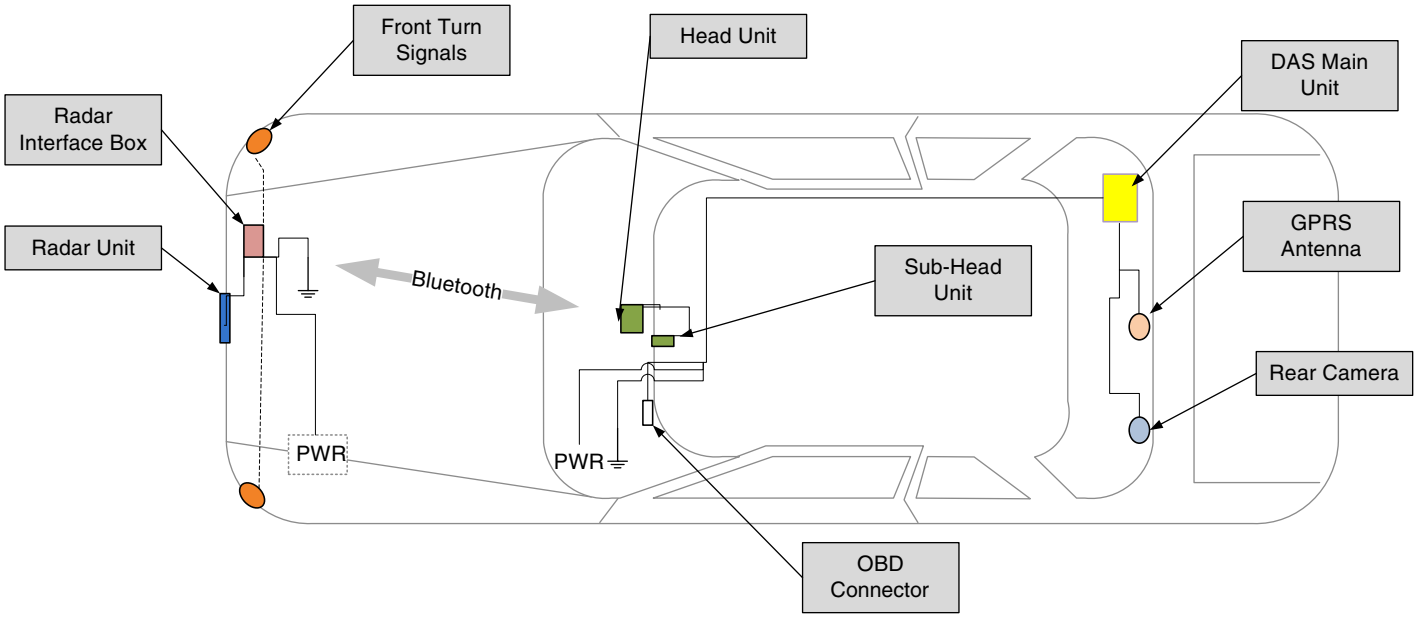


Figure ES.3. Typical in-vehicle locations of DAS components.

Figure ES.4. Quad image of video views. (Note: Driver in image is a nonparticipant employed by Coordination Contractor.)

NDS; additional quantities of several strategically chosen parts were purchased for logistical or replacement purposes.

DAS sensors and capabilities included the following:

- Multiple video and still views;
- Machine-vision-based applications;
- Accelerometers (*x*, *y*, and *z* axes);
- Rate sensors (*x*, *y*, and *z* axes);
- GPS;
- Forward radar;
- Illuminance sensor;
- Passive cabin alcohol presence sensor;
- Incident pushbutton;
- Turn signal state; and
- Vehicle network data (as available).

Video output included a four-quadrant image of the video data. The upper left quadrant features a color view of the forward roadway. The upper right quadrant features a monochrome image of the driver's face and driver-side views (rotated 90 degrees to maximize use of available pixels but seen in its correct orientation during analysis). The bottom right quadrant features a right-rear view, while the bottom left quadrant captures a view of the driver's interactions with the steering wheel and the center stack. Figure ES.4 demonstrates the quad view of the video images.

A cabin snapshot was also recorded once every 10 minutes during a drive. This snapshot was irrevocably blurred at the time of collection and is intended to be used to determine, as possible, the number and other basic characteristics of passengers (e.g., approximate age and/or gender; see Figure ES.5).

Data Collection Site Facilitation

The Coordination Contractor was responsible for technical coordination of the six data collection sites. The preparation activities needed to support ongoing coordination efforts included assessing and certifying each site for readiness to collect data, training site contractor personnel, and providing software tools to assist them in managing their DAS kit installations, maintenance, and deinstallation. Software was also provided to help the site contractors manage their inventory, participants, and vehicle fleets.

Training

To ensure consistency across the six data collection sites, the Coordination Contractor provided in-depth training to site contractor personnel on all study protocols, including human subjects protection standards, encompassing ethics and special situations; enrollment, including providing informed consent; the collection of participant functional assessment data; and the installation, maintenance, and deinstallation of DAS kits (Figure ES.6).

Sample Design

The high-level goal for the sampling plan was to recruit an equal number of male and female licensed drivers across the full breadth of the driver age spectrum. It was also a goal to oversample the youngest and oldest drivers, as these are the most interesting due to prior indications of

Figure ES.5. Blurred cabin image. (Note: Driver in image is a nonparticipant employed by Coordination Contractor.)

Figure ES.6. Hands-on DAS installation training.

elevated crash risk. More than 18,000 individuals were recruited using a variety of approaches, and more than 3,000 ended up participating for 4 months or more.

Network Data Classification

Initial difficulty in recruiting younger and older drivers compelled the Coordination Contractor, in cooperation with SHRP 2 program managers, to expand the vehicle fleet to include older vehicle-years for which a less robust set of vehicle network data was available. The enlargement of the vehicle fleet necessitated the creation of four distinct vehicle classes with three discrete hardware installation configurations: prime, subprime, legacy, and basic, as described in Table ES.1. The parameter identification (PID) refers to the codes used to interpret the network data.

Reports

A wide variety of reports was generated by the Coordination Contractor on weekly, monthly, or quarterly bases; many were produced on an ad hoc basis. These reports provided crucial information on the current and projected status of key progress metrics that continually provided the information needed to help leadership guide the study toward its ultimate goals.

Operations Metrics

An operations metrics report was prepared weekly and circulated among Coordination Contractor staff to present a glimpse into current study operations. The report encompassed all aspects of the study, including data quality, data ingestion progress, fleet communications status, counts of participants and vehicles installed in the past week, solid-state drive status, outstanding maintenance items, inventory counts, and statistics pertaining to fleet issues of particular interest. The counts dictated the work activities each week, and the associated spreadsheets provided a road map for the completion of that work, identifying vehicles with communications issues, video quality problems, or nearly full data drives.

Data Volume Reports

One metric of the total quantity of data collected was the number of vehicle-months. According to this concept, each participant contributed one vehicle-month of data for each full month of

Table ES.1. SHRP 2 NDS Vehicle Classes

Class	Vehicles Included	Vehicle Network Information Collected	Vehicle Count	Percentage of Fleet
Prime	Vehicles for which PIDs were available	Speed, plus wiper activation, brake actuation, headlight activation, turn signal activation, and steering data, as available	1,717	51%
Subprime	Generally vehicles manufactured after 2009 for which PIDs were not available	Speed and accelerator position	488	15%
Legacy	Vehicles manufactured between 1996 and 2008	Speed and accelerator position	736	22%
Basic	Vehicles manufactured before 1996 without vehicle networks	None	421	13%
Total			3,362	100%

participation in the study, regardless of the actual number of driving miles or hours represented during that time period. It is true to state, on the one hand, that driving distance and time are more accurate ways to determine overall data quantity, but these were also more difficult to accurately capture or estimate during the conduct of the study. The total number of vehicle-months collected, on the other hand, could be much more readily calculated at any given point in time for any desired subset of the data (e.g., by age group, gender, and/or data collection site). In addition, when aggregated over a large number of drivers, the vehicle-months metric closely approximates the accuracy of driving time or distance metrics. These reports provided weekly information on study progress and important feedback, which guided recruiting strategy.

Data Ingestion and Protections

Data Ingestion Process

Data ingestion involved the movement of data from the vehicle to secure storage on Coordination Contractor servers. First, data-filled solid-state drives were harvested from study vehicles by site contractor technicians when the health check indicated the drives were at 70% or more of capacity (or when a convenient opportunity otherwise arose). These drives (up to five at a time) were then physically placed into custom-designed drive bays connected to staging servers at each site contractor's facility. At that point, the staging server commenced automatic upload of the data from each inserted drive. Once a drive's data were uploaded to the staging server, the drive was provisioned so that it could be recirculated into the next vehicle needing a fresh drive at that site.

Data on the staging server were then automatically transmitted via the Internet2 high-speed research network to servers at the Coordination Contractor facility. At that time, a copy of the data was made for processing, and the original encrypted files were sent to permanent archival storage for the duration of the lifetime of the data. The copied data remained in their original encrypted state until they were queued for processing in the workflow system. At that time, the data were decrypted to perform any transformations required before loading the data set into its ultimate repository. Figure ES.7 illustrates the transfer of data from the site contractor staging servers to servers at the Coordination Contractor facility.

Data Protections

SHRP 2 data were protected from the moment they were collected and throughout their migration from the vehicle into the final research repository. In addition, data were stored "as collected" in a modern peta-scale hierarchical storage management (HSM) system where an archival copy was maintained in the HSM's tape library. The first line of protection started on the DAS with a sophisticated data encryption process. Once data were transferred, decrypted, and ingested, they were protected by role-based security. That security limited users' access based on either their Institutional Review Board (IRB) approvals—in the case of access to personally identifying information (PII)—or their need for access to data elements required to address research questions. Additionally, multiple copies of SHRP 2 data were maintained at separate facilities within the same locality, in case one facility was to suffer a disaster of any sort.

Data Quality Processes

With any study, it is imperative to not only continually monitor but also work to ensure that the data in the database are as high quality as possible in terms of completeness and accuracy. To that end, data checks were applied to ensure data were being collected appropriately and meeting the expected high level of quality. These checks are described below.

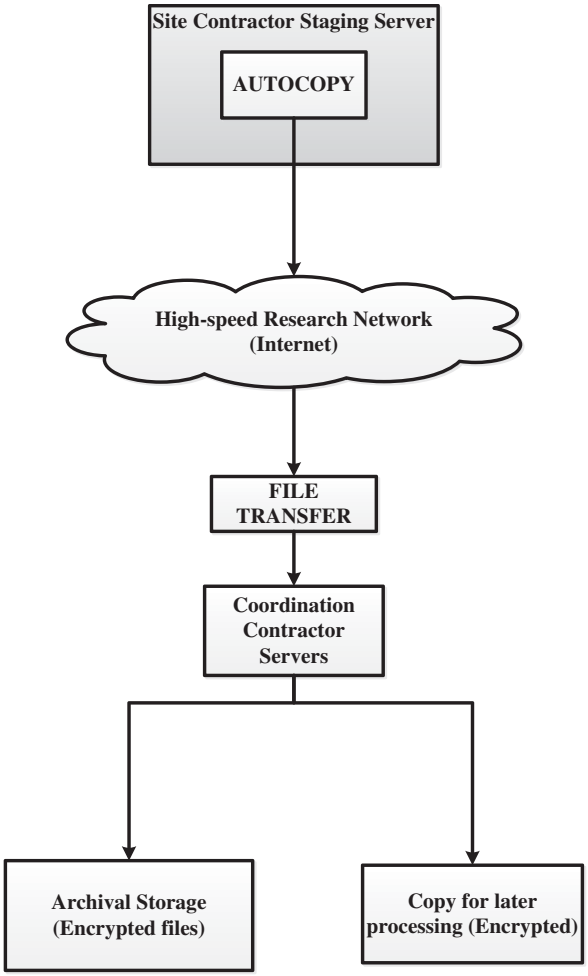


Figure ES.7. Data collection and ingestion workflow.

Sensor Data

Once ingested into the database, data underwent a standardization process and a subsequent battery of automated quality checks as follows:

- *Not present* indicates whether at least one data point was captured for a variable within a particular file. If a variable was not present for an entire file, no other checks for that variable were necessary.
- *Bounds* indicates whether the values recorded for a given variable were within the bounds defined in the relevant data dictionary available at the SHRP 2 Data Access website (https://insight.shrp2nds.us). Boundary values (i.e., lower, upper, both) could be specified independently for each variable.
- *Simple dependency* indicates whether the dependent variable (i.e., the variable being checked) should be considered of questionable quality given that a "parent" variable had failed one or more of its quality checks. These comparisons were made on a timestamp-by-timestamp basis. Each simple dependency consisted of only one dependent and one independent variable, but more than one simple dependency could be applied to a single dependent variable. For example, one of the quality metrics for the processed accelerometer values considered whether the corresponding raw values exhibited good quality during the same time period.

- *Complex dependency* is similar to a simple dependency but with more complex conditions allowed. While a simple dependency was a function of the independent variable having "good" quality when the dependent variable was collected, a complex dependency could further refine what values of the independent variable indicated "good" quality for the dependent variable. Each complex dependency consisted of only one dependent and one independent variable, but multiple complex dependencies could be applied to a single dependent variable. For example, a check for any variable collected from the vehicle network modules required that the last reported status for that module indicated a "recording" status to output a good quality score.
- *Duplicates* indicates whether a particular variable had two entries on the collected data under the same timestamp. If that was the case, the data quality for the timestamp in which this occurred was considered "bad."
- *Spike identification* indicates whether a data point that was otherwise within the expected bounds for the variable should be considered experimental noise, typically due to sensor noise. This particular check was used for longitudinal and lateral accelerations. The code examined preceding and following values around the suspected spike and assessed whether the overall pattern was feasible based on the expected physics of the scenario. Multiple metrics were used in this assessment, including the derivative of acceleration, the variance in the sample, and measures from basic principles of motion.

Video Data

Part of these subsequent analyses entailed a manual review of images transmitted via Advanced Health Checks, with an eye toward identifying specific vehicles in need of camera adjustment or replacement. Health checks were provided via periodic transmissions from the DAS to the database with an accompanying notification and included gross performance metrics related to select sensors and cameras. Table ES.2 summarizes the standards to which each camera view was held for the quality review.

Table ES.2. Camera Views—Ideal Descriptions and Purposes

Camera View	Ideal	Purpose
Face camera	Complete, clear view of the driver's face, including eyes and mouth. Camera should be positioned to exclude views of backseat passengers.	A clear view of the face facilitates eye-glance analysis and evaluation of distraction associated with secondary tasks of talking, eating, and singing.
Forward camera	High-quality, color video of the forward roadway. Forward road and traffic, traffic lights, and cars in front should be visible, with roadway centered horizontally and with the horizon just above the center line.	A clear view of the forward roadway facilitates evaluation of traffic density, visibility, road conditions, and time of day, as well as recognition of potential hazards posed by oncoming traffic and activities of drivers in surrounding vehicles.
Instrument panel	High-quality video of the distance from the driver's door to the center console, featuring a complete view of both of the driver's hands and steering wheel, radio/CD player/cigarette lighter, and center console.	A clear view of the hands and center console facilitates analysis of distractions resulting from secondary tasks such as adjusting cabin temperature or radio, using a cell phone, and reaching for objects.
Rear camera	High-quality video of the traveled roadway. Traveled roadway, following traffic, and traffic lights should be visible, with roadway centered horizontally and with horizon just above center vertically.	A clear view of the traveled roadway facilitates analysis of traffic density and potential hazards posed by following traffic.

Video data review of a sample of 10 trip files per month per participant was undertaken by a team of trained data reductionists under a protocol that elicited a quality assessment for each of the four camera views: face, forward, instrument panel, and rear. The quality assessment for each view was selected from one of four options, defined as follows:

- Good quality: Video is clear, viewable, and correctly aligned.
- Misaligned video: Video is misaligned from target (i.e., pointing in the wrong direction).
- Distorted: Video is available but not usable for research purposes.
- Not available: Video is unavailable.

Non-DAS Data

In addition to driving- and vehicle-related data collected via the installed data acquisition equipment, a variety of non-DAS data were also procured, including

- Basic demographic information;
- Functional ability relative to driving safety and risk;
- Vision tests;
- Cognitive assessments;
- Physical ability metrics;
- Vehicle information; and
- Post hoc crash investigations.

These non-DAS data were obtained through a variety of instruments, including questionnaires; assessments of physical acumen, cognitive capacity, and visual acuity; and participant interviews. Assuring the quality of the time series data and video collected via the DAS was a central focus of the overall quality efforts; but considerable effort was also devoted to assuring the quality of the many non-DAS sources of data (e.g., questionnaire and visual field data collected from each driver). Several approaches were used to identify outliers, including applying basic knowledge of the data when applicable (e.g., for male and female heights and weights). In the absence of such baseline knowledge, a statistical outliers approach was employed such that extreme values were distrusted and discarded, except when independent verification suggested otherwise. With this interquartile range (IQR) approach, any value $\leq [Q1 - (1.5 \times IQR)]$ or $\geq [Q3 + (1.5 \times IQR)]$ was considered an outlier, where Q1 = first quartile, Q3 = third quartile, and IQR = interquartile range or $(Q3 - Q1)$ for the particular variable distribution in question. When excluding extreme values, it was decided to implement methods that would tend to eliminate only the most obviously extreme values.

Study Metrics by Site

Progress at each of the six data collection sites was measured by a variety of metrics, including the number of primary and secondary participants enrolled and vehicles instrumented. Participant periods of study participation varied from as little as a single day to as long as 3 years. For the purpose of participant counts provided here, a criterion of at least 4 months has been applied.

Primary Participants

Table ES.3 presents the number of primary participants with a minimum of 4 months in the study across the six data collection sites.

Vehicle Installations

Figure ES.8 depicts the growth of the SHRP 2 fleet over the course of 38 months of data collection.

Table ES.3. Primary Participants with 4+ Months in Study

Site	Primary Participant Count
Buffalo, New York	719
Tampa, Florida	698
Seattle, Washington	676
Durham, North Carolina	504
Bloomington, Indiana	239
State College, Pennsylvania	256
Total	**3,092**

Participant-Related Outcomes

Primary Participants by Age

Figure ES.9 presents the total number of primary participants across age groups, with the horizontal line indicating the original study targets for each age group as per the original sample design.

Vehicle-Related Outcomes

Vehicles constituting the SHRP 2 fleet were further classified according to a number of parameters, including vehicle type and manufacturer.

Types

Figure ES.10 depicts the vehicle fleet by type.

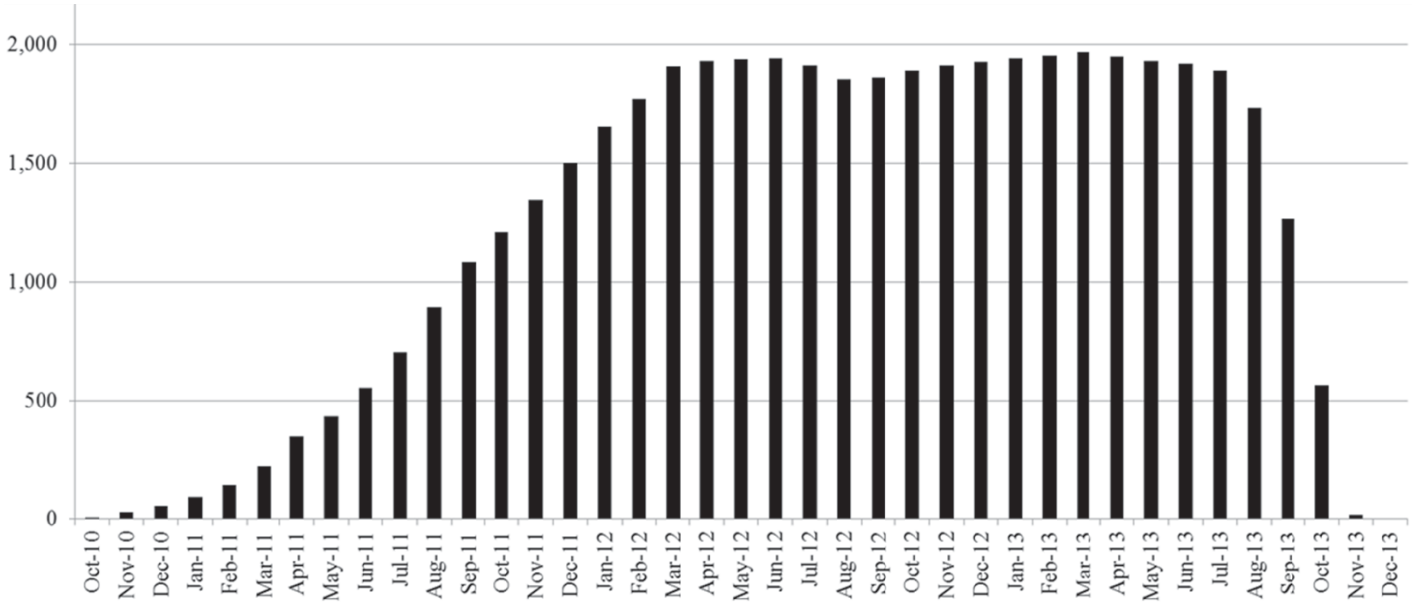


Figure ES.8. Number of installed vehicles over time.

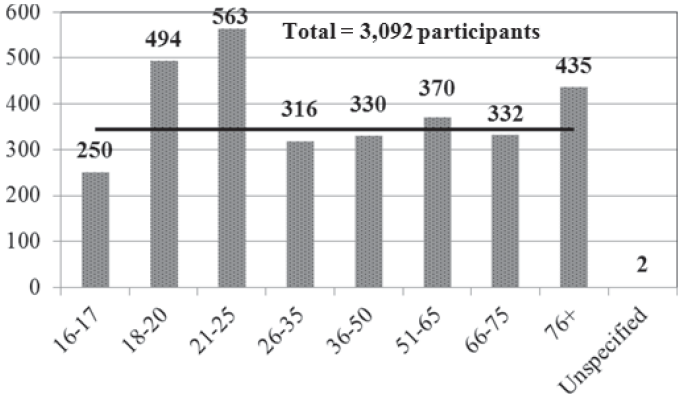


Figure ES.9. Primary participants across age groups relative to original targets (horizontal line).

Manufacturer

Figure ES.11 presents a view of the SHRP 2 vehicle fleet broken down by manufacturer.

Crashes

Five hundred thirty-two possible crash events were identified in the data set. Potential crashes were discovered via a variety of means, including participant reports, automatic crash notification (ACN) algorithms on the DAS, and similar ACN algorithms run on ingested data. Once identified as possible events, classification as actual crashes was verified via video review. Each time it was established that a potential crash had occurred, the event was assigned to one of four severity categories decreasing in severity from Level 1 to Level 4:

- Level 1: Airbag/injury/rollover, high delta-V crashes (virtually all would be police reported);
- Level 2: Police-reportable crashes (including police-reported crashes, as well as others of similar severity which were not reported);
- Level 3: Crashes involving physical contact with another object; and
- Level 4: Tire strike; low-risk crashes.

Figure ES.12 presents the number of verified crashes across severity categories. The pyramid shape is employed to reinforce the basic and fortunate truth that as crash severity increases, the

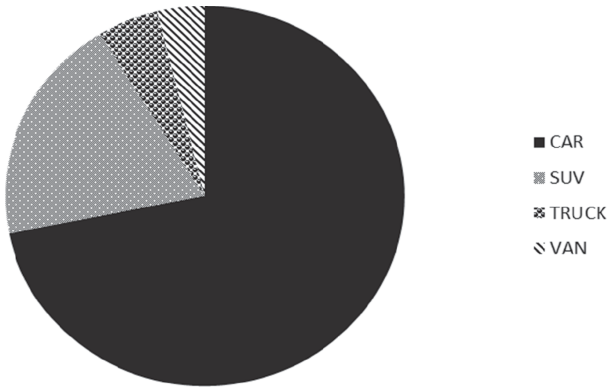


Figure ES.10. SHRP 2 vehicle fleet by type.

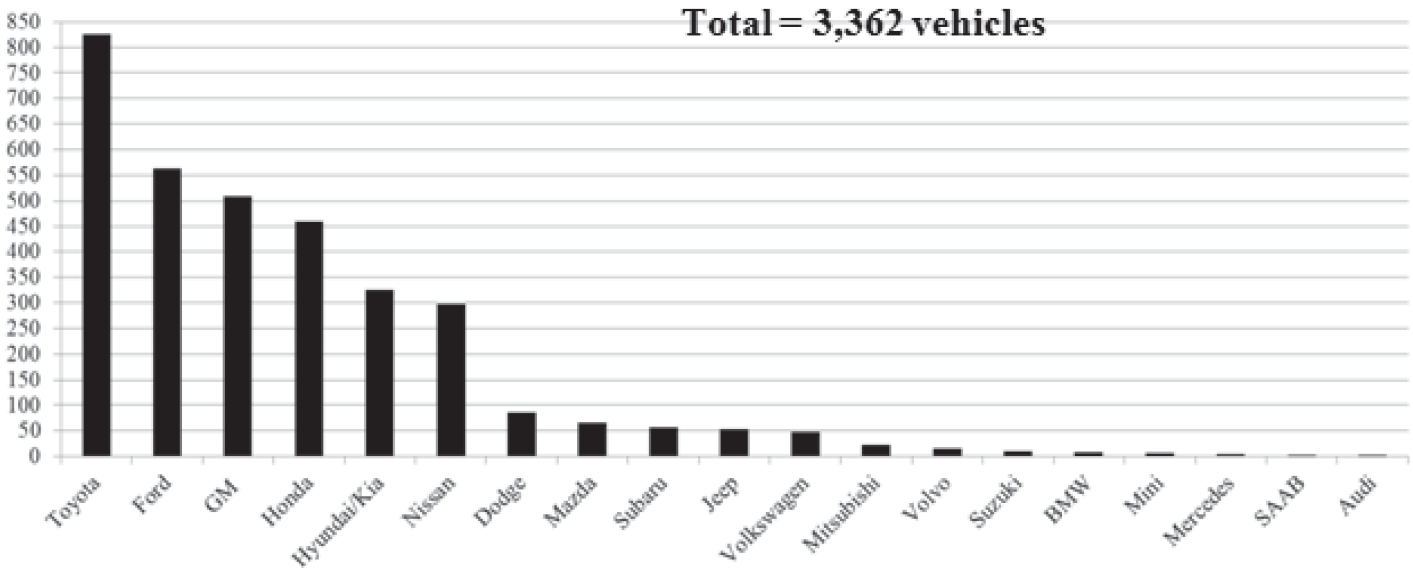


Figure ES.11. SHRP 2 fleet distribution by manufacturer.

frequency of occurrence diminishes. Thus far, more than 500 possible crashes have been identified, so the numbers in Figure ES.12 are expected to increase as the verification process continues.

Cell Phone Records Study

The Cell Phone Records Study (CPRS) was commissioned as the first follow-on to the SHRP 2 NDS. Participants were asked when exiting the driving study whether or not they would agree to participate in future studies. Those who did agree were then immediately asked if they would like to participate in the CPRS by allowing researchers access to specific aspects of their calling and texting records for the duration of their participation in the driving study. In this way, the driving and cell phone records could be more easily matched based on universal time syncs, indicating—with video verification—which trips might have included the use of cell phones. The data being collected were limited to the date, time, and duration of calls, origin of the call (participant or other), and the date, sent time, and origin of text messages (including picture or video messages, as available). In no case was the content of a call or text message captured

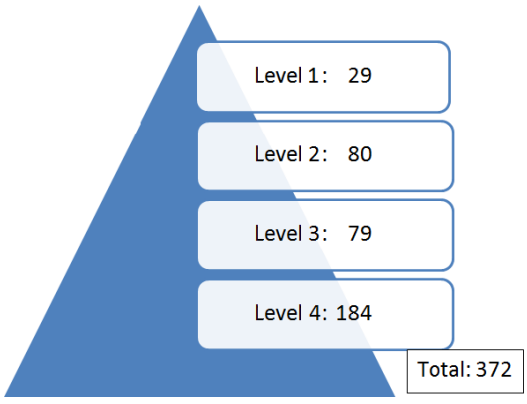


Figure ES.12. Evaluated crash events by crash severity level.

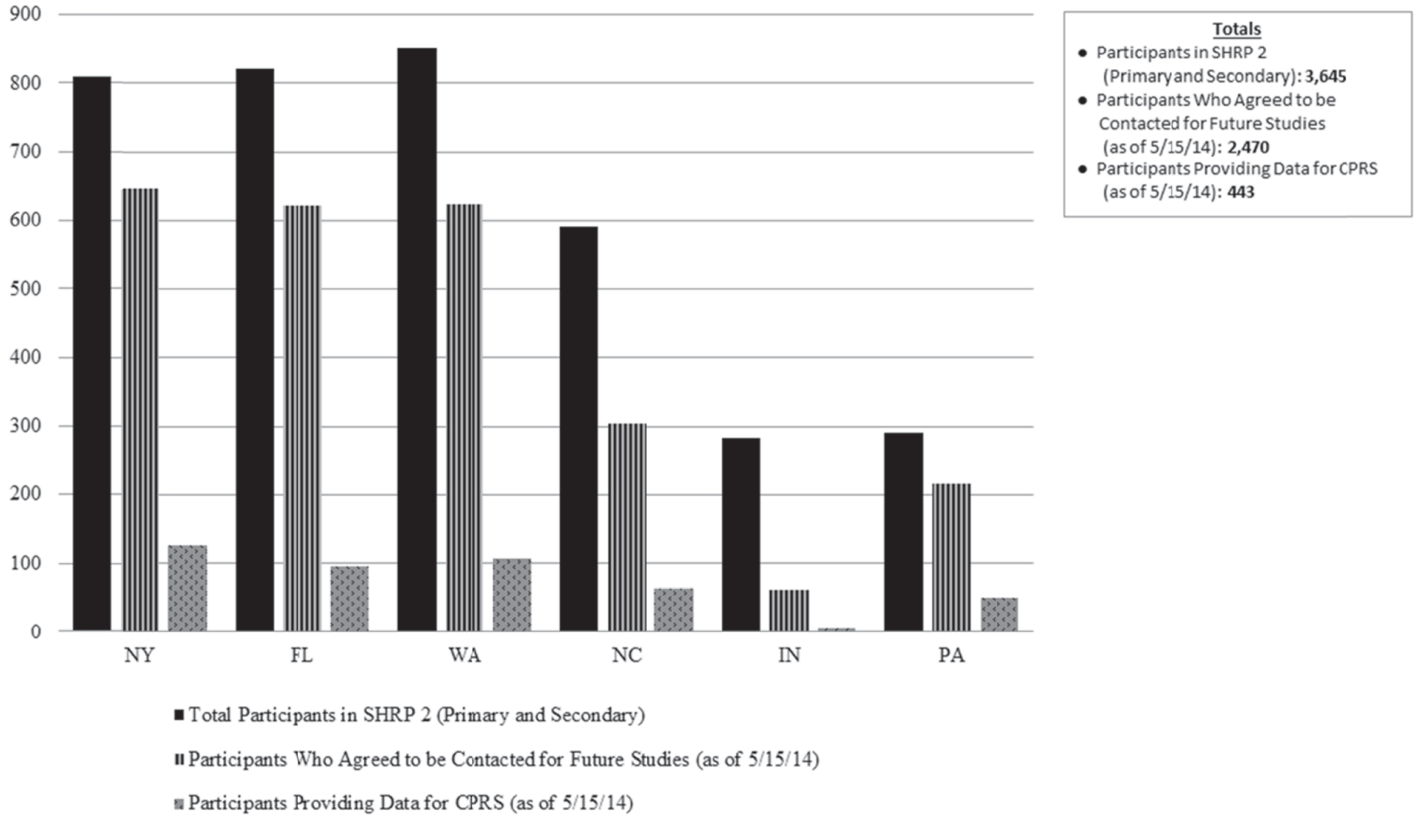


Figure ES.13. Total participants versus participants who agreed to be contacted for future studies.

(including picture or video text messages) nor was the identity or number of the other person engaged in the call with the participant.

To be eligible for the CPRS, participants had to be 18 years old or older and able to access a minimum of 3 months of their cell phone records overlapping their participation in the driving study. Use of minors in a study requires parental consent in addition to the minor's assent, both of which typically must be given in person to ensure freedom from parental coercion. The CPRS design called for consent to be provided remotely via mail. Therefore, including minors in the CPRS was deemed infeasible; however, younger participants expressing a willingness to be contacted regarding participation in follow-on studies were invited to participate once they reached the age of consent.

Figure ES.13 presents the total number of participants, both primary and secondary, versus the number of participants who agreed to be contacted for future studies and the number of participants who agreed to participate in the Cell Phone Records Study, respectively.

Conclusions

The driving study resulted in the successful collection of two petabytes of real-world driving video and sensor data from more than 3,000 participants over a 3-year period between October 2010 and December 2013. This data set includes some 50 million miles of travel and well over a million hours of naturalistic driving data. The participant pool consisted of individuals aged 16 to 98, with an approximately equal mix of males and females. The overarching goal was to collect a very large, extremely rich, and detailed store of data, which is expected to be mined and analyzed by a generation of transportation safety researchers and others attempting to answer many of the key traffic safety-related questions of today and well into the future.

Lessons Learned

The SHRP 2 NDS has already led to a number of operational observations that should prove helpful to research teams undertaking similar ventures in the future, specifically in the areas of securing necessary human subjects protections, site-based facilitation, equipment management, and participant recruitment and management.

Securing initial IRB approvals of study protocols and materials, and the approvals of subsequent amendments, took a great deal more time, money, and effort than was initially anticipated. This was greatly exacerbated by the need to deal with the sometimes differing requirements of multiple IRBs. Allocating sufficient resources to this considerable task is essential before, during, and after the data collection period. Likewise, a plan for keeping the IRB amendment process in constant motion to address unforeseen events is crucial in maintaining fluidity in the conduct of the study. In short, expect the unexpected and plan accordingly.

Adequate time must be built into the project timeline to allow for unavoidable delays in manufacturing and delivery of components as well as for equipment repairs. Likewise, adequate time and resources must be devoted to design modifications, such as the one necessitated by the addition of legacy vehicles to the vehicle fleet. Such design adjustments can result in kinks in the supply chain that appreciably impede study progress. Ideally, the entity providing oversight for the project would have a sizable inventory from which to draw and a plan for necessary repairs and modifications in advance of the commencement of installations. Once installations are under way, a real-time mechanism for monitoring activities and inventory levels at remote sites is essential to adequately provision each and respond to inevitable fluctuations in demand.

In terms of participant recruitment, researchers must be prepared to make adjustments to compensation schemes and recruitment strategies to successfully meet the challenges of recruiting for this type of study, especially if the goals include recruiting younger and older drivers or other special population subsets. The challenge of managing over 3,000 participants is by no means limited to recruitment. Managing a participant pool of this size, even employing a site-based model as was done here, requires equal measures of flexibility and creativity. Addressing problems of participant recalcitrance (i.e., not responding to repeated communications), responding to participant requests for access to some portion of their video data, and securing consent and necessary reference images (especially from secondary drivers with whom study personnel have little, if any, actual contact) are issues researchers must thoughtfully prepare to confront.

Another consideration when planning the project timeline is whether to conduct initial data analyses concurrent with data collection or after its conclusion. SHRP 2's Safety Technical Coordinating Committee authorized initial analyses before the completion of data collection and processing because sufficient time was not available for SHRP 2 to conduct any analysis otherwise. Four analysis projects were funded under SHRP 2 Project S08. While some degree of analysis is necessary to ensure proper functioning of study equipment and to assure stakeholders that suitable data are being collected, SHRP 2's experience suggests it is preferable to start providing data access for researchers only after the data set is complete. Data analysis on an incomplete and constantly changing data set is frustrating for the analyst and could possibly result in misleading conclusions. In addition, data sharing while the data set is being built is also disruptive to and inefficient for the data management process. In the end, researchers are not satisfied, the usefulness of the data is misrepresented, and database completion is delayed.

CHAPTER 1

Background and Objectives

Background

In 2005, Congress approved the second Strategic Highway Research Program (SHRP 2) to define a program of research into roadway safety and congestion. To support that program effort, it was decided that a major aspect of the Safety area of SHRP 2 would be to conduct a large-scale naturalistic driving study (NDS) that would provide unique insights into the way people drive, what else they are doing while driving, and what situations and activities precede particular crash-related event types. The goal of this unprecedented data collection effort was to create a rich data resource for researchers, regulators, advocates, students, and other interested parties all over the world to analyze and address many of the key transportation safety research questions for at least a generation to come.

In 2007, the SHRP 2 Study Design project (S05) was undertaken to plan all aspects of the SHRP 2 NDS. Its outcome was a comprehensive study plan for the SHRP 2 NDS, ranging from the development of research questions (which guided all subsequent activities) to the definition of the onboard data collection system, sampling targets, and driver assessment plans. It further addressed how the study would be managed and administered across the distributed data collection sites. Quality assurance was considered for all phases of the study, including assessing and assuring the quality of all collected data. The outcomes of this planning effort are documented in the Study Design final report, *Design of the In-Vehicle Driving Behavior and Crash Risk Study* (Antin et al. 2011).

On the heels of the Study Design project, the Virginia Tech Transportation Institute (VTTI), the Project S06 Coordination Contractor, began implementing the framework established in Antin et al. (2011) to conduct the ambitious research task of collecting, archiving, reducing, and beginning to analyze this extensive database of driving and related data. The scope of this study ranks among the largest of any driving-based research study conducted in the world to date, facilitated by recent technological advances in collecting, storing, compressing, and mining data.

This final report for Project S06 provides a summary of the oversight and coordination efforts for the SHRP 2 Naturalistic Driving Study (NDS) with special emphasis on the technical coordination and quality control. One goal of this report was to capture the key elements of the study so that it can be replicated (or improved on) if a consortium of individuals so desires in the future. Another goal was to provide sufficient details such that all researchers who desire to analyze the data will have sufficient understanding of how the data were collected to make appropriate analytical and scientific decisions during the course of their data mining/analysis efforts.

Objectives of the Technical Coordination and Quality Control Project

The Coordination Contractor was tasked with the technical coordination and quality control of the SHRP 2 NDS. The objectives of this effort entailed the following:

- Human subjects protection, including design of the IRB consent forms and application for the Certificate of Confidentiality and design of the participant enrollment protocols;
- Development of the driver assessment protocols;
- Design and development of all custom installation, alignment, and calibration hardware;
- Design and development of all custom software to support bench testing, installation, shakedown testing, maintenance, and deinstallation;
- Design and development of all custom hardware and software in support of the vehicle-based data collection;
- Design of the data management system including collection, encryption, staging, transmission, security, storage, and quality assurance; and
- Design of the inventory management software and protocols.

In addition to these objectives, the overarching task was to coordinate and oversee the participant- and vehicle-based operations at each of the six data collection sites. The desired results included the collection of valid participant, vehicle, driving, and crash-related data collected via interviews and questionnaires as well as from continuous onboard sensors and video cameras. The collected data had to be stored securely in a manner that protected the rights and privacy of the more than 3,000 participants enrolled in the study.

This study involved a wide range of activities, including the coincident design and purchase of the onboard data acquisition system (DAS) equipment (actually procured under Project S12A, DAS Procurement). The major efforts fell into six key task categories described below.

Human Subjects Protection

Efforts to coordinate the human subjects protection and IRB requirements of multiple IRBs began a full 2 years before the first NDS study vehicle was installed. Throughout the SHRP 2 NDS, the task of protecting participants and their data has remained among the most critical. The study sponsor and all contractors were fully committed to protecting the data and identity of study volunteers and to treating them in a manner that complies fully with the requirements of the Virginia Tech and National Academy of Sciences (NAS) IRB policies and procedures. Further, these policies were drawn directly from the Code of Federal Regulations, Title 45 Public Welfare, Department of Health and Human Services, Part 46, Protection of Human Subjects (45 CFR 46), widely regarded as the gold standard of guiding principles in human subjects research.

In addition, issuance of a Certificate of Confidentiality was initiated through the National Institutes of Health (NIH). The Certificate of Confidentiality served to protect participants from forced disclosure requests originating in the legal arena, such as subpoenas, that might seek identifying information or data to be used against them in a court of law. This certificate protects the identity of the participant, and thus the identifying research information and data collected during the term of the Certificate of Confidentiality; however, the identity of consented participants is intended to be protected in perpetuity.

Data Categories

To fulfill the goals of this study, several categories of data were collected, each encompassing from several to many individual data items. These categories are described below at a high level; details on each category and individual data element can be found in the Data Dictionaries located on the SHRP 2 Data Access website (https://insight.shrp2nds.us). As of December 20, 2013, registration was required to access the site; there is no cost associated with the registration.

DAS Data

The DAS collected time series sensor data from a suite of integrated sensors and cameras as listed below. Note that each stream of data was collected at its own native frequency, and these details can be found in the Time Series Data Dictionary in the SHRP 2 Data Access website (https://insight.shrp2nds.us).

- Multiple video views:
  - Forward roadway, driver's face and upper torso, driver interactions with wheel and center stack, and rear and right of the vehicle;
- Periodic still photo of cabin (permanently blurred);
- Machine-vision-based applications:
  - Head pose monitor, and
  - Lane tracker;
- Accelerometers (*x*, *y*, and *z* axes);
- Rate sensors (*x*, *y*, and *z* axes);
- GPS:
  - Latitude, longitude, elevation, time, velocity;
- Forward radar:
  - X and Y positions, and
  - Xdot and Ydot velocities;
- Illuminance sensor;
- Passive cabin alcohol presence sensor;
- Incident pushbutton:
  - Marks data and opens a 30-s audio recording channel;
- Turn signals; and
- Vehicle network data (as available; examples listed below):
  - Accelerator,
  - Brake pedal activation,
  - Antilock braking system (ABS),
  - Gear position,
  - Steering wheel angle,
  - Speed,
  - Horn,
  - Seat belt information, and
  - Airbag deployment.

Demographics

A variety of basic demographics data were collected from each participant during the screening and enrollment processes. Examples include birth date, gender, marital status, and profession. Additional information was gathered regarding other members of the household, vehicle counts, and licensure information.

Driver Assessments

Participants were evaluated along several dimensions of functional ability relevant for driving safety and risk. In this way,

researchers can correlate any one or more scores on these metrics of functional ability to the safety-related or other outcomes observed in the naturalistic driving record. The entire suite of assessments was designed to be precisely replicable across the six data collection sites and to be conducted within a 2-hour window, coinciding with vehicle installation. Questionnaires could be filled in at the installation site or later, as per the participant's needs; paper versions were also available if requested by a participant. Assessment protocols are detailed in Appendix A.

Questionnaires were used to assess sleep, health, Attention Deficit Hyperactivity Disorder (ADHD), sensation seeking, risk perception and behaviors, and driving knowledge and behaviors (Table 1.1). A complete listing of every item on every questionnaire can be found in the Data Dictionaries (https://insight.shrp2nds.us). Other assessments included a wide range of vision tests conducted using an Optec 6500P Vision Analyzer (Table 1.2) and metrics of cognitive functioning (Table 1.3). Finally, Table 1.4 lists the tests of physical ability intended to serve as very gross metrics of upper- and lower-body strength and capability.

Upon exiting the study, participants were given the opportunity to express their feelings about their experiences during the study by completing an Exit Survey (Appendix X).

Table 1.1. Assessment Questionnaires Administered

Name	Description
Sleep Questionnaire	A questionnaire designed to determine the participant's sleeping patterns, habits, and level of fatigue (Appendix B).
Perception of Risk Survey and Frequency of Risky Behavior Questionnaires	A questionnaire designed to gauge the participant's perception of dangerous or unsafe driving behaviors or scenarios and a questionnaire designed to gauge the frequency and a participant's willingness to engage in dangerous, unsafe, or risky behaviors (Appendix C).
Barkley's ADHD Quick Screen	A short, clinical ADHD screening assessment. This screening instrument operationalizes ADHD symptoms in terms of specific behaviors (Appendix D).
Sensation Seeking Scale	A survey comprising questions to gauge the degree to which the participant engages in sensation seeking behavior. The test measures the participant's sensory stimulation preferences (Appendix E).
Driving Knowledge	A test of knowledge of driving laws and appropriate behaviors (Appendix F).
Medical Conditions and Medications Survey and Exit Survey	Questionnaires designed to obtain participants' self-reported medical history. The questions focus on the identification of conditions that could affect driving performance and safety (Appendix G).
Modified Manchester Driver Behavior	A self-reported driver behavior survey. The participant is asked to indicate how often he/she commits each described error (accidental) or violation (deliberate) (Appendix H).

Table 1.2. Vision Tests

Near/Far	Visual Ability	Monocular/ Binocular	Day/ Night	Glare/ No Glare
Far	Acuity	Binocular	Day	
Near	Acuity	Binocular	Day	
	Contrast sensitivity	Monocular	Day	
	Contrast sensitivity	Monocular	Night	Glare
	Contrast sensitivity	Monocular	Night	No Glare
	Depth perception	Binocular		
	Color perception	Binocular		
	Peripheral vision	Monocular		

Vehicle Information

In addition to make, model, year, and vehicle category (i.e., car, van, sport utility vehicle, or truck), the presence of integrated onboard technologies was recorded, including communications features such as Bluetooth cell phone and OnStar.

Post Hoc Crash Investigations

One of the primary motivations for this study was that it would afford the opportunity to record and observe actual crash-related events (i.e., crashes and near crashes) from multiple perspectives, including the participant's behaviors leading up to the event, and with high temporal resolution kinematics information synchronized with the video images.

In addition to all of these DAS-based crash data, site contractors also performed more traditional post hoc crash analyses for some of the most salient crashes. In most cases, site contractors were informed by the participant that a crash had taken place, though the timing of such notifications relative to the crash event varied widely. A rubric or guide was created by the Coordination Contractor to help site contractors determine for each crash of which they were aware whether or not to conduct a post hoc investigation, and, if so, whether to conduct a Level 1 or Level 2 investigation. The rubric incorporated

Table 1.3. Cognitive Assessments

Assessment	Type	Description
Clock drawing test	Dementia screen	The participant is presented with pencil and paper; on the paper is a circle and nothing else. The participant is asked to draw numbers in the circle to make the circle look like the face of a clock and then draw the hands of the clock to read "10 after 11."
Conners' Continuous Performance Test Version 5 (CPT II)	Executive function	The CPT II is a task-oriented computerized assessment of attention disorders and neurological functioning. Results indicate the likelihood that an individual has an attention disorder.
Visualizing missing information—Motor-Free Visual Perception Test	Visual-cognitive	Participants are shown a reference image and four similar but incomplete figures. Participants are instructed to indicate which incomplete figure could be completed to duplicate the target figure; only one of the incomplete figures can be completed in such a way as to form an exact duplicate of the target figure.
Visual information processing speed—Useful Field of View (UFOV)	Visual-cognitive	Participants are briefly presented one of two very similar target stimuli (truck or car icon that differed only slightly) in the center of the display. Simultaneously, a second target icon—the same as the central target—is presented in one of eight possible peripheral locations at varying eccentricities in a 35-degree region around the central visual field. Participants have to identify both what the central target is and the location of the peripheral target. The presentation duration of the stimulus display is dynamically varied up or down until the participant reaches a 75% correct response accuracy. Presentation time is recorded.
Trail making (Parts A and B)	Visual-cognitive	In Part A, participants use a touch screen to connect in order (i.e., 1-2- … *n*) a series of randomly arranged numbers, then in Part B they connect a series of randomly arranged numbers and letters in alternating progressing sequences (i.e., 1-A-2-B-3 … *n*). Time-to-completion of the entire series is recorded.

factors related to crash severity (i.e., injuries, speed, and property damage), roadway factors, driver age, and driver condition (e.g., drowsy, emotional, focused).

A *Level 1 post hoc crash investigation* involved the collection of as much data about a crash as could be accomplished without having an investigator visit the actual site of the crash. Such data included, as available, a police accident report, redacted to remove any personally identifying information; publicly available images of the site of the crash (e.g., from Google Earth); photos of the participant's post-crash vehicle, obtained during retrieval of the data drive; and a phone interview of the participant. Items in the phone interview (Appendix I) were modeled after data items collected in the National Highway Traffic Safety Administration's National Motor Vehicle Crash Causation Survey (NMVCCS). These interview questions were delivered electronically with branching functionality incorporated. Only the relevant portions were visible to the person submitting information.

A *Level 2 post hoc crash investigation* included everything involved in a Level 1 analysis; in addition, it involved visiting the site of the crash to document it photographically and to construct a crash site diagram using specialized software. This same software package was also used to collect all of the Level 1 or 2 post hoc crash data for a crash in a single PDF file. Note that active crash scenes (i.e., with vehicles still at final rest and emergency personnel on site) were never visited as a part of any SHRP 2 post hoc crash investigation.

Table 1.4. Physical Ability Metrics

Assessment	Body Area	Description
Grip strength	Upper body	Left- and right-hand grip strength measurement is conducted using the Jamar Hydraulic Hand Dynamometer.
Rapid pace walk	Lower body	Participant is asked to walk as quickly as possible, without tripping or falling, 10 feet, then the same 10 feet back to the starting point.

DAS Management

The management of the DAS involved procurement and acceptance testing, as well as distribution and warranty/repair efforts throughout the course of the study. This entailed ensuring that the equipment was purchased and inventoried in a manner compliant with federal regulations and contractual obligations. Further, it required ensuring that equipment was built to rigid performance specifications and repaired as needed. Acceptance testing was performed at both the component level and in the context of a full system before being

released for use as a field-ready system. In addition, constrained DAS resources had to be continually redistributed across the site contractor, manufacturer, and Coordination Contractor sites in a manner that maintained sufficient working stock for each planned installation and maintenance.

System Integration

Due to the complex interaction among the DAS, related software, and the SHRP 2 NDS database, a series of integration efforts were prepared and monitored throughout the study to assess all aspects of data collection, including participant-based information and data, vehicle-based information and data, and DAS functionality. These integration efforts required that security protocols be implemented in such a way that, if data or information were lost, no personally identifying information would be compromised. Vehicle-based data were encrypted to prevent the unintended release of such information. System integration efforts were also employed to ensure the healthy functioning of the DAS, relying on a series of routinely and remotely administered automated "health" checks to monitor DAS performance.

Supporting Activities for the Site Contractor Efforts

The objective of supporting activities for the site contractors was to provide sufficient operational infrastructure and equipment so that high-quality data could be collected in a consistent manner across the six different data collection sites, each operated by a different contractor (though the Erie County, New York, site contractor did oversee operations at both the New York and Florida sites at a high level). To this end, procurement of all study-related hardware and software was conducted by the Coordination Contractor who provided it to the site contractors. This effort included the development or procurement of vision and grip strength testers; over 45 laptop and desktop computers; custom-built DAS installation, calibration, and alignment tools; and custom software.

Quality Control and Oversight

An essential requirement for the conduct of the SHRP 2 NDS included elements of quality control and structured oversight. To meet this contract deliverable, the Coordination Contractor routinely tested data elements from participant-, vehicle-, and DAS-based perspectives, applying both manual and automated processes to sampled data files. A sampling of vehicle metric variable quality is shown in Table 1.5.

In addition to automated and manual quality checks of DAS-generated sensor and video data on an ongoing basis, the Coordination Contractor checked and validated the presence and quality of nonsensor/nondriving data. These included demographics, driver functional assessments, vehicle features, and post hoc crash investigations data. Outliers were identified, and validation was requested from the site contractors or data were flagged as anomalous.

Table 1.5. Quality Assessment of Select Vehicle Metrics (7/15/2013)

Data Item	Good Quality (%)
NETWORK SPEED	97.35
ACCELERATOR Position	97.65
TURN SIGNAL Status	94.29
BRAKE PEDAL	96.15
Usable FACE video (i.e., >80% per vehicle)	99.08
Usable FORWARD video (i.e., >80% for car)	97.61
Usable REAR video (i.e., >80% per vehicle)	94.07
Usable LAP video (i.e., >80% per vehicle)	99.26
Usable IMU (acceleration, *x*-axis)	99.27
Usable GPS (speed only)	96.06

Reporting

A required component of the Coordination Contractor's role included reporting on an array of project activities. A wide variety of reports was generated by the Coordination Contractor on weekly, monthly, or quarterly bases; many were produced on an ad hoc basis. These reports provided crucial information on the current and projected status of key study metrics, which helped study leaders guide the progress of the study toward its ultimate goals.

Early in the study, reports focused on administrative efforts and the procurement and provision of equipment. Once inventory supplies met demand, ad hoc reports refocused on data quality, sample design, and the volume of data being collected and processed.

Project Management

Overall guidance of the SHRP 2 Safety program was the responsibility of the Safety Technical Coordinating Committee (TCC) composed of volunteer experts. All aspects of the SHRP 2 Safety program were reviewed and approved by the Safety TCC, and the committee met biannually to review progress and approve any program modifications. The Safety TCC was assisted by Expert Task Groups that developed requests for proposals

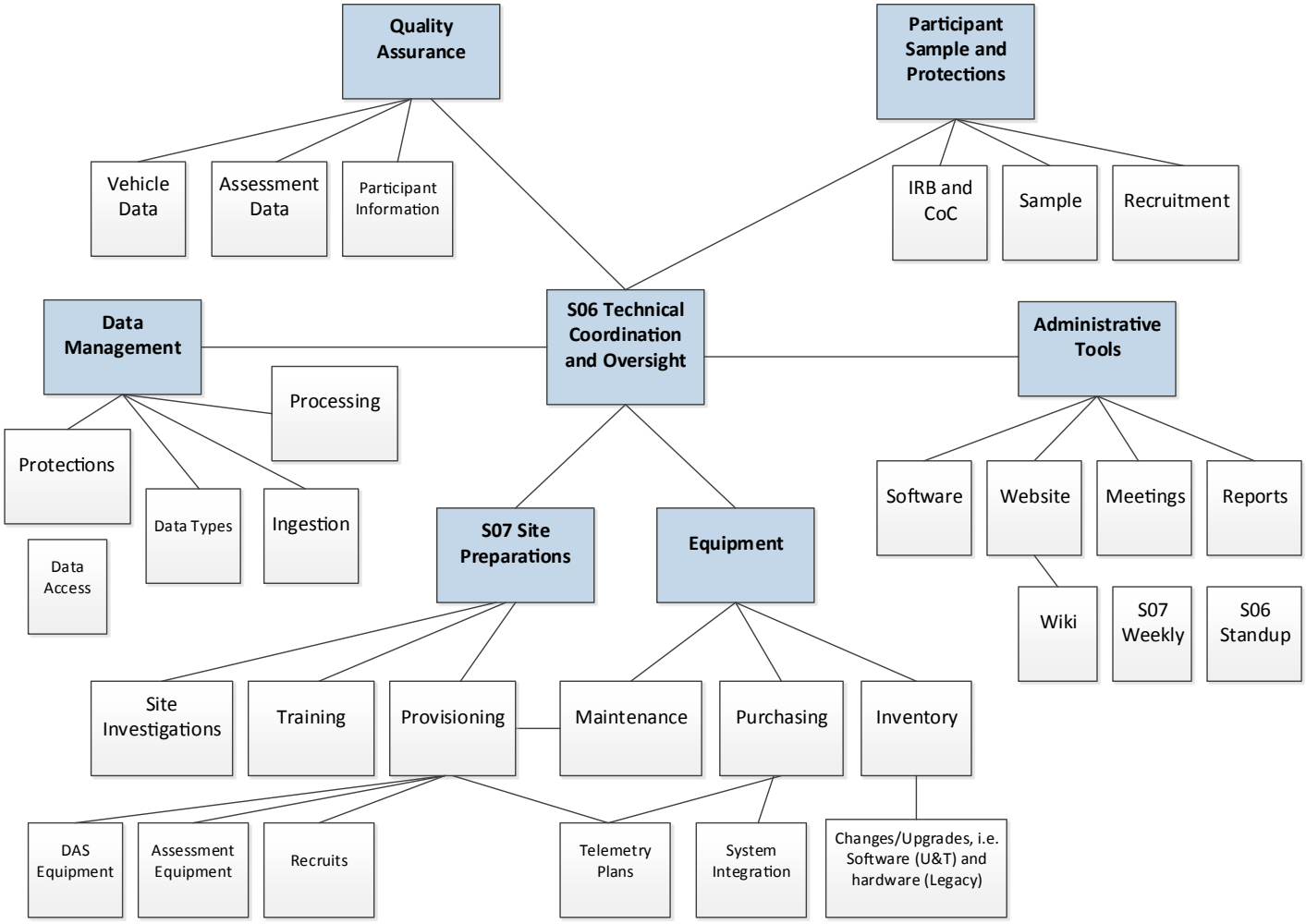


Figure 1.1. Visualization of project.

(RFPs), proposals, and recommended contractors and provided expert guidance on many issues such as data access policies and procedures. SHRP 2 staff were responsible for communicating all committee directions to the Coordination Contractor and monitoring contract activities.

Visualization of Project and Report Layout

This report maps the key objectives described previously to the generalized project phases bulleted below. Then, summaries of outcomes, lessons learned, and future research implications follow.

- Preparation;
- Data collection;
- Data management and processing; and
- Cell phone records (stand-alone task).

The preparation phase describes those activities that had to be accomplished before the start of data collection from both a studywide perspective and in terms of the readiness of each individual site. The data collection phase describes the period that began on October 26, 2010, when the first vehicle was installed by the site contractor in Erie County, New York. However, preparation activities continued well into the early months of 2011, when the last data collection site began installing vehicles. The data management and processing phase describes the data collected and what processes were used to collect, secure, and protect the data and to assess their quality.

The cell phone records chapter of this document describes the stand-alone project managed by the Coordination Contractor with cooperation from the site contractors. This task provided a valuable resource for researchers to answer research questions related to the participants' use of cell phones while driving.

Figure 1.1 illustrates the areas of NDS study importance.

CHAPTER 2

Study Preparations

Human Subjects Protections

In the United States, the use of humans in research is covered by the Code of Federal Regulations (45 CFR 46). These regulations nominally apply to the Department of Health and Human Services, but several other departments and agencies have adopted the same regulations through a mechanism known as the *Common Rule.* The U.S. Department of Transportation is among those departments adopting the Common Rule. The backbone of 45 CFR 46 is the concept of *informed consent,* namely that participants must be informed of study details including protocols, risks, benefits, and the steps taken to ensure confidentiality of participant data. Participants must also be informed that their participation is voluntary and that they may discontinue it at any time for any reason. Special protections are required for minors (children) who participate in research. Minors typically provide *assent,* as they are legally incapable of providing *consent.* Thus, in addition to the minor's assent, his or her parent or legal guardian must also provide consent before the minor is allowed to participate. Summarizing, study personnel must obtain *informed consent* from each participant before enrolling him or her into the study. In the U.S., human subjects research is reviewed by Institutional Review Boards as described below.

All human subjects research conducted under the SHRP 2 NDS projects was reviewed by several IRBs to ensure compliance with 45 CFR 46. After the site contractors were selected, a meeting was held at the Keck Center in Washington, D.C., on July 9, 2009, with IRB representatives from all sites invited (eight IRBs were represented at this meeting, including the Virginia Tech and NAS IRBs). All attendees had access to a draft consent form before the meeting. This form was nearly identical to one used in a pilot study conducted during the study design phase of the SHRP 2 NDS. The meeting began with a SHRP 2 NDS overview, followed by a VTTI overview of previous naturalistic driving studies and the IRB/human subjects issues encountered in those studies. This meeting resulted in several conclusions and recommendations:

- The consent form was missing information and should be expanded.
  - Every person who reviewed the form added information but did not delete an equal amount of information from other areas.
- The consent form was too long and should be simplified and shortened. Due to the inherent conflict with the first point, the group then came to consensus on the following recommendations:
  - An abbreviated information sheet should be prepared to highlight the key points of the consent form.
  - A brief video should be created to explain the key points of the study and of the consent form.
  - All consent materials (including the video and information sheet) should be available for review on the SHRP 2 Participant Portal website before the participant goes in for formal enrollment.
  - A frequently-asked-questions (FAQ) format should be used to organize the consent forms.
- A consistent policy should be developed for handling data obtained from unconsented drivers of study vehicles.
- A method should be developed for communicating concerns, issues, adverse events, and complaints across sites to SHRP 2 staff and Coordination Contractor staff in a timely fashion.
- Consent forms should be as consistent as possible across sites, differing only in site-specific information and, as necessary, due to site-specific IRB requirements.
- Participants should be strongly warned against crossing international borders (and other places where cameras are not allowed) in the study vehicle.
- Site IRBs should have the option of signing a letter of reliance with the Virginia Tech IRB.
  - The Virginia Tech IRB agreed to this arrangement.

The next several months were spent ironing out the details of the consent forms, research protocol, policies, and procedures to the satisfaction of the various IRBs. The Erie County, New York (CUBRC), and Durham, North Carolina (Westat), sites agreed to formally rely on the Virginia Tech IRB, while the other sites decided to retain local IRB control. The NAS IRB also decided that it would need to review all materials and amendments and to provide continuing review on an annual basis. The protocol underwent full board review at all sites due to the study's high profile (given the thousands of participants located across the United States) and the plan to include minors. Materials were initially submitted to the Virginia Tech IRB on February 23, 2009, and went through three rounds of full board review before being granted approval on May 6, 2010. The approved materials were then sent to the NAS IRB and to the four site IRBs not relying on the Virginia Tech IRB.

These submissions resulted in additional requests for changes, which resulted in four amendments to the Virginia Tech IRB protocol before any of the other four sites granted approval. These amendments were concerned with clarifying the processes by which secondary drivers would be recruited, specifying that data from unconsented drivers would be expunged, and modifying the Certificate of Confidentiality language per request from the National Institute of Mental Health (NIMH), as discussed further below. By October 14, 2010, the NAS and Virginia Tech IRBs had granted study approval, and NIMH had granted the Certificate of Confidentiality, thus allowing installations to begin at the Erie County, New York, and Durham, North Carolina, sites.

The other four sites continued to respond to their IRBs' concerns, resulting in an additional two amendments before all sites had approval (all sites were approved and recruiting participants by June 2011). These additional amendments clarified the withdrawal/dismissal protocol, expanded recruitment methods, allowed semiannual drawings for prizes for all enrolled participants (disallowed by the Seattle, Washington, site due to conflict with state law), and created a mechanism for including leased vehicles in the study.

Categories of Participants

Two types of participants were identified. *Primary drivers* were the main focus of the study. They (or, in the case of minors, their parents) owned, co-owned, or leased the vehicle to be instrumented, and they provided explicit permission for data to be captured whenever the vehicle was driven. Alternatively, if the primary participant did not own the vehicle to be instrumented, he or she must have been the primary driver of that vehicle and have obtained the written permission of the vehicle's owner or lessee. In this case, it was the vehicle owner who provided explicit permission for data to be captured whenever the vehicle was driven. Primary driver participants underwent a full suite of driver functional assessments, provided permission for their identifiable and deidentified data to be used for research purposes, and were compensated for their participation in the study. Either the primary driver or the vehicle's owner/lessee (where these were different individuals) could independently withdraw the vehicle from the study.

Secondary drivers were those who regularly drove the instrumented vehicle of a primary driver. They were initially informed about the study by the primary driver and were given the opportunity to have their identifiable data included in the database by going through a consent process and filling in the demographic survey and driving history questionnaire. These drivers received a small amount of compensation for their role in the study.

A waiver of consent was granted by the IRBs such that the DAS could collect data whenever the vehicle was driven, with the understanding that data collected from unconsented drivers would be expunged from the data set as soon as it was definitively determined that the driver within a particular trip file was neither a consented primary nor a consented secondary driver.

While secondary drivers or other nonconsented drivers could not withdraw the vehicle from the study, every effort was made to design the study so that others who drove the vehicle on a regular basis were neither encouraged nor discouraged from granting consent. They were merely given the opportunity to do so.

Site-Specific Informed Consent

The initial study design called for participants to enroll for either 1 or 2 years. The initially intended enrollment period was later made more flexible, allowing participants more enrollment period options and the opportunity to extend current enrollment periods beyond their originally planned dates of exit. With the two study enrollment periods, six sites, and four types of consent/assent/permission forms (i.e., adult primary participants, adult secondary participants, minor primary participants, and parental permission), there were initially 48 forms to review and reconcile, each 15–16 pages in length. The goal was to have the forms be identical except for site-specific information (local phone numbers, local principal investigator (PI), and IRB names and contact information). VTTI IRB personnel conducted a consistency check for each amendment across all forms. After the forms were reconciled and approved by the various IRBs, they were saved in PDF format with a watermark to prevent tampering and placed on the SHRP 2 NDS Participant Portal website. Appendices J and K include the final consent forms related to primary drivers and secondary drivers, respectively. The Buffalo site is used in each example.

Informed Consent Video

As part of the site preparations, the Coordination Contractor developed a brief video discussing and illustrating study details and informed consent procedures and implications. The video was about 10 minutes in duration and was available for viewing on the SHRP 2 NDS Participant Portal website (http://www.shrp2nds.us/informed-consent.html). Each site was also provided with a copy on DVD for local use, and participants were encouraged to watch the video as part of the consent process. Given that the final consent forms were typically 15–16 pages long, the video was seen as a way to make the consent process and study details easier to understand.

One-Page Information Sheet

One-page information sheets were developed in an additional effort to make the consent process and study details easier to understand. These sheets encapsulated the study description, vehicle instrumentation, risk, data security and confidentiality, study procedures, and compensation aspects of the study. One of these "one pagers" was aimed at adult participants and a separate one was developed for minors, as it included information about the parental permission process. Both versions were available on the SHRP 2 NDS Participant Portal website and are appended to this document in Appendices L and M, respectively.

Minor Assent Confirmation

As noted above, minors provided assent for their participation. However, as it was possible that a minor could have been coerced into assenting, an important part of the minor assent process was to confirm—outside of the presence of the consenting adult—that the teen's assent was being freely offered without reservation. If not, then the would-be participant was politely dismissed in a way that deflected attention from the teen (i.e., the site manager indicated that there was an incompatibility between the vehicle and study equipment and offered the parent and teen nominal compensation for their inconvenience). Appendices N and O include the final assent and parental consent forms related to primary drivers and secondary drivers. The Buffalo site is used in each example.

Certificate of Confidentiality

A Certificate of Confidentiality was secured from the NIMH for the SHRP 2 NDS for the duration of the data collection process. A Certificate of Confidentiality helps researchers protect the privacy of participant information and data against compulsory legal demands (e.g., court orders and subpoenas) that seek the names or other identifying characteristics of a research subject. The certificate covers the collection of sensitive research information for a defined time period; however, the personally identifiable information obtained about subjects enrolled while the certificate is in effect is protected in perpetuity.

Compensation Scheme

The initial compensation scheme was as follows (several modifications to this scheme were implemented in later amendments, which are listed within the relevant consent/assent forms in Appendices J, K, and N with final compensation schemes described in later chapters of this report):

- Primary drivers enrolled for 1 year were compensated at $300 per year, paid in three installments (increased to $500 per year beginning summer 2011).
- Primary drivers enrolled for 2 years were compensated at $300 per year, $600 total (increased to $500 per year, $1,000 total beginning summer 2011).
- Secondary drivers initially received no compensation.

DAS Design and Procurement

The DAS design specifications were set forth as part of the Study Design project. During the final design phase, the selection process for a contract manufacturer (CM) to build the printed circuit boards (PCBs) and carry out final assembly began. A parallel effort began to select vendors to manufacture the custom cables and custom plastics (primarily enclosures and mounts). Integrated system components such as cameras and the radar were purchased separately, as necessitated by design details.

Design of the DAS

The system-level design was done by the Coordination Contractor based on the specifications outlined in the Study Design project, as there was not a suitable off-the-shelf data collection system available. To comply with the requirements for the categories of in-vehicle performance, ease of handling, and ease of installation, the DAS for the SHRP 2 NDS was a comprehensive custom design. The initial process included the following steps:

- Develop a list of data elements to be collected in the SHRP 2 NDS, which minimally included
  - Multiple video views:
    - Forward roadway, driver's face and upper torso, driver interactions with wheel and center stack, and the rear and right of the vehicle;
  - Occasional still photos of cabin (permanently blurred);

  - Machine-vision-based applications:
    - Head pose monitor, and
    - Lane tracker;
  - Accelerometers (*x*, *y*, and *z* axes);
  - Rate sensors (*x*, *y*, and *z* axes);
  - GPS:
    - Latitude, longitude, elevation, time, velocity;
  - Forward radar:
    - X and Y positions, and
    - Xdot and Ydot velocities;
  - Illuminance sensor;
  - Passive cabin alcohol presence sensor;
  - Incident pushbutton:
    - Marks data and opens a 30-s audio recording channel;
  - Turn signals;
  - Vehicle network data (as available; examples listed below):
    - Accelerator,
    - Brake pedal activation,
    - Antilock braking system (ABS),
    - Gear position,
    - Steering wheel angle,
    - Speed,
    - Horn,
    - Seat belt information, and
    - Airbag deployment;
- Define procedures required to change instrumentation midstudy; and
- Assess trade-offs.

Consequently, the procurement process focused on finding manufacturing partners that had the capabilities and experience to manufacture electronic boards and to build and fully test final electronic assemblies rather than selecting vendors with similar hard goods that met the design specifications.

While the primary design of the main data collection unit (the NextGen main unit) was contracted to an external contractor, the remainder of the system and component design was carried out by Coordination Contractor personnel.

The DAS incorporated six primary components: NextGen main unit, head unit, network box, radar, radar interface box (RIB), and solid-state data drive. The NextGen main unit was the computing source for the system, the electronics for which were encased in a rugged plastic enclosure with room for the solid-state drive. As shown in Figure 2.1, the NextGen was to be mounted in an out-of-the-way location in the vehicle—such that it would not take up too much space (e.g., mounted in the trunk on the underside of the rear parcel shelf)—but also in a manner which facilitated the maintenance and drive-swapping activities performed by site contractors, when necessary. Often, the location was under or behind the driver's seat or in the trunk. The head unit was mounted to the windshield in the vicinity of the rear view mirror and featured a smaller subhead arm. The radar was mounted to the front license plate frame and was the most vulnerable component. The RIB was located under the hood of the vehicle and used Bluetooth technology to communicate with the NextGen. The network box was used to gather information from the vehicle network.

Procurement Strategy

As is standard practice for custom designs, vendors had to be selected for the construction of different components and for

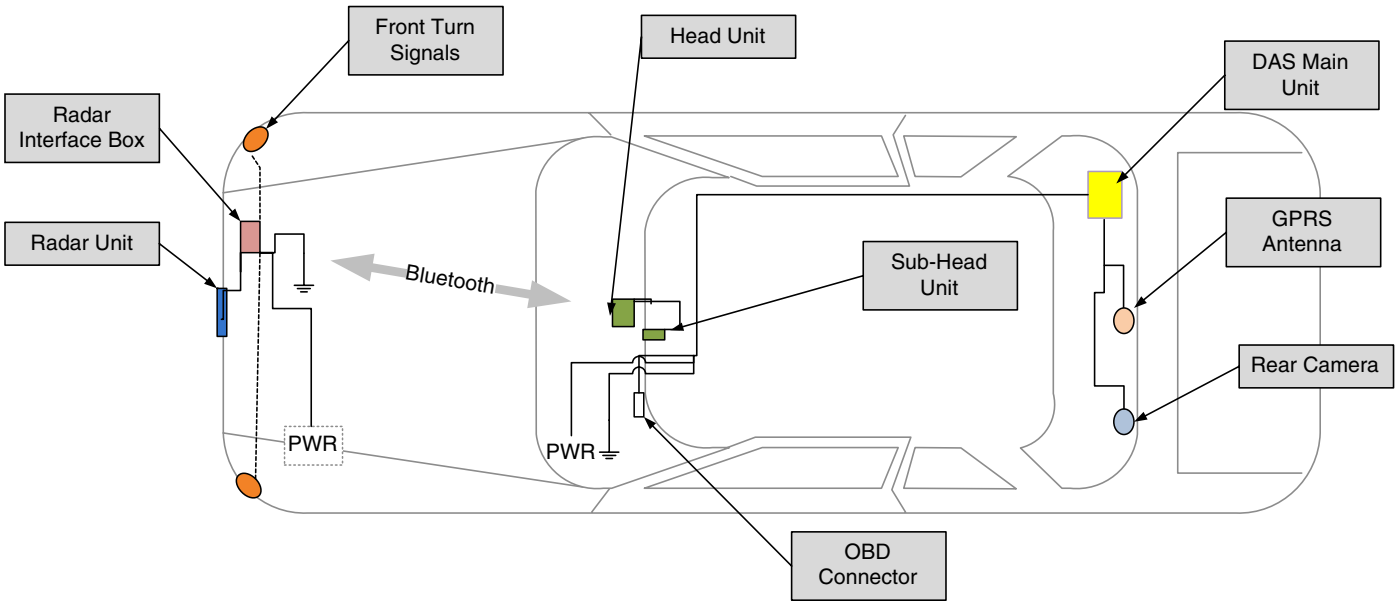


Figure 2.1. Installed DAS schematic.

system assembly. The primary selection was for a CM to produce the PCB assemblies and to perform assembly and test procedures for individual system components along with the full system. An RFP was issued to select a viable CM. Vendor selection for the manufacture of custom cables and plastics was carried out using an invitation for bid (IFB). Evaluation of the responses from the IFB was based on price for the build of the system. Separate purchases were made for select commercially available products that were integrated into the system design (i.e., radar and cameras).

A selection committee consisting of representatives from the Virginia Tech (VT) Purchasing Department, the Coordination Contractor, a National Research Council contract specialist, and SHRP 2 personnel reviewed and approved all procurement processes, solicitations, and vendor responses, and selected the winning bidders. The rigorous selection process met all SHRP 2, federal, and Virginia Tech guidelines for securing the build services and involved systematic financial and experience-based evaluations of respondents.

The selection committee established the criteria and their relative weighting (listed in Table 2.1), and these were used throughout the selection process to evaluate the candidates.

Final Vendor Selection

The final scoring for the three candidates is provided in Table 2.2.

Telemetry Service Integration and Procurement

Each NextGen featured cellular machine-to-machine (M2M) modem technology that was configured for Verizon Communications Inc.'s code division multiple access (CDMA) wireless network. This specific CDMA-based technology was selected based on the totality of cellular coverage availability at each of the site contractor locations. These M2M communications were used to disseminate software upgrades to installed units, collect biweekly DAS function or health check reports, and transmit crash epochs to Coordination Contractor servers. A health check entails running predetermined algorithms on DAS systems and reporting out a confidence measure for each variable or functional category to indicate whether or not it is functioning properly and consistently. Results for each variable had to be interpreted holistically, with a deep understanding of DAS functionality in the context of other related variables to get a truer understanding of the nature of any particular problem detected. The health check and software upgrade capabilities permitted the research team to dynamically maintain and improve the DAS operations of the in-field fleet and maximize the efficiency of the integrated data collection systems.

The transmission of high *g*-force epochs allowed for automatic crash notification (ACN) when algorithms indicated that a vehicle had potentially been in a collision. Each ACN epoch was verified via visual inspection, as the proportion of false alarms was relatively high. Validated ACNs facilitated the timely conduct of crash investigations, including interviewing participants while the incident was still fresh in the participant's memory.

Beginning with the Study Design project and continuing into the start of the SHRP 2 NDS, estimates were prepared to determine the required level of telemetry service that would yield the best value in terms of minimizing costs while maintaining sufficient service levels to support the telemetry activities noted above. In the months preceding the first vehicle installation, the ordering process was initiated in earnest. Of the available options, the monthly 8-megabyte (MB) service per DAS was deemed to be the best value in terms of balancing

Table 2.1. Selection Criteria Weighting Scale

No.	Criterion	Maximum Point Value
1	Ability to meet delivery requirements	10
2	Services offered	10
3	Price of goods	35
4	Price of services	15
5	Prototype evaluation	20
6	Small, Women-owned and Minority-owned business (SWaM) use	10
Total		**100**

Table 2.2. Vendor Selection Criteria and Final Scores

No.	Criterion	ACDI[a]	Alternative B	Alternative C
1	Ability to meet delivery requirements	8.2	8.3	8.3
2	Services offered	8.3	8.3	8.7
3	Price of goods	35.0	30.2	31.7
4	Price of services	20.0	18.4	15.9
5	Prototype evaluation	13	4.0	13
6	SWaM use	10	10.0	10
Total		**94.4**	**79.1**	**87.5**

[a] ACDI, American Computer Development, Inc., was selected based on the scoring performed by the selection committee. On completion of the selection process, an order was placed for the turnkey assembly of the DAS systems for the SHRP 2 NDS.

cost and level of service. This level of service was determined based on the average packet size of software updates and anticipated average volumes of incoming routine health check information and crash notifications. In addition, it is important to understand that total system bandwidth (i.e., 8 MB × the total number of enabled DAS units) was pooled across the entire fleet. Thus, DAS kits using more than their share of the total bandwidth in a particular month (e.g., due to transmitting an ACN epoch) could be absorbed within plan limits if several other units consumed less than their nominal share that same month.

Data Collection Site Facilitation

The Coordination Contractor was responsible for technical coordination of six data collection sites. The preparation activities needed to support ongoing coordination efforts included assessing each site for readiness, training site contractor personnel, and providing software tools to assist them in managing their DAS kit inventory, participants, and vehicle fleets. The tools built for this purpose provided ongoing technical support for participant recruitment efforts; DAS installation, maintenance, and deinstallation; and project oversight over the duration of the study. The Coordination Contractor established a number of software support resources, all of which are discussed in greater detail later in this chapter. These included the following: a telephone and web-based "hotline" service to support site contractors with urgent installation or assessment questions during active installations, web resources for both study partners and prospective participants, a web-based information-sharing tool or "wiki," the study URL (www.drivingstudy.org), a portal for interested parties and active participants, and weekly conference calls.

Readiness Visit and Checklist

Site readiness was facilitated and validated by the Coordination Contractor along with SHRP 2 staff primarily via two in-person visits. The first series of visits entailed participating in a kick-off meeting with the site contractor and Transportation Research Board (TRB) staff. These meetings took place over a period from June to December 2010 at each site contractor's location. At these meetings, a Coordination Contractor PI discussed the three-tiered recruitment strategy and plans for training site contractor personnel. The training discussion included required installation technician background and expected training outcomes. Required tools to equip a site were listed, including both custom tools that would be provided by the Coordination Contractor (e.g., DAS alignment and calibration tools) as well as those standard shop tools that needed to be supplied by each site contractor, such as pliers, wrench sets, screw driver sets, and battery chargers. IRB issues were discussed at a high level, including current progress on attainment of the Certificate of Confidentiality from NIH. Finally, a discussion of custom software, including its purpose and a high-level introduction on to how to use it, was included. These meetings were important contributors to providing the necessary details and face-to-face communications the site contractors needed to develop their sites into final study-ready form.

A Coordination Contractor PI and TRB staff also visited each site a second time approximately 2 weeks ahead of that site's first scheduled participant enrollment and DAS installation. These visits took place from September 2010 to February 2011. These visits were conducted to validate each site's readiness to conduct all study operations in a safe and consistent fashion, and in a manner conducive to collecting high-quality data. This was accomplished by visual inspection of all study facilities in the context of a detailed site readiness checklist (Appendix P). The checklist encompassed the following areas: general facilities (e.g., signage, parking, waiting areas), participant enrollment (e.g., privacy, secure storage for hardcopy documents), participant assessment (e.g., sufficient and safe space for the rapid pace walk, suitable space and equipment if enrolling two or more participants simultaneously), and the garage/shop area (e.g., space sufficiency, suitable carbon dioxide exhaust/ventilation, accessible DAS storage). Each element on the checklist was either validated as approved or noted as an area for remediation before commencing data collection.

Training

To ensure consistent understanding of human subjects protection structures and protocols across sites, each individual who expected to interact with a human participant (or might come into contact with personal information or items belonging to a participant) had to provide evidence of successful completion of standard IRB training offered by various entities such as NIH, the Collaborative Institutional Training Initiative, or a university IRB training course. This applied to experimenters performing driver assessments, managers, installation technicians, and crash investigators. In addition to this general IRB training, the Coordination Contractor developed specialized IRB training for each of these groups of researchers based on knowledge gained and lessons learned during past naturalistic driving studies. The content of each training session was customized to the audience, but each session included some subset of the following topics tailored to naturalistic driving studies:

- Professionalism;
- Recruitment;
- Informed consent;
- Disqualification guidelines;

- Installation;
- Driver assessment;
- Adverse events;
- Crash investigation;
- Data retrieval;
- Payment issues; and
- Out-processing (deenrollment).

Institutional Review Board and Special Situations

Two special situations were identified early in the study preparation phase. First, two of the six sites (Erie County, New York, and Seattle, Washington) are located very near the United States–Canadian border. Still and video image recording is forbidden at such international border crossings, which would be a problem for instrumented vehicles whose onboard systems are continuously recording video images while the vehicle is running. Attempts to secure permission for study vehicles to pass freely across the border without being stopped or divulging the participant's personally identifying information were unsuccessful. Therefore, screening protocols excluded all potential participants who planned to cross the border with an instrumented vehicle at any time. This requirement was reiterated verbally by site personnel and in the consent materials.

A second anticipated special situation entailed participants in an instrumented vehicle encountering law enforcement or other officials due to, for example, a traffic stop or crash. Although the study equipment is unobtrusive, it was possible that an officer might notice and ask about it, thus possibly compromising participant anonymity as well as the measures put into place to protect participant data. To guard against this type of security violation, a letter was specially prepared for these situations, and participants were advised to keep it handy in the vehicle, for instance in the glove box, so that it could be presented to the authorities as needed. This letter incorporated the following features:

- Description of the vehicle's role in the study without divulging the identity of the driver or any particular person as being enrolled in the study;
- A portion of the vehicle's license plate number to definitively link the vehicle to the letter;
- A photo of the head unit to definitively link the vehicle to the study; and
- Contact information for the site PI.

Enrollment

Participant enrollment is the process by which a potential participant or recruit is formally inducted as a participant into the study. There are several aspects to this process, but key is thoroughly informing the individual of all study-related protocols, risks, benefits, and compensation—then having him or her sign an informed consent document. In September 2010, a single 1-day enrollment training was provided to the site contractor personnel gathered in Blacksburg, Virginia, at the Coordination Contractor facility. All site contractor personnel were required to complete this IRB training. Best practices were shared with trainees in the following areas: privacy, record keeping, management of the consent process, participant payments, the coordination of activities at installation, and management of difficult or otherwise delicate situations.

Assessment

All primary participants were assessed along a variety of functional dimensions important for driving, including cognitive, perceptual, and physical dimensions. In September 2010, training on exactly how to conduct these assessments was provided to the site contractor personnel assembled in Blacksburg, Virginia, in conjunction with the previously described enrollment training. During this portion of the training session, the protocols for conducting assessments using standard equipment and software were demonstrated to and practiced by trainees for on-site, in-person testing (e.g., vision tests), as well as filling in questionnaires, which could be conducted online at the enrollment site or at the participant's home or other preferred location. Following the classroom instruction, an assessment practice session was conducted so that trainees could demonstrate competence, and so that any questions could be identified and discussed with members of all the site contractors.

Vehicle Installation

In early fall 2010, hardware technicians representing each site contractor traveled to Blacksburg, Virginia, for vehicle installation/maintenance/deinstallation training at the Coordination Contractor facility. Multiple sessions were scheduled across several weeks to enrich the experience and balance the instructor/trainee/practice vehicle ratio. In each session, 3 days of training covering all aspects of the installation, maintenance, and deinstallation activities were provided. In all, four such training sessions were conducted to train all hardware technicians.

Hardware technicians were also required to complete IRB training. Additionally, as described above, an introduction to IRB best practices was provided at the start of each hardware technician training session. Training included sessions on installation, troubleshooting, maintenance, and deinstallation, as well as data upload demonstrations. All portions of the training involved a lengthy hands-on practical session so that as hardware technicians were trained, they also demonstrated their new skills on a variety of different vehicle types. Figure 2.2 shows the hands-on learning experienced

Figure 2.2. Installer hands-on training.

by trainees during the 3-day session. Site managers were also provided a high-level version of the hands-on installation training session.

Training for each site's group of technicians was scheduled to be completed about 2 weeks before the start of installations at that site to maximize retention while still permitting time to perform practice installations and deinstallations. In addition, Coordination Contractor representatives traveled to each site contractor location for the first 3 days of actual installations of participant vehicles to guide or advise the newly trained hardware technicians as needed.

Additionally, conference calls led by Coordination Contractor technicians were conducted quarterly to provide updated information and training directly to installation technicians. Documentation of further training sessions was then uploaded to the SHRP 2 wiki website (Wiki.shrp2nds.us) to serve as a reference to installation as well as other project support staff.

Software Support Resources

The Coordination Contractor employed a number of custom software support resources to coordinate, oversee, and support the daily operations of the study. As the study progressed and emerging needs were identified, enhancements were made to existing programs and new ones were developed in an effort to provide a more robust set of study management tools.

Mission Control System

The Coordination Contractor developed Mission Control Software (MCS), a password-protected, user-friendly, web-based interface to the operations database maintained by the Coordination Contractor. MCS facilitated real-time viewing of information pertaining to recruitment, installation activity, component disposition, participant records, and vehicle activity within a secure environment. MCS was designed to serve three primary functions:

1. Coordination Contractor support for coordination of site contractor activities;
2. Coordination Contractor monitoring of the SHRP 2 fleet; and
3. Site contractor management of their respective fleets.

MCS users fell into one of three user groups, each with its own unique scope of information; access was controlled using role-based security protocols. Coordination Contractor and SHRP 2 staff members were able to view information on participants, vehicles, and components across all sites; however, these two user groups could not view personally identifying participant information. In contrast, site contractors were able to see the same categories of information, including personally identifying information—but only those study elements pertaining to their own sites.

MCS was designed to support site contractor recruitment, installation, and maintenance activities; facilitate fleet management; and inform decisions regarding study coordination and oversight. It proved to be a vital tool in the conduct of daily study operations. It featured overall study status information and detailed information on any particular participant or fleet vehicle. Its many features facilitated efficient completion of the daily operational tasks of the study and allowed Coordination Contractor staff and site contractor staff alike to proactively monitor many key aspects of the study. A sample image from MCS is shown in Figure 2.3.

Request Tracker System

Request Tracker (RT) afforded the Coordination Contractor the means to track all study issues from inception to resolution, making certain that none were simply lost as may have been the case using conventional, non-tracking-based communication media (e.g., phone or e-mail). Study issues encompassed problems related to components, installations, software development, and other emergent situations. The Coordination Contractor used this system to manage workflow among the Coordination Contractor staff, to prioritize maintenance items for site contractors, and to track and analyze systemic issues across the study. The site contractor users employed RT to alert the Coordination Contractor to DAS issues, to communicate difficulties and questions regarding maintenance activities, and to make requests for technical support, equipment, and logistical assistance.

Study personnel were able to access work items by means of an individualized dashboard view, pictured in Figure 2.4. Each issue was identified in the form of a ticket and placed into a work queue based upon which entity was deemed most

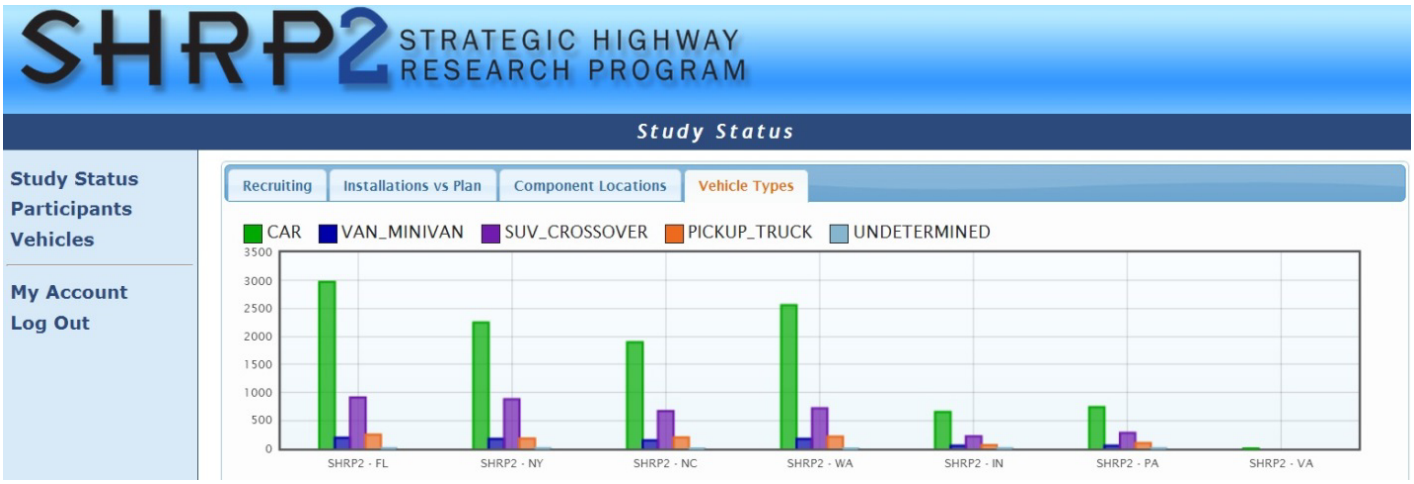


Figure 2.3. MCS screen capture.

appropriate to take responsibility for that particular work item. RT was structured on the basis of a series of queues, which were virtual containers of categorized tickets or issues that needed to be worked on by a user or users within a group of individuals slated to monitor a given queue.

For the SHRP 2 NDS, there was a collection of specific site contractor queues to address administrative, assessment, or installation issues. These queues were jointly monitored, and the issues contained within each were worked on by the site contractors; thus, the queues served as a way to communicate the specific work needs. An example of such a ticket might include a given vehicle needing a data drive swap or a specific secondary driver whose consent date had not yet been entered into MCS. Additionally, a number of queues were managed by

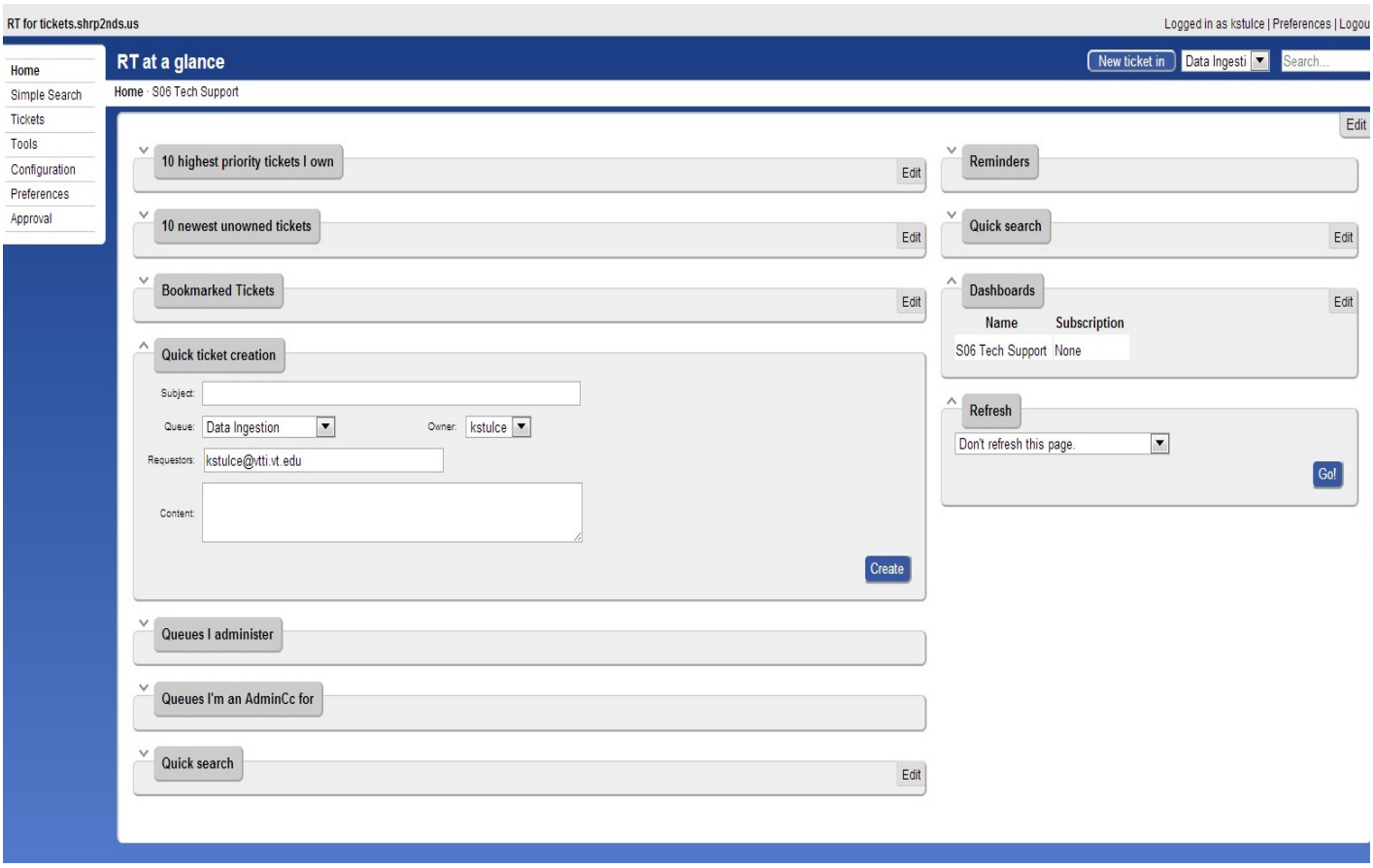


Figure 2.4. Request Tracker dashboard.

the Coordination Contractor. Site Contractors could post tickets to a general queue simply by sending an e-mail to the designated e-mail address. Eventually, most tickets were directed to more specific queues to be addressed by the most suitable personnel. Such queues included Computer Technical Support and Hardware Repairs. From the vantage point of his or her dashboard, a user could view a list of his or her tickets, take responsibility for a ticket, view all unowned tickets, generate a ticket, monitor queues of which he or she was a member, or search for a specific ticket.

RT was used as an issue identification mechanism, workflow prioritization and management system, and issue reporting tool. The ability to search for a ticket or group of tickets based on a number of variables or variable combinations supported the issue tracking and analysis functions of RT. The queries allowed the user to assemble a timeline of maintenance issues for a particular vehicle or component, or to survey a history of interactions with a particular participant. This function further lent itself to tracking and analysis of systemic study issues and guided the timely adjustment of policies on issues.

Hotline

RT, as noted above, was used as a means to report and manage issues that arose during the study. However, some problems were deemed so urgent that another mechanism was implemented to facilitate rapid response to these time-critical problems, typically installation-related problems experienced while a participant was waiting on his/her vehicle. To this end, a hotline telephone service was established. The Coordination Contractor staff were available 8:00 a.m. to 8:00 p.m. daily, Eastern Daylight Time, Monday through Saturday to provide guidance and technical assistance to site contractor hardware technicians. The hotline—using Google Voice, a free technology—was set up such that calls to a central number could be forwarded to any one or more on-call members of Coordination Contractor staff. Any missed calls resulted in the generation of a transcript of the call being sent as a text message to the same designated staff. In addition, the system's web-based user interface also displayed the same automatically generated transcript as well as an audio recording of the missed call's voice message. Average resolution for a hotline call was 1 hour. Typical hotline situations included component status issues, technical support needs, installation and maintenance anomalies, and requests for database changes to facilitate installations and maintenance.

Wiki

Delivering a continual flow of up-to-date information was deemed a vital component in the conduct of the SHRP 2 NDS. The Coordination Contractor developed a wiki as one mechanism for addressing this need. A wiki is a web-based application that allows designated users to modify the content of information. The wiki proved to be a dynamic, comprehensive source of information regarding individual vehicles makes and models, recruitment, enrollment, assessment, participant management, and direction regarding vehicle eligibility, classification, and requisite installation procedures. The site contractor hardware technicians were not only encouraged to use the information available to them, but also to add contributions based on their own observations and experiences. The wiki also featured a mechanism for uploading images and documents.

Coordination Contractor personnel issued a recurring e-mail called the "Wiki Digest." This included hyperlinks to relevant wiki pages, summarized recent additions to this growing body of knowledge, and highlighted other wiki elements.

Drivingstudy.org

A website, www.drivingstudy.org, shown in Figure 2.5, was developed as a recruiting tool for the SHRP 2 NDS. It served as the public face of the study, targeting potential recruits, existing participants, and the general public. In addition to providing a comprehensive introduction to the study, the site also included links to a web-based participant eligibility screener, information regarding compensation, participant assessment, and study confidentiality policies and measures taken to safeguard participant privacy. Informed consent documents and a detailed description of study equipment for the edification of prospective participants were also featured. Information about the site contractor data collection sites (e.g., address, phone numbers, and driving directions) was featured on the home page.

While this was a publicly accessible website, it also included a link to a password-protected section where participants could log in and fill in study questionnaires from home or any other convenient location.

Provision of Site Contractors: Equipment and Other Tools

The collection of a high-quality data set required the uniform administration of a consistent set of protocols at the six site contractor locations. To that end, all data collection equipment, installation fixtures and software, assessment equipment and software, and data ingestion equipment were centrally built, procured, and configured so that all sites collected and processed data in the same way as had been approved by the individual and collective IRBs. Each type of equipment, tool, or software will be discussed below within the context of its relevant functionality.

DAS Equipment

The provision of DAS kits to the site contractor sites involved a delicate balance between obtaining component elements from

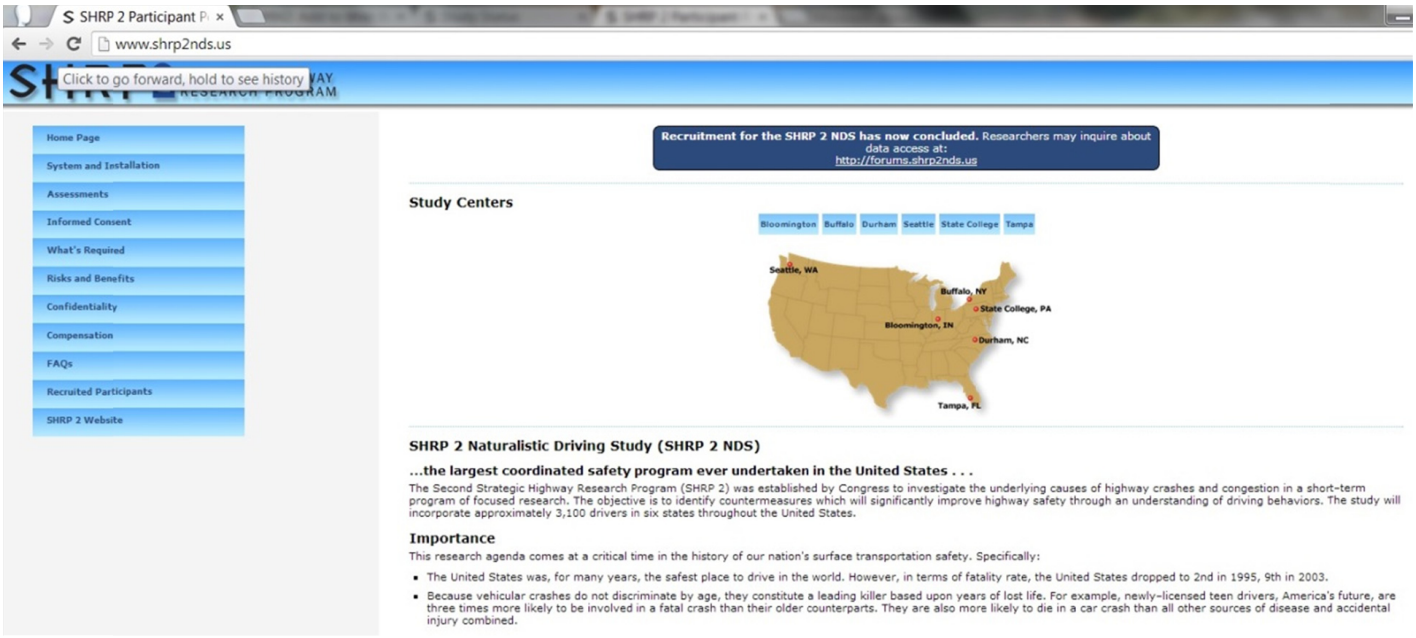


Figure 2.5. Drivingstudy.org.

suppliers, building kits, and supporting the varying installation scheduling needs of sites. Table 2.3 indicates the full complement of kits that were allocated to each site contractor data collection site. In addition, a 10% surplus of kits was purchased. Additional components were provisioned, which allocated an additional 5–7% to sites based on the quantity of any individual component available less those that were out for repairs. Not all DAS kits were initially available at the outset of the study, so distributions were made to each site as kits became available from the CM, keeping in mind the goal numbers indicated in Table 2.3.

Throughout the study, weekly assessments of equipment supplies at sites were conducted, thus allowing strategic equipment reallocation to be performed as needed. Approximately 11 equipment redistribution exercises were implemented to transfer components among the site contractor sites. Additional parts were procured as study needs dictated.

Table 2.3. Kit Projections by Site Contractor Data Collection Site

Site Contractor Data Collection Site	Nominal Quantity of Designated Kits
Buffalo	450
Tampa	450
Seattle	450
Durham	300
Bloomington	150
State College	150

As described previously and shown in Figure 2.6, each DAS kit comprised six main components (NextGen main unit, head unit, radar, radar interface box (RIB), network box, solid-state drive) with associated cabling, a General Packet Radio Service (GPRS) antenna, and rear camera. Pictured in Figure 2.6, beginning in the top left corner and moving clockwise, are the NextGen, head unit, network box, RIB, and radar. The solid-state drive is not pictured. It is important to note that the build of these kits relied not only on the electronic components and cabling, but also on the plastic housings for the main components. Each DAS kit was bench tested by the equipment manufacturer to ensure the operability of the equipment before shipping.

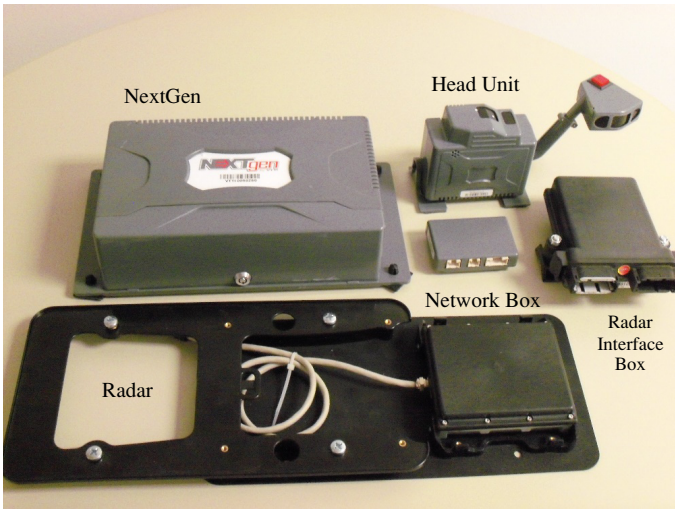


Figure 2.6. DAS kit.

The NextGen main unit hosted the computing functions of the DAS kit and served to coordinate all sensor nodes, communications, and data storage on the 128-gigabyte (GB) solid-state drive. An asynchronous data collection model was applied so that each variable was recorded at its native frequency. All data streams were marked with a timestamp to facilitate synchronizing during analysis.

During the installation process, software packages specific to the unique combination of vehicle year, make, and model were initialized to capture the available vehicle network data. This software allowed components to communicate vehicle-specific data variables such as brake actuation or turn signal use. The NextGen main unit was equipped with a cellular modem that allowed for routine M2M communications.

Cabling provided hard-wired connections between the head unit and NextGen main unit as well as a power source. Additional cabling connected to the onboard diagnostics port (OBD-II) so that network data could be obtained from those vehicles, as available. The GPRS antenna and rear camera were both located on the rear package shelf or affixed to the rear window and were connected by cabling to the NextGen main unit. Radar data were communicated via Bluetooth wireless technology to the RIB, which significantly reduced the amount of time needed to perform the installation because cabling did not have to be run through the vehicle's firewall.

The head unit assembly (Figure 2.7) featured three cameras that captured video images of the forward roadway, the driver's face, and the instrument cluster interactions.

Figure 2.8 demonstrates the quad view of the video images. An additional camera in the head unit assembly periodically captured an image of the cabin intended to assist in the determination of passenger presence, including possible indication of approximate age and gender. These still images were irretrievably blurred to protect the identity of unconsented passengers. Additional sensors housed in the head unit assembly measured ambient illuminance, acceleration in three dimensions, yaw

Figure 2.7. Head unit assembly.

Figure 2.8. Quad image of video views.

rate, and the presence of alcohol in the cabin. In addition, the head unit included a button that the participant could press to open a 30-second audio channel so an event of interest could be described and to mark the data stream for later analysis.

Installation Equipment and Software

Custom vehicle management software was developed to facilitate the installation, deinstallation, and midstudy maintenance of DAS units. This software suite was designed to provide the hardware technicians with a systematic way to proceed with the installation and confirm proper functioning of all DAS components as they were installed. All vehicle management software was resident on the desktop of each provisioned Dell Latitude E6400 laptop for hardware technicians, and information captured on it was stored on a local database installed on the laptop. After each installation, maintenance, or deinstallation activity, hardware technicians initiated a process to synchronize the local database, which included the metadata pertaining to all DAS-related activities, with the primary database housed on VTTI servers. Automatic synchronizations were also performed overnight to ensure that all laptops were synchronized with database updates.

Custom software used during vehicle installation was designed to capture information about the vehicle and install vehicle-specific software packages on the DAS. Hardware technicians confirmed the participant vehicle year, make, and model, and entered the vehicle identification number (VIN) and license plate information. Further, hardware technicians tested cold cranking amps and voltage of the vehicle battery to confirm that it maintained sufficient charge to operate the vehicle and the study equipment. Participants with vehicles that did not have sufficient battery life were notified that the installation could not proceed unless a new battery was installed and were provided with a gift card or reimbursement

to defray the cost of the replacement battery or compensate them for their time if they chose not to purchase a new battery. This was done to forestall situations in which participants might unfairly blame the installed system for a battery failure. Odometer readings and measurements of tire tread depth and pressure were recorded, and photographs of the vehicle were taken to document the vehicle's condition before installation.

A unique bar code was affixed to each main DAS component; the bar code was scanned into the software on installation as well as deinstallation so that components would be accurately associated with the correct vehicle or location and tracked in the database. Once the equipment was connected, the NextGen main unit began initializing the installation package. During this process, if errors occurred, the hardware technician was notified to check a specific area. As prompted, the hardware technicians performed the designated actions to test the component functionality and calibrate the sensors as needed. Last, the participant was brought back to the vehicle so the technician could take images with the driver inside the vehicle (to aid the post hoc process in which each analyzed trip file is definitively associated with a consented driver) and conduct an inspection of the vehicle, verifying that no damage was caused by the installation process.

Custom software was also used to guide the deinstallation process. By scanning the vehicle barcode, hardware technicians checked and confirmed that the proper vehicle record was retrieved from the database before conducting the deinstallation. Components were scanned during removal, and a reason for deinstallation was recorded in the software.

Similarly, hardware technicians used custom software during midstudy visits when they conducted routine data drive swaps or other DAS maintenance. Use of the vehicle and component barcodes in conjunction with the maintenance software allowed the Coordination Contractor to maintain accurate inventory records as components were replaced midstudy. In addition to capturing inventory changes, this software also imaged the solid-state drives with the appropriate and most up-to-date vehicle-specific software packages.

In conjunction with the software suite described above, several hardware tools were provisioned to the site contractor sites to ensure DAS units were properly aligned and calibrated during installation. Specifically, a custom-built alignment panel (Figure 2.9) was used to center the radar and record measurements about the headlight alignment and pattern associated with a vehicle's headlights. Custom-built laser alignment tools were designed, developed, and provisioned to ensure lateral alignment of the head unit and to measure the vehicle width for use with machine-vision programs. Additionally, a laser-based tool was used in conjunction with the alignment panel to calibrate the radar installation.

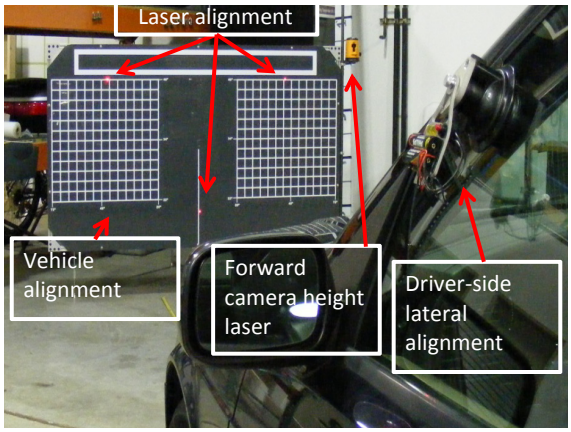


Figure 2.9. Alignment panel and driver-side lateral alignment laser apparatus with left-right-center laser spots.

Driver Assessment Equipment and Software

During the Study Design project, the importance of measuring driving-related functional capabilities was identified. A comprehensive driver-testing suite was devised by study design personnel and vetted by an external blue-ribbon committee with substantial expertise in the use and interpretation of driver assessment tests. Assessment details are fully discussed in Antin et al. (2011), and the protocol by which they were administered is found in Appendix A. In support of the assessment activity, the equipment and software discussed below were provisioned to the site contractor data collection sites. The provision of the equipment supported a consistent approach to data collection and the data variables across multiple site contractors and data collection sites.

The Optec 6500P Vision Tester (pictured at far left in Figure 2.10) was selected to measure a variety of visual abilities,

Figure 2.10. Driver assessment workstation.

including contrast sensitivity under a variety of lighting conditions, near and far static acuity, depth perception, color perception, and peripheral field of view. The Jamar Hand Dynamometer (pictured at bottom right in Figure 2.10) was used to measure participants' grip strength and as a gross measure of overall upper-body strength.

Select software packages and processes were administered on the assessment computer provisioned to the site contractor data collection sites. The Dell Optiplex 780 Minitower with touch screen monitor was used for this purpose. The computer was loaded with Driving Health Inventory (DHI) software and Conners' Continuous Performance Test II (CPT II) Version 5. The DHI software featured several tests of visual-cognitive ability that were used in the study, including Useful Field of View (UFOV Subtest 2, divided attention), Trail Making Test, and Visualizing Missing Information. Administration of the CPT II software captured a measure of executive function and working memory as well as reaction time.

Data Ingestion Equipment

To transfer collected driving data efficiently from the site contractor data collection site to the SHRP 2 NDS database, a custom-built drive bay data ingestion apparatus and Dell PowerEdge 2900 staging server were provisioned at each data collection site. Data collection site personnel inserted solid-state data drives retrieved from study vehicles into the drive bay ingestion apparatus. An automated process transferred data from the solid-state drive to the staging server, using a series of checks and balances to ensure that all data were transferred. Once the transfer was completed, the status of the solid-state drive was reset, allowing site contractor staff to reuse the drive in another vehicle.

Hardware/Software Infrastructure

When conducting a study of any size, researchers must consider a variety of data storage and processing solutions. In the case of SHRP 2, those data storage concerns were magnified due to the distributed nature of the data collection effort (six site contractor locations across the United States, remotely located from the Coordination Contractor's site) and the immense scale of the data to be collected. In addition, there were separate concerns for managing and storing the data required for day-to-day operations of the study, especially the data required by Project S07 to identify participants, their vehicles, any components installed in those vehicles, and participant assessment data.

Preliminary planning revealed the need for a significant hardware and software infrastructure to meet the estimated data storage, data transfer, and data analysis requirements for this study. The infrastructure was projected to require the following components:

- A petabyte (PB)–scale file storage for video;
- A 100-terabyte (TB)–scale database for parametric (sensor) data;
- High-speed networking for data transfer from the site contractors to Coordination Contractor servers;
- Multi-TB on-site storage at site contractor facilities to serve as temporary staging storage for collected data awaiting transfer;
- A large computer cluster to process data received from the staging servers;
- A bidirectional replicated database platform to allow component installations, maintenance, and deinstallations to occur without requiring a network connection;
- A flexible workflow (state engine) to track each and every file collected from a vehicle; and
- A database platform to support the various participant assessments.

The total collected data has required approximately 1.5 PB of archival (tape) storage, 700 TB of parametric data, and over 1.2 PB of video storage, thus far. When the storage requirements for the operational data (60 GB of database storage plus 8 TB of storage available at each of six remote site servers) are considered, the data storage requirements approach 3 PB of allocated storage space, and exceed 3 PB in raw storage capacity. The difference is due to the additional storage requirement to support Redundant Array of Independent Disk (RAID) configurations that provide data recovery methods for restoring data when disks fail.

In addition to data storage, it was critical to provide network infrastructure to transfer data efficiently from the field sites to storage servers at the Coordination Contractor facility. The SHRP 2 study relied on a high-speed research network (Internet2) along with tuned transmission control protocol/Internet protocol (TCP/IP) connections that facilitate sustained transfer rates in excess of 100 megabits per second. Once the study was under way and data drive (128 GB SSD) swaps reached a steady state, the Coordination Contractor received in excess of 2 TB of collected data on a daily basis.

To handle the millions of files that have resulted from the SHRP 2 data collection effort, a flexible workflow (state) engine was established to track each file at every step in its path from the time it was retrieved from its data drive until it was loaded into its final resting place (archive, database, and/or file storage).

With over 13,000 SHRP 2 components in the database, it was critical to be able to track each of them for inventory purposes—whether they were installed in a vehicle, removed from a vehicle, in a repair status, or in inventory at either a site or a Coordination Contractor facility. A barcode system was developed in which a component's bar code was scanned

as it was installed or deinstalled. Inventory management software could then track the location of a component within the database. Likewise, when shipping components in a box, the shipping box received a barcode, then each component was virtually scanned into the box as it was physically added to the box. Thus, when a box was received (unopened), the box barcode could be scanned to virtually receive all of the components inside.

Remote Updates

Another critical function of the database was to serve as a repository of the software files used to deliver software updates to one or more individual vehicles in the SHRP 2 fleet. When a single vehicle was targeted for a software update, the database table associated a specific update with the vehicle ID. The applications that supplied the update to the DAS's file system generally operated within the installer or maintenance software, or Transerve. The DAS itself was programmed to look in a predetermined location for any software updates and apply them accordingly. Once applied, the database was updated to reflect the current versions of all software installed in the vehicle.

Installer and Assessment Computing Efforts

Each site contractor was provisioned with desktop(s), laptops, and a site server with 8 TB of storage. The desktops and laptops ran Windows 7 and had Microsoft Office and LogMeIn installed along with barcode scanning drivers, while the site server ran a Linux operating system. The laptops were also provisioned with Microsoft SQL Server 2008 R2 Express loaded with a subscription to the database as outlined in Chapter 3. The desktops were provisioned with the DHI (flash drive) dongle, CPT II software, and a touchscreen. Initial purchase and domain configuration were handled at the Coordination Contractor facility before delivery to the site contractors, which allowed for consistent and reliable system builds across all SHRP 2 desktops and SHRP 2 laptops.

The LogMeIn application turned out to be very beneficial as Coordination Contractor technicians were able to observe issues on the laptops and/or desktops in real time.

System administrators at the Coordination Contractor worked with system administrators and network engineers at each site contractor location to configure wide-area network (WAN) access between the Coordination Contractor and the respective site contractor site.

Sample and Recruiting Infrastructure

Sample Design

Sample design is a crucial aspect of any study involving human subjects. The selection and screening criteria chosen as well as the recruitment practices used to attract participants may determine to a large extent the nature of the interpretations that can be gleaned from any subsequent analysis of the collected data. The high-level goal for the sampling plan was to recruit an equal number of male and female licensed drivers across the full breadth of the driver age spectrum. It was also a goal to oversample the youngest and oldest drivers, as these are the most interesting drivers to study due to elevated crash risk.

Participant screening. All participants had to pass the following eligibility criteria:

1. Is a licensed driver;
2. Drives at least 3 days per week;
3. Plans to keep vehicle for duration of anticipated study participation (i.e., 1 or 2 years for most participants);
4. Is competent to grant informed consent (or for minors, informed assent with consent granted by parent or guardian);
5. Has an eligible vehicle (note: eligible vehicles list grew as the study progressed); and
6. Has a suitable vehicle in terms of mechanical soundness and anticipated life, cleanliness/hygiene, and freedom from other concerns (e.g., leaks or presence of illegal materials).

Participant selection factors. The sampling plan was based on participant age group and gender as well as whether or not the study vehicle was equipped with advanced vehicle technologies (e.g., brake assist or other collision avoidance and mitigation technologies). The initial sampling plan is shown in Table 2.4. It incorporated the aforementioned factors of age group, gender, and vehicle technology; in addition, it includes the number of DAS units allocated to each cell as well as the idea that some participants would be recruited to participate for 1 year, while others would be recruited for a 2-year duration. The objective of oversampling the youngest and oldest drivers was accomplished in the design by creating a greater number of equal-cell-size age groups at the ends of the spectrum. Note that the design shown in Table 2.4 represents the initial studywide sampling plan; each data collection site was only responsible for a subset of the overall design proportional to its nominal DAS unit allocation, as indicated in Table 2.3.

Site selection factors. Study sites were selected by a SHRP 2 Expert Task Group (ETG) formed for this purpose. The ETG used a two-stage process: first, a request for qualifications (RFQ) was released, and then, a request for proposal (RFP) was sent to contractors that passed the qualification stage. The RFQ was released a second time after the first release resulted in no qualified contractors in southern states. After the second release, the RFQ stage produced 11 qualified sites, three located in southern states. The RFP stage considered cost as well as site characteristics. Not all qualified contractors responded to the RFP. The RFP stage resulted in the selection of the final six sites (Antin et al. 2011). It should be noted that data collection site selection could not be based solely on a desire to

Table 2.4. Initial Studywide Sample Design

Participants' Gender and Age Range (years)	Participants' Age Groups	Participate One Year	Participate Two Years	Total Participants [(2 × One Year) + Two Years]	DAS Units	Vehicle-Years
M 16–17	Minor teen	72	28	172	100	200
M 18–20	Adult teen	72	28	172	100	200
M 21–25	Young adult	72	28	172	100	200
M 26–35	Adult	72	28	172	100	200
M 36–50	Middle adult	72	28	172	100	200
M 51–65	Mature adult	72	28	172	100	200
M 66–75	Younger older	72	28	172	100	200
M 76+	Older older	72	28	172	100	200
F 16–17	Minor teen	72	28	172	100	200
F 18–20	Adult teen	72	28	172	100	200
F 21–25	Young adult	72	28	172	100	200
F 26–35	Adult	72	28	172	100	200
F 36–50	Middle adult	72	28	172	100	200
F 51–65	Mature adult	72	28	172	100	200
F 66–75	Younger older	72	28	172	100	200
F 76+	Older older	72	28	172	100	200
Any	Advanced Vehicle Technology	0	350	350	350	700
Totals		**1,152**	**798**	**3,102**	**1,950**	**3,900**

have geographic diversity or dispersion. Instead, each site had to be supported by a qualified and vetted research organization that proposed to support a site at one or more particular locations, and only six such sites could be supported within the scope of the program. The final set of selected sites and how DAS units were allocated across them are illustrated in Figure 2.11.

Data collection sites were managed by the respective organizations listed in Table 2.5.

Call Center

At the outset of the study, all recruitment activities were conducted and coordinated by the Virginia Tech Center for Survey

Figure 2.11. Site locations and their nominal DAS allocations.

Table 2.5. Data Collection Site Contractors

Site Center	Managing Organization(s)	Nominal DAS Units Allocation (Percent of Total)
Buffalo	CUBRC, Inc., supported by CalSpan Corp.	450 (23%)
Tampa	CUBRC, Inc., supported by Center for Urban Transportation Research, University of South Florida	450 (23%)
Seattle	Battelle	450 (23%)
Durham	Westat	300 (15%)
Bloomington	Transportation Research Center, University of Indiana	150 (8%)
State College	Larson Institute, Pennsylvania State University	150 (8%)
Total		**1,950 (100%)**

Research (VT CSR). A three-tier approach was planned for recruitment, with Tier 1 representing the most desired approach, Tier 2 the next most desired approach, and Tier 3 the fallback position if Tiers 1 and 2 proved less successful or efficient than desired. The Tier 1 approach used random cold-calling: numbers (procured by VT CSR management) within site boundaries were called at random. Tier 2 entailed focused random calling: numbers were prefiltered to include only those believed to own eligible vehicles. Tier 3 entailed using a wide variety of traditional recruiting efforts such as posting ads in local newspapers or other media, distributing flyers, and making personal appearances at a wide variety of venues.

Regardless of the approach used, once on the phone, CSR staffers would engage interested parties in a brief discussion of study protocols and establish whether eligibility criteria were met. If interested and eligible, the recruit's contact information was passed along to the Coordination Contractor, who processed the recruit's vehicle information within the database (to facilitate proper DAS installation), then passed along that individual's relevant information to the appropriate site contractor. The site contractor, based on its sample design needs at that time, would then contact the most desirable recruits for scheduling of the participant enrollment and assessment and vehicle installation processes.

Onboard Network Parameter IDs

The initial slate of eligible vehicles (Appendix Q) was determined by those vehicles for which various original equipment manufacturers (OEMs—i.e., the auto manufacturers) had agreed to provide certain parameter IDs (PIDs) for certain vehicles. These PIDs permitted interpretation of the data generated by the vehicle's onboard network. Some PIDs are standard and publicly available, while others are strictly proprietary. Each OEM that provided proprietary PIDs to the Coordination Contractor entered into a nondisclosure agreement to ensure that all of its proprietary PID information would remain private and secure. Furthermore, it is important that the data gleaned from the use of these proprietary PIDs be stored in the database in a manner and resolution that would not permit their reverse engineering. The final list of eligible vehicles is featured in Appendix R. Note that recruiting obstacles ultimately necessitated an expansion of the list to include vehicles for which PIDs were not obtained; data were procured through custom-designed components to be described later in the report.

Administrative Tools and Processes

In addition to MCS, RT, the SHRP 2 wiki, and the hotline, the Coordination Contractor coordinated a number of regular conference calls to allow for dialogue between SHRP 2, partners, and contractors. Communication of study protocol, clarification of study-related issues, and reporting of metrics describing study health were all included in these meeting opportunities.

Meetings

A study of the scope of the SHRP 2 NDS by necessity involves multiple stakeholders and study partners. Regular communication with SHRP 2 program managers, principal investigators, and equipment hardware technicians was accomplished through a series of weekly and, in the case of installation technicians, quarterly, conference calls hosted by the Coordination Contractor.

Weekly Operations Team Conference Call

The Coordination Contractor hosted a weekly operations team meeting, which included representatives from the Coordination Contractor and the site contractor PIs and study managers as well as SHRP 2 staff, to exchange current information about study status, particular and general issues, and plans for upcoming events. Topics ranged from recruitment, vehicle data

classification issues, installation schedules, and inventory management to study closeout and equipment return.

Weekly Conference Call

The Coordination Contractor PIs hosted weekly conference calls with SHRP 2 staff. In addition to providing a forum for the discussion of various critical issues and the formulation of related policies, these meetings afforded study leaders the opportunity to discuss a wide range of study metrics produced by the Coordination Contractor. These weekly metrics described progress with regard to recruitment, data ingestion, processing and quality control analysis, and site contractor progress in the areas of installations, deinstallations, and attendance to maintenance items. The Coordination Contractor documented action items for all parties and noted key decisions regarding study protocols and goals.

Quarterly Installer Technician Meetings

The Coordination Contractor conducted a quarterly conference call for the installer technicians, affording the site contractor hardware technicians the opportunity to communicate directly with software designers, hardware engineers, and other Coordination Contractor staff on whom they relied for hotline assistance. These meetings created a helpful dialogue essential to the advancement of study goals. Early calls focused on installation procedures and troubleshooting for frequently encountered situations. As the vehicle fleet expanded, the conversations turned to finer points of vehicle classification and its implications for installation configurations. Conferences held later in the study focused on deinstallation protocols. Discussion of component scanning procedures was a constant due to the essential nature of inventory tracking and control.

CHAPTER 3

Data Collection Phase

Human Subjects Protections

The data collection phase involved a greater than anticipated level of effort related to human subjects protection and other IRB-related activities. Continuing IRB activities ranged from coordination and synchronization of multiple independent IRBs, coordination of amendment requests, assessment and reporting of adverse events, and addressing the IRB and ethical aspects of participant requests for data (typically to demonstrate to authorities or insurance adjustors that she or he was not at fault in a particular incident). Each site (and the study as a whole) also underwent an annual IRB review (sometimes known as continuing review and approval); these applications for continuing approval often required that summary data be gathered as of a certain date (e.g., demographic information about participants). There was IRB-related activity every month of the 38 months of data collection, and for many months of preparation before data collection.

Coordination of Multiple IRBs

Once the study was under way, coordination activities were primarily concerned with the timing of amendment requests and consistency reviews conducted for any amendment that resulted in a change to the consent, assent, and parental permission forms. The timing of amendment requests initially followed a VT→NAS→ data collection sites serial pattern of approvals (i.e., first Virginia Tech IRB approval was sought and secured, then NAS IRB approval was sought and secured; finally, all sites not formally relying on the Virginia Tech IRB submitted the amendment to their respective IRBs in parallel with one another). Later amendments followed a VT→NAS and data collection sites pattern (i.e., first Virginia Tech IRB approval was sought and secured, then the amendment was submitted in parallel to the NAS IRB as well as the IRBs of all data collection sites not relying on the Virginia Tech IRB). This latter method was found to be more efficient given that both the Virginia Tech and NAS IRBs occasionally presented amendments for full board review, and the IRBs in each case met monthly at most.

Reviews of site contractor amendments affecting the consent, assent, and parental permission forms were conducted by Coordination Contractor personnel. Such reviews served to keep forms and protocols across the data collection sites as consistent as possible, as permitted by the respective IRBs involved.

Amendment Overview

As reported in Chapter 2, six amendments were required before the first participants were enrolled in the study. Once the study was under way, operational logistics and alterations in sample design strategies resulted in an additional 12 amendments (about one every 3 months, on average). A few of the amendments were site specific (e.g., a special recruiting method that only applied to one or two sites), while most were intended to be applied studywide (e.g., allowing for varying periods of participation beyond the initially envisioned 1- or 2-year periods). Appendix S includes a brief description of each of the amendments submitted and approved during the data collection phase of the study.

Adverse Events

In general, as part of the IRB approval and continuing oversight process, PIs must agree to identify and report unanticipated problems and adverse events to the governing IRB(s).

In the course of this project there were eight adverse events reported to the various IRBs, all in the less-than-serious, unanticipated-problem category. The typical reporting process involved the site personnel reporting the incident to the Coordination Contractor using the RT system. Coordination Contractor staff would note the event (usually within hours) and circulate it among the Coordination Contractor and SHRP 2 staff (including the VTTI IRB coordinator). Coordination Contractor personnel would gather more information as

required for IRB reporting purposes, then develop an action plan to prevent future occurrences (if applicable).

Once it was determined that an adverse event had occurred, an Adverse Event Report would be drafted and circulated among the Coordination Contractor and site staff, as appropriate, for refinement in terms of technical accuracy. Within five business days of becoming aware of the event, the Coordinating Contractor would submit the final Adverse Event Report to the VT IRB, as was the Coordination Contractor's obligation. Once the VT IRB had responded (usually within two business days), the report and its resolution would be provided to the NAS IRB. At the same time, the affected site (if not relying on the VT IRB) would submit reports to its own IRB to meet its reporting deadlines. Those issues determined to be adverse events in this study ranged from possible radio-frequency interference to stolen DASs to complaints from a nonparticipant about the study vehicle recording video information on his property to a potential breach of privacy.

Participant Video Requests

During the Study Design project, great care was taken to ensure the security of participant data, most notably through the acquisition of the Certificate of Confidentiality. On 33 occasions, participants asked to view or obtain their driving data, and, while not a contractually mandated aspect of the study, site and Coordination Contractors made prudent decisions to support such requests when the seriousness of the incident in question—from financial, legal, or ethical perspectives—warranted such attention. Most often, these requests were made so that participants could demonstrate that they were not at fault in the case of a crash. Other requests were made out of curiosity about the participant's own driving habits. In 17 cases, concerns were alleviated without the review of video. In five cases, video was unavailable. In the 11 remaining cases, video was shared with the site contractor and/or the consented participant in a secure fashion. Videos were shown by Coordination Contractor personnel via WebEx to a room at a site contractor's facility. The site contractor's role was to provide for a secure video screening environment, making certain that only appropriate individuals (e.g., family member, attorney or counselor, or police officer) were in attendance and that no recordings were made. No video was ever released to anyone.

DAS Design Updates and Procurement

The DAS system continued to go through design revisions during the procurement phase and even into the production phase. These changes were necessitated by three major factors: industrywide changes in technology, system performance, and needs of the study.

Industry-Driven Changes

The primary change that occurred due to shifts in technology was the data drive interface. When the design process started, Parallel Advanced Technology Attachment (PATA) was the standard interface used in hard drives. By 2010, Serial Advanced Technology Attachment (SATA) had replaced PATA as the standard, which was reflected in both the price and the availability of solid-state drives with the PATA interface. Because the physical interface is incompatible between the two standards, the NextGen main unit had to have a design modification to allow for the inclusion of a daughterboard to accommodate the new interface and extend the functionality of the existing motherboard to include the change.

System Performance

As a result of early testing that coincided with the procurement phase, both PCBs in the NextGen main unit required an additional design revision to improve the performance and robustness of the system. The final design of one of the two boards was released and introduced early in the production cycle.

There were complaints that because the system was radiating electromagnetic interference (EMI), it might be affecting some vehicles' onboard systems, which themselves relied on radio frequency (RF) to function [e.g., the tire pressure monitoring system (TPMS)]. Due to such concerns, a small filter board was designed that attenuated the frequency corresponding to the TPMS carrier frequency. This board was added to a subset of the NextGen main units so that site contractors could install them on vehicles perceived to have such problems. It should be noted that TPMS systems routinely malfunction with no DAS installed, and it was never definitively demonstrated that the RF signature emitted by the DAS was actually interfering with any vehicle's functionality.

Study Needs

To help meet the recruiting requirements of the study, the Coordination Contractor provided engineering support to accommodate a larger pool of vehicle types. The additional changes required the design and procurement of new plastics, cables, and the addition of a derivative design in the manufacturing process. Two examples—one mechanical and one that involved hardware and software—are provided.

- *Mechanical upgrade.* Additional parts to work with the radar mounts were designed to allow installers to have a greater range of adjustment of the angle of the radar to accommodate a wider variety of vehicles (i.e., by fitting a greater range of front bumper designs).

- *Hardware/software upgrade.* To expand the pool of vehicles, it was decided to include older vehicles that conform to the legacy OBD-II network protocol (i.e., essentially accommodating vehicle model years 1996–2008). This required a modification to the existing network box, a new cable design, and a change to the database. In addition, this necessitated a modification to the installation software to ensure that correct network cables were installed to avoid the possibility of negatively affecting the vehicle's network.

Software Upgrades

Shakedown Software

In early 2011, study leadership recognized the need to capture and rectify any installation problems before the newly equipped vehicle left the installation facility. As a result, a "shakedown" process was implemented. The shakedown activity was performed by hardware technicians immediately following vehicle installation. During the activity, hardware technicians performed a short, predefined test drive to collect baseline data and, using shakedown software, confirm that all video cameras and primary sensors were functioning properly. This brief process ensured quality data were being captured from the initial installation.

Usage and Tracking Software

In summer 2012, the Coordination Contractor released a software package to the DAS which populated the trip database with trip-specific information, including time-stamped begin and end GPS coordinates. In over a dozen cases, prospective vehicle coordinates were identified that enabled the location of participants/vehicles that had been nonresponsive to repeated site contractor servicing requests. In a number of cases, the participant had either moved or sold the vehicle without notifying the site contractor, or the vehicle had been repossessed.

Supplemental Procurement of Components

The Coordination Contractor initially procured 2,085 units of each of the major components of the DAS. Additional supply was procured in the cases of radars and solid-state drives. More radars were procured because that was the most vulnerable component when the front of a subject vehicle struck another car or object. More data drives were procured so that supplies would be available to install in a new vehicle while others were still in the process of having their data extracted. Consequently, 2,155 radars and 2,212 solid-state drives were included in the original purchase. Additionally, supplemental requisition of parts not intended for reuse, such as GPRS antennas and rear cameras (the fragility of which necessitated frequent replacement), were also undertaken by the Coordination Contractor.

Coordination Contractor Facilitation of Site Contractor Activities

The Coordination Contractor performed multiple functions in support of study operations throughout the data collection phase of the project, employing a highly developed protocol for providing equipment to site contractors in support of installation, maintenance, and deinstallation activities. As necessary, redistribution of study equipment was conducted to maximize overall study installation and maintenance efficiency.

Provision of DAS Kits

From the inception of the data collection period, the Coordination Contractor gathered information regarding shelf inventory and site contractors' planned installation activities on a weekly basis. As the study grew increasingly complex, collected information also elicited more detailed information concerning planned maintenance activities, deinstallations, and types of equipment configurations (e.g., prime or legacy networks) to be installed in vehicles. This information was collated into an inventory planning spreadsheet, which transformed these inputs into a detailed set of expected near-term hardware required to fulfill all needs at each site.

Summary of S07 Inventory Needs

The inventory goal for DAS equipment was for each site to have enough equipment to support 3 to 6 weeks of installation and maintenance activities. To establish a basis for DAS supplies, it was decided that a site's inventory status would be based on scheduled activities over the upcoming 3-week period, actual activities undertaken over the previous 3-week period, and on-the-shelf inventory. Each site was then classified as falling into one of the following status categories:

- Shortage: Site has less than 3 weeks' supply.
- Sufficient: Site has 3–6 weeks' supply.
- Surplus: Site has more than 6 weeks' supply.

Based on each site's status, Coordination Contractor staff could readily allocate on-hand resources to the neediest sites or call for equipment redistribution across sites to ensure the greatest overall study throughput and efficiency. Introducing an additional layer of challenge to the Coordination Contractor's equipment hardware provisioning task was its lack of access to real-time information pertaining to scheduled

Table 3.1. Example Site Performance Summary

Variable	Buffalo	Tampa	Seattle	Durham	Bloomington	State College	Total
Vehicles on road	438	443	423	303	158	147	**1,912**
June–July installations	11	14	6	4	10	7	**52**
Scheduled June–July installations	22	15	21	8	1	3	**70**
Percentage of scheduled June–July installations performed	50%	93%	29%	50%	1,000%	233%	**74%**
June–July deinstallations	13	20	13	6	3	6	**61**
Scheduled June–July deinstallations	12	5	10	6	1	5	**39**
Percentage of June–July deinstallations performed	108%	400%	130%	100%	300%	120%	**156%**
Full kits on shelf	11	18	17	10	10	10	**76**
Partial kits on shelf	4	0	8	0	0	0	**12**
Kits en route to site	0	0	0	0	0	0	**0**
Total kits at site	**453**	**461**	**448**	**313**	**168**	**157**	**2,000**
Percentage of allocated inventory at site	100%	102%	106%	101%	108%	101%	**96%**

activities at data collection sites. Information was procured from the data collection sites on a weekly basis, but that information could conceivably prove out-of-date even as soon as close of business on the day it was received due to cancellations, reschedulings, and the like. Table 3.1, an example taken from one of the regularly generated site performance summaries, illustrates the discrepancy between planned activities and actual rates of installation and deinstallation. This incongruity required the Coordination Contractor not only to consider a site's intended slate of activities but also to examine historical data regarding actual completed activities relative to planned activities in devising equipment-provisioning strategies.

Parts to Be Used for DAS Maintenance

Ideally, maintenance activities (i.e., replacing components that had been determined to have malfunctioned in some manner) were to be supported by a site contractor's spare parts inventory, preserving complete kits for use in installation activities. The parts to be used for maintenance, listed in Table 3.2, were included in the equipment supply estimation tool so that Coordination Contractor personnel could swiftly identify quantities of specific component types that needed to be sent to a particular location. In this way, planned maintenance appointments could be conducted in the most efficient fashion.

Table 3.2. Parts to Be Used for Maintenance

Site	Maintenance Items Next 3 Weeks	Surplus/Shortage After Maintenance Activities of Next 3 Weeks			
		SSDs	NextGens	Head Units	Radar Interface Boxes
Buffalo	4	18.6	20.8	25.2	28.2
Tampa	11	30.4	–3.8	0.8	0.8
Seattle	15	28	–2	18	15
Durham	0	39	16	4	5
Bloomington	0	17	6	7	8
State College	0	39	3	9	10
Total	**30**	**172**	**40**	**64**	**67**

The surplus figures (indicated by positive numbers) and shortage figures (denoted by negative numbers) were automatically generated using an algorithm grounded in the following assumptions based on previous experience in the study:

- 80% of maintenance visits require a NextGen;
- 60% of maintenance visits require a data drive;
- 20% of maintenance visits require a head unit; and
- 20% of maintenance visits require an RIB.

Outstanding maintenance tickets were reviewed periodically and the algorithm adjusted accordingly.

Kit Builder

Recognizing the NextGen to be the primary component of the DAS, the Coordination Contractor defined a partial kit as a NextGen lacking accompanying parts to support a complete installation. For example, if a site contractor returned an inventory assessment like the one in Table 3.3, the Coordination Contractor would conclude that the site had 31 full kits and 2 partial kits on the shelf based on the algorithm employed by the tool to calculate kit quantities (that is, 25 full kits, as listed, plus a sufficient number of individual components to comprise 6 additional full kits, with 2 partial kits left over).

The kit builder tab, pictured in Table 3.4, afforded an efficient means for Coordination Contractor staff managing

Table 3.3. Sample Site Contractor Inventory Assessment

Component	Quantity Good	Quantity in Need of Repair/Service
Full kit	25	0
NextGen	8	0
Head unit	6	0
RIB	6	0
Radar	6	0
Network box	6	0
Legacy network box	15	0
Rear camera	15	0
Antenna	15	0
OBD-II cable	15	0
Legacy OBD-II cable	15	0
RIB power cable	7	0
Network box power cable	7	0
NextGen power cable	7	0
RIB/radar cable	7	0
Network box/DAS cable	7	0
Head unit/DAS cable	7	0
SSD	7	0

Table 3.4. Kit Builder

Component	Buffalo	Tampa	Seattle	Durham	Bloomington	State College
NextGen	26	16	10	0	10	3
Head unit	0	2	8	6	–4	6
RIB	3	8	–4	5	0	7
Radar	–4	–1	–6	5	–3	3
Network box	4	12	3	17	1	8
Legacy network box	–16	–9	–3	2	–9	0
Rear camera	7	2	–10	8	1	16
Antenna	–3	9	30	21	13	23
OBD cable	3	24	36	45	11	13
Legacy OBD cable	–17	–7	–1	7	–2	7
RIB power cable	1	15	–9	5	2	5
Network box power cable	1	13	–10	2	0	3
NextGen power cable	1	12	–8	2	2	6
RIB/radar cable	1	16	–7	1	2	4
Network box/DAS cable	1	4	–7	0	–3	2
Head unit/DAS cable	1	11	–8	1	1	2
SSD	–16	4	30	8	15	27

equipment provision for multiple locations to readily assess the studywide inventory situation and quickly formulate a strategy for maximizing the number of complete kits, and consequently, for maximizing the number of installations performed and the amount of data collected. The numbers in the table were automatically generated based on encoding of the partial kit parameters into an Excel spreadsheet. Negative values indicate the designated quantity of a component should be sent to a site to complete a kit.

The kit builder pictured in Table 3.4 was featured in the June 20, 2012, site contractor supply estimation report; it was used to construct a plan that ultimately led to the completion of 52 kits at three project sites from previously nonintegrated parts, providing support for 52 additional vehicle installations.

Equipment Redistribution Plans

The complex and varied nature of daily operational activities at six data collection sites necessitated frequent and thoughtful equipment redistribution exercises to provide adequate support for installation and maintenance activities and maintain appropriate inventory levels studywide. These efforts were planned using the site contractor supply estimation tool described in the previous section and implemented keeping in mind the primary study goals of maximizing data collection efforts and maintaining the health of the vehicle fleet. The design of each required a commitment to balancing the needs of individual sites with those of the larger study. Cumulatively, these endeavors resulted in 314 vehicle installations and 46 maintenance activities that might not have otherwise been possible to accomplish.

Technical Support

The Coordination Contractor established a separate trusted domain (shrp2nds) and provisioned SHRP 2 NDS users under that domain to share designated network resources at the Coordination Contractor. This arrangement allowed the Coordination Contractor's technical support staff to access shrp2nds domain resources (e.g., desktops, laptops, site servers).

The Coordination Contractor also worked with network engineers at each of the site contractor locations to facilitate the flow of data to/from the Coordination Contractor. This effort was critical to establish networks that could support the bandwidth required to move the amounts of data generated at each data collection site.

Recruiting Processes

In the course of the study design phase, Battelle researchers conducted a pilot study to assess the efficacy of the cold-calling approach to recruitment. Though the outcome of this exercise was not published, the findings of the Battelle research team (led by Christian Richard in 2008) suggested that such an approach would be feasible, at least for older drivers. However, contingency plans were also implemented. As a result, a three-tiered approach to recruitment was employed. The Tier 1 approach, random cold-calling, was begun in the Erie County, New York, area approximately 1 month in advance of the hoped-for first vehicle installation. This process was continued across all sites, during which time the efficiency of the process was continually monitored. It was agreed in early 2011 that the recruitment efficiency rate for this approach was too low in terms of success rate per attempt (i.e., in the order of <2%) and overall cost per recruit. Further, a major efficiency-limiting factor identified by VT CSR management was that many of the individuals called did not have an eligible vehicle. Therefore, it was decided in July 2011 to move to the Tier 2 approach, focused random calling: phone calls were still randomly placed but only to those households believed to possess eligible vehicles. This was accomplished by procurement of data from Polk and other similar organizations as well as receipt of customer lists from certain OEMs. The efficiency of the Tier 2 approach was also continually monitored; it was used from July 2011 through April 2012, at which point its efficiency was also determined to be insufficient.

Site-Based Recruiting Tactics

On January 19, 2011, the site contractors were authorized to begin pursuing local recruitment using more traditional methods in tandem with VT CSR activities. They employed a wide range of approaches including those listed below. In addition to maintaining a list of these approaches and publishing it on the wiki, the Coordination Contractor facilitated discussion of these ideas in the context of a weekly conference call with the site contractors. These coordinating efforts on the part of the Coordination Contractor permitted the best and most innovative approaches devised by the site contractors to be efficiently shared with the others and deployed as appropriate.

- Flyers:
  - Distributed at student centers on campus,
  - Distributed at departments of motor vehicles,
  - Distributed at private schools,
  - Tailored to specific demographic groups, and
  - Distributed on cars;
- Facebook, Twitter, and LinkedIn;
- Facebook-targeted ads;
- Banner ad on traffic website;
- State department of transportation websites;
- Craigslist;
- Local news spot;
- Television advertisement;

- Posters in high schools;
- Contacts with local school boards;
- Tour of facility for high school science classes;
- Parent Teacher Associations and band boosters;
- Community driver education school;
- Community traffic safety team;
- Senior centers;
- Focus groups for teens and older people;
- Booths at local events and fairs;
- Local Virginia Tech alumni chapter e-mail;
- University magazine;
- Civic organizations;
- PowerPoint presentations;
- Radio advertisements;
- Radio station events;
- Professional marketers;
- Newspapers:
  - Classified ads,
  - Nonclassified ads, and
  - University papers;
- Mass e-mail;
- Local movie banner advertisements;
- Cable news feed;
- Instrumented vehicle at events;
- Collegiate summer orientation;
- Vehicle wrap or magnet;
- Additional letter sent to follow up on stale leads; and
- Postcards.

Recruitment was tracked in terms of recruitment medium:

1. *Calls out.* VT CSR personnel made random or focused cold calls, or called individuals on an OEM-provided list.
2. *Calls in.* The participant called a toll-free number after having seen an ad or flyer.
3. *Web-based screening tool* (WBST). VT CSR staff developed this tool around February 2011. The WBST facilitated the standard screening process but required no human screener, which proved to be extremely efficient.

The total number of individuals who expressed an interest in participating and who were successfully screened is shown in Table 3.5.

Network Data Classification

Difficulty recruiting younger and older drivers compelled the Coordination Contractor, in cooperation with SHRP 2 program managers, to expand the vehicle fleet to include a broader range of vehicles for which incomplete vehicle network information was available. The enlargement of the vehicle fleet necessitated the creation of four distinct vehicle classes with three discrete hardware installation configurations: prime, subprime, legacy, and basic as described in greater detail below.

Prime. The Coordination Contractor, through negotiations with various OEMs independent of this project, procured onboard diagnostic parameter IDs (OBD-II PIDs), thus enabling the acquisition of network variables. These included Controller Area Network (CAN) speed, turn signal, brake light, and headlight information. Acquisition of these variables facilitated the collection of the most robust possible data set. Hardware technicians used a standard network box and OBD-II cable connected to the Data Link Connector (DLC) of the vehicle to communicate with the vehicle network. The initial study design limited the eligible vehicle list to these vehicles, later termed *prime* vehicles.

Subprime. These vehicles were generally manufactured in 2009 or later and not included on the initial eligible vehicle list, as the OBD-II PIDs had not been acquired for these vehicles. These vehicles only yielded information on vehicle speed, throttle position, and ambient air temperature. Subprime vehicles were installed with a standard DAS configuration, identical to that used in prime vehicles.

Legacy. These vehicles, like their subprime counterparts, provided a reduced set of network data in comparison to that generated by the prime vehicles. Legacy vehicles were manufactured before 2009 and employed an older communications network for onboard diagnostics. The data set for legacy vehicles was limited to speed, throttle position, and ambient air temperature. Legacy vehicles required specially modified legacy network boxes and cables.

Basic. These vehicles were manufactured before 1996 and did not have modern vehicle networks compatible with the SHRP 2 network interface box. Basic vehicles were installed with the standard network box, omitting any network cable; and no vehicle network data were acquired.

The Coordination Contractor provided site contractors with considerable guidance concerning vehicle classification and installation. Table 3.6 summarizes the salient features of the four SHRP 2 NDS vehicle classes, listed in descending order of data richness. While the Coordination Contractor was able to make an initial judgment as to whether a vehicle of a particular year, make, and model would be eligible for inclusion, site contractors were instructed to bench test potential legacy vehicles to confirm availability of speed and accelerator position variables.

The expansion of the vehicle fleet increased the intricacy of the equipment provisioning process. As Table 3.6 shows, legacy vehicles required a different installation configuration from vehicles in the other classes. This additional layer of complexity required Coordination Contractor staff to broaden their focus to consider not only the number of kits required to support installations at data collection sites, but also the specific types of kits required at each location.

Table 3.5. Recruitment Summary by Method, Age Group, and Site

Method	Age Group (years)	State College	Bloomington	Durham	Seattle	Tampa	Buffalo	Total
Calls Out	**16–17**	1	0	3	1	1	0	**6**
	18–20	1	5	6	4	4	9	**29**
	21–25	13	10	13	11	17	19	**83**
	26–35	47	45	93	56	86	94	**421**
	36–50	138	109	284	191	222	283	**1,227**
	51–65	208	168	284	243	297	370	**1,570**
	66–75	86	68	142	190	213	191	**890**
	76+	37	29	42	91	111	88	**398**
Subtotal		**531**	**434**	**867**	**787**	**951**	**1,054**	**4,624**
Calls in	**16–17**	3	4	23	0	19	5	**54**
	18–20	11	15	42	0	68	17	**153**
	21–25	6	9	44	5	75	19	**158**
	26–35	7	13	49	10	41	32	**152**
	36–50	9	17	78	21	97	62	**284**
	51–65	15	16	81	15	148	76	**351**
	66–75	8	5	72	7	108	48	**248**
	76+	4	9	95	2	49	37	**196**
Subtotal		**63**	**88**	**484**	**60**	**605**	**296**	**1,596**
WBST	**16–17**	27	44	172	255	282	125	**905**
	18–20	92	80	188	398	840	413	**2,011**
	21–25	142	140	290	671	650	584	**2,477**
	26–35	138	61	339	517	503	508	**2,066**
	36–50	127	75	427	532	662	396	**2,219**
	51–65	125	56	220	414	456	269	**1,540**
	66–75	42	24	100	102	214	70	**552**
	76+	27	15	84	117	68	76	**387**
Subtotal		**720**	**495**	**1,820**	**3,006**	**3,675**	**2,441**	**12,157**
Total		**1,314**	**1,017**	**3,171**	**3,853**	**5,231**	**3,791**	**18,377**

Note: WBST = web-based screening tool.

Goal-Based Recruitment Strategy

Drivers at the ends of the age spectrum were among the most interesting participants from risk and behavioral perspectives. However, as recruitment progressed, early summaries showed that recruits roughly mirrored the driving population at large in terms of age distribution, which meant that recruitment efforts were not sufficiently effective at oversampling the youngest and oldest groups of drivers. Figure 3.1 shows the distribution of the age of participants as of April 2012 plotted against that of drivers in the United States for 2011. Once study leaders realized that recruitment at the ends of the spectrum was lacking, the Safety TCC was consulted in April 2012 and they agreed to discontinue strict adherence to the experimental sample design shown in Table 2.4.

Instead, a set of goals or guiding principles was established to guide further recruitment strategy and installation priorities. These goals focused on allocating recruitment, inventory, and human resources in a manner aimed at increasing the number and time in study of participants in the following age groups: 16–17, 18–20, 21–25, and 76+, with the higher-risk males being prioritized over females. In addition, whenever

Table 3.6. SHRP 2 NDS Vehicle Classes

Class	Definition	Vehicle Count
Prime	Vehicles included on the original eligible vehicle list for which the Coordination Contractor procured PIDs	1,717
Subprime	Vehicles manufactured primarily after 2009 for which Coordination Contractor was not able to procure PIDs but was able to obtain information through the CAN communication protocol, an industry standard after 2009	488
Legacy	Vehicles manufactured between 1996 and 2008, employing an older network for vehicle communications	736
Basic	Vehicles manufactured before 1996	421

possible, site contractors were asked to prioritize the installations of vehicle network classifications in the following order: (1) prime, (2) subprime/legacy, and (3) basic. Further, no additional drivers of Toyota Priuses were permitted to be enrolled in the study, as it was determined that this particular make/model was already overrepresented in the sample. Finally, an overarching goal was to collect as much data as possible; in other words, a DAS kit collecting data from a vehicle (any driver, any vehicle) was preferable to that same DAS kit sitting on a shelf.

Of course, it was not typically an easy task to prioritize recruits with this approach as some of the goals, while conceptually compatible, were often practically at odds. An example is that both young drivers and prime vehicles were highly desired, but there were virtually no recruits satisfying both criteria. In other cases, the goals were conceptually at odds. An example of this is the notion of allocating DAS kit resources to the most highly desired recruits, while at the same time not wanting to let a DAS kit remain unused in inventory. In all such cases, the Coordination and site contractors used best judgment to make recruiting decisions in the best interest of the goals of the study.

Secondary Drivers

As noted above, during the course of an extended period of participation, it was quite likely that individuals other than the consented participant might drive the vehicle. That presented both a significant problem as well as a tremendous opportunity.

The significant problem was that when an unconsented individual drove an instrumented vehicle, data, including potentially identifying face video were being continuously recorded during that trip. Of course, this recording of data and video occurred automatically, with no known way to prevent or stop it. This was a serious issue because any trip could end in a serious at-fault crash or otherwise include the recording of embarrassing, compromising, or illegal behaviors. All IRBs providing approvals for the study vetted this issue, and the solution agreed to by all was that it was permitted to *record* such data (as it was essentially impossible to prevent this from taking place). However, once definitively determined to have been collected from an unconsented driver, these data ultimately had to be expunged, without ever being analyzed or otherwise used in any research protocol or related activity.

However, there was also a tremendous opportunity. If one or more individuals other than the primary participant

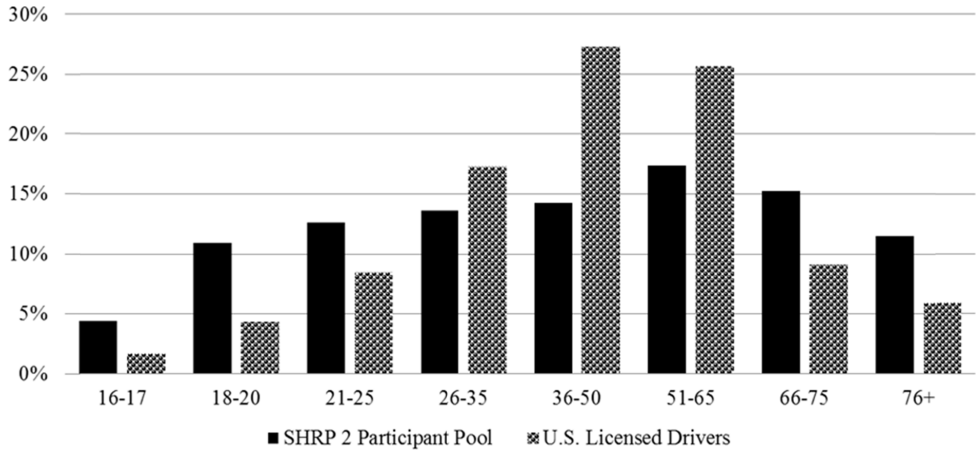


Figure 3.1. Distribution of age of participants as of April 2012 versus that of U.S. drivers for 2011.

were expected to drive the vehicle on a fairly regular basis (e.g., the participant's close family members), then these individuals might generate interesting and/or useful data. Thus, up to three additional individuals for a given participant were given the opportunity to enroll in the study as *secondary drivers.* These were individuals other than the primary participant who could be expected to regularly drive the instrumented vehicle, and who granted informed consent to use their driving data over a particular period. In addition, these secondary drivers were asked to fill in two surveys (Demographics and Medical Conditions and Medications) and to provide a face image of some kind. Each was compensated $25 for participating.

Collecting a face image from each consented participant was crucial because it served as a reference image for the post hoc driver identification process, in which every trip file was evaluated manually by trained analysts to determine whether or not the driver was a consented participant. This process of collecting a reference image was relatively simple for most primary participants, because the system's in-vehicle cameras took a facial snapshot reference image of the driver in the driver's seat as a part of the DAS installation process. This image would ostensibly serve as a high-quality reference image as it could be expected to be very similar to actual trip file images seen by the driver identification analysts. However, there was no similar procedure available for secondary drivers, as these individuals consented by mail and never actually visited the site contractor's site. Thus, secondary drivers were asked to provide a reference image by sending a hardcopy or electronic photo or by pressing the incident button on the head unit while preparing to drive the vehicle. After pressing, the secondary participant was asked to state, "My name is [first name only spoken here], and I am a secondary driver in the study." Pressing the incident button created a marker in the data stream, making it possible for an analyst to find that specific portion of the data record and capture a reference image from the secondary driver's face video. Figure 3.2 shows the number of known secondary drivers by age group across the sites. Note that even if a secondary driver was consented, and thus provided data that can be analyzed, a reference image was still needed to positively identify trips by that individual as being a consented driver. Such images are still being collected. Note that the number of "not known" is far larger than any other age-group-gender combination. That is because secondary drivers typically never came to the site contractor facility and often provided incomplete information on their intake forms.

The subset of those consented drivers who provided a usable reference image as of January 14, 2014, is shown in Figure 3.3. Additional reference images may still surface through a variety of processes.

Multiple Primary Participants

Initially, only one primary participant per household was permitted. However, in a concerted attempt to recruit more teens and other young drivers into the study, it was later agreed that if a household included a young driver (typically a child of the first primary driver) whose primary vehicle was the first primary driver's vehicle, then those young individuals were also eligible to be consented and to be treated, essentially, in every respect as primary participants, including having all their assessment data collected. In August 2011, the Coordination Contractor implemented a protocol for the inclusion of these drivers in the study. Figure 3.4 shows the number of households with two primary drivers enrolled in the study across the six data collection sites.

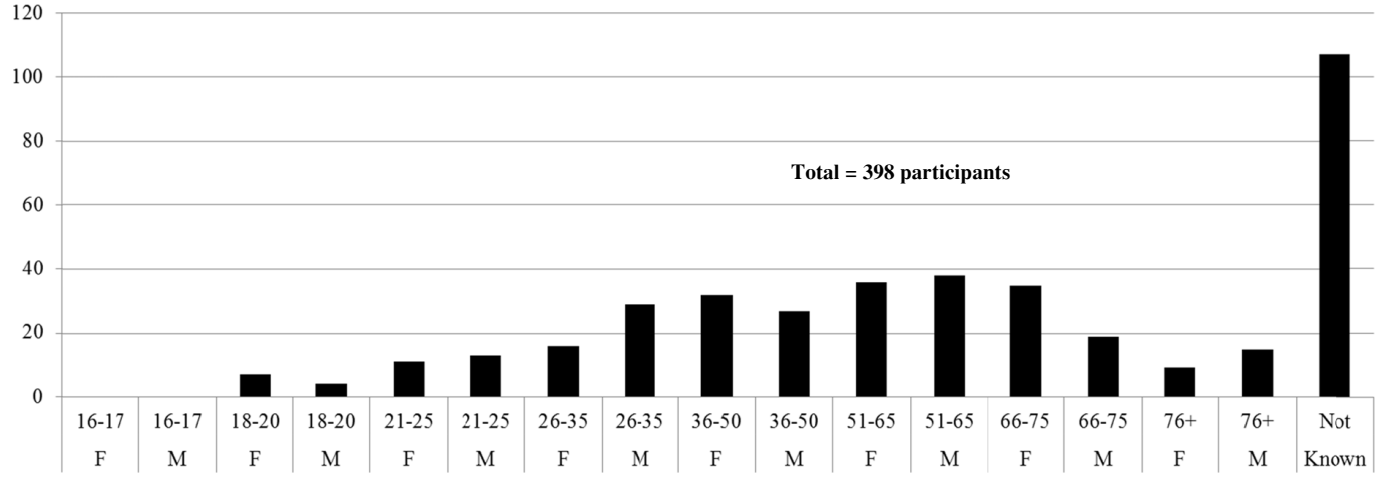


Figure 3.2. Consented secondary drivers by age-gender group across site irrespective of reference image.

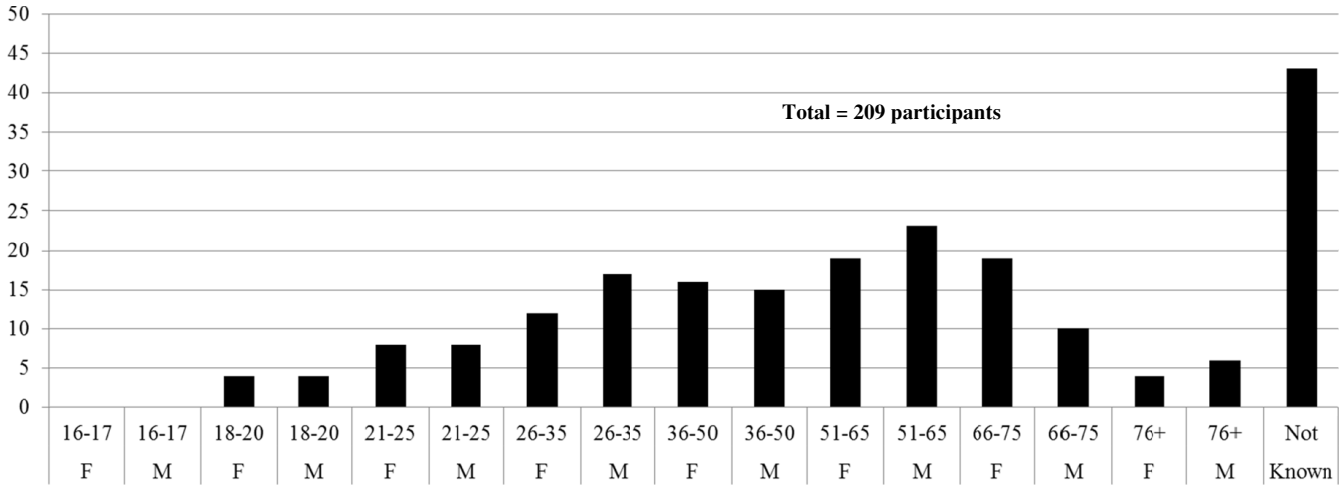


Figure 3.3. Consented secondary drivers by age-gender group across site with reference image.

Administrative Tools and Processes

Software Additions and Improvements

Throughout the course of the SHRP 2 NDS, several improvements were identified that could positively influence the efficiency with which the study processes could be managed. Of particular benefit, inventory, telemetry plans for the DAS, and participant management tools were addressed in midstudy cycles, which complemented existing management tools.

Component Information Tracker

In late 2010, the need to be able to assess the history of a component's installations in vehicles and known problems during particular time periods was recognized as offering the potential for use in troubleshooting. For example, if a problem was found with a component that affected data quality, then it might be a good idea to investigate whether that component had previously been installed in another vehicle and whether or not it demonstrated that same problem in the previous installation. To this end, a database viewer, the Component Information Tracker, was designed. The initial intent was for Coordination Contractor staff to respond to hotline-generated issues during after-hours calls. Later, the tracker became a heavily relied on software tool that streamlined the diagnosis of all vehicle and component issues. The Coordination Contractor used this software program to provide a simple view into the database that succinctly presented logged activity related to all components, including the history of a component's location, from creation at the manufacturer through installation in one or more vehicles, inventory exercise updates, deinstallations, and shipping and receiving activities. Figure 3.5 shows an example of a component history detail using the Component Information Tracker.

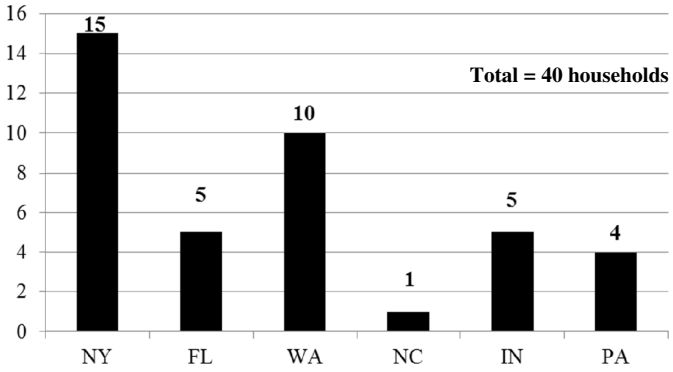


Figure 3.4. Number of households with multiple primary drivers, by site.

Component Shipping Tool

In large part because the study inventory was in a continual state of flux across the six data collection sites, the Coordination Contractor site, and the contract manufacturer site, the need for more standardized protocols for shipping and inventory management processes was identified. The resulting software, Component Shipping Tool, allowed S07 sites to associate components with a shipping box via barcode scanning protocols so that shipments could be tracked at box and component levels. This midstudy improvement allowed for better component location information within the database and significantly eased the amount of time needed to inventory components as they were returned from site contractors during the deinstallation phase of the project.

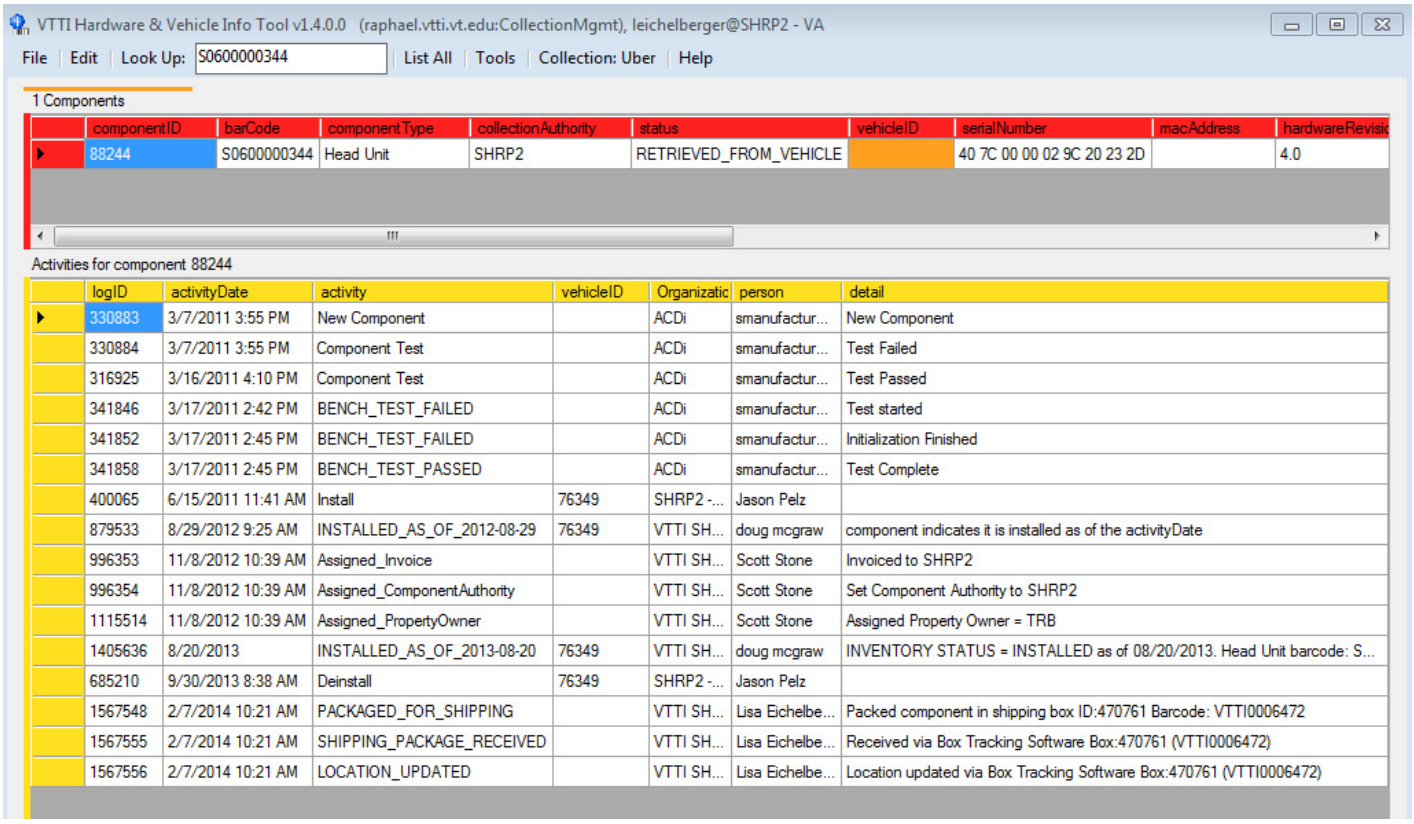


Figure 3.5. Example of component-level information via the Component Information Tracker.

Mission Control System Enhancements

During the study, a number of design improvements to MCS were identified, which can be generally characterized as improvements to display views and cross-referenced information that linked participants and vehicles and components. Further improvements added functional capabilities for uploading additional types of documents and linked participants to additional primary and secondary participants. While many of these served to improve efficiency of site contractor activities, others improved the efficiency of back-end algorithms.

Intra-Study Communications

Continual communication among all stakeholders was crucial to the success of this project. The Coordination Contractor provided weekly status updates on all aspects of the project to TRB staff at a standing meeting. This weekly meeting also provided a routine avenue for the Coordination Contractor and TRB staff to discuss the most pressing issues, and for TRB staff to contribute to problem solving. VTTI senior leadership provided similar updates to TRB's Technical Coordinating and Oversight Committees during their biannual project oversight meetings to make critical decisions and provide future guidance. In addition, the Coordination Contractor also conducted weekly operations team meetings with site contractors and TRB staff to discuss the issues faced by the site contractors and to address communications, supplies, outstanding work items, resources, or efficiency-enhancing solutions. Further, the Coordination Contractor conducted quarterly meetings involving their technical resources and the hands-on technicians working with each of the site contractors. At these meetings, detailed technical issues were discussed and solutions offered. Figure 3.6 illustrates the Coordination Contractor's communications model.

Weekly Operations Team Conference Call

As discussed in Chapter 2's description of preparations for the conduct of the study, the weekly operations team conference call was designed to provide continuing training and to elicit feedback concerning study progress at remote sites. This call proved to be an essential component of the collaborative relationship between Coordination Contractor and site contractors. Site contractors were encouraged to contribute to the setting of the weekly agenda by submitting topics of concern via the RT system. Topics addressed included IRB policy and its practical implications, issues of recruitment and participant

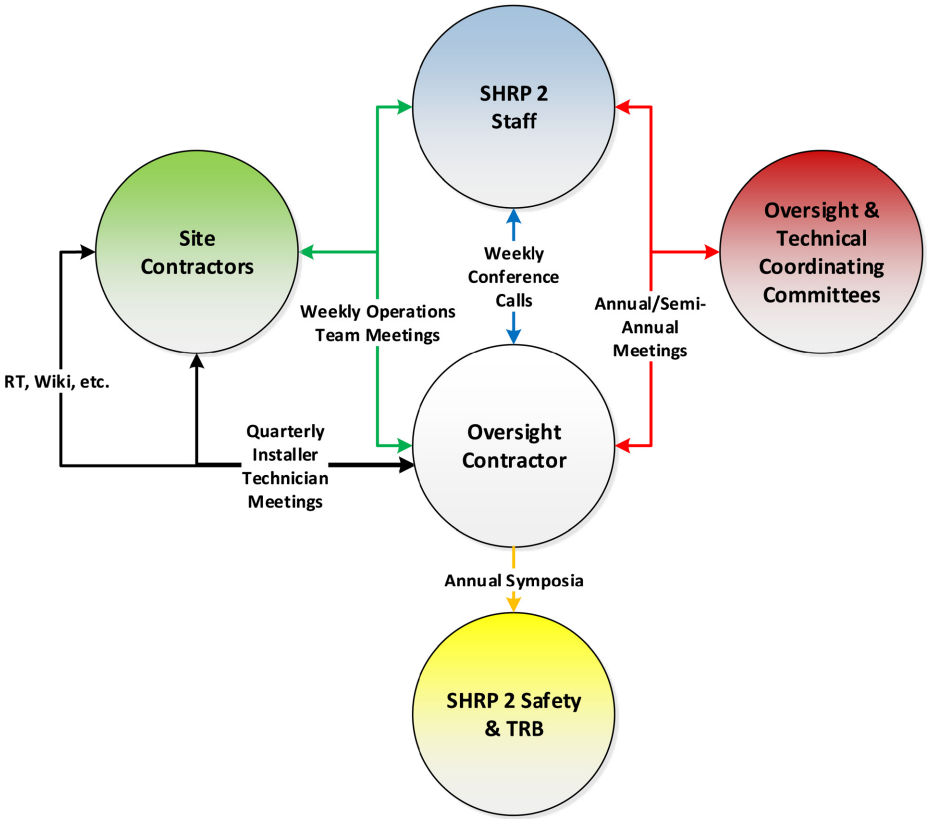


Figure 3.6. Communications model.

management, and matters related to vehicle installation and maintenance. Not only did it provide an opportunity for dissemination of vital study information and policy to site contractor PIs, it afforded the group a forum for discussion of systemic issues faced by the site contractors. All of these aspects contributed to decision making by the Coordination Contractor in conjunction with study sponsors.

Weekly Conference Call

Weekly conference calls, including SHRP 2 staff and Coordination Contractor personnel, afforded an occasion to monitor and reflect on study status (as represented by a robust suite of reports) and guide the study through every issue encountered. Often, these calls served as decision points for critical operational issues. Decisions on many critical and time-sensitive operational issues were made quickly and verbally rather than using a lengthy process of written proposals, review, amendments, and sign-offs. This provided the necessary flexibility to keep the whole project moving forward as quickly and effectively as possible. Strategic issues were referred to the relevant SHRP 2 committee.

Successful conduct of a research program on the scale of the SHRP 2 NDS required clear, consistent, and constant communication between SHRP 2 and Coordination Contractor staff, Coordination Contractor staff and site contractor staff, and Coordination Contractor staff and DAS technicians. Maintaining a regular schedule of conference calls along with the SHRP 2 wiki provided a continual flow of information, and sustained a high level of flexibility in managing critical issues.

TRB and Other Ad Hoc Presentations

Summer Safety Symposium

One key communications medium was the SHRP 2 Summer Safety Symposium, which served to communicate SHRP 2 activities to the broader research community and other interested parties. The Coordination Contractor coordinated the 3rd Annual SHRP 2 Safety Symposium in the summer of 2008. In addition to the standard introductions and overviews provided by SHRP 2 staff, the agenda for this symposium included a presentation and discussion of the SHRP 2 NDS study design. Further, updates and presentations were made by representatives from European and Canadian naturalistic driving studies and other SHRP 2 Safety contractors. Future SHRP 2 NDS project plans were also communicated with the larger research community. A keynote presentation was provided by Dr. Christine Branche, then Acting Director of

the National Institute for Occupational Safety and Health (NIOSH). The relevance of this presentation was especially well received given that the missions of the SHRP 2 NDS and NIOSH are so closely related—that is, to generate new knowledge about safety (and health) and transfer that knowledge into practice globally.

In subsequent years, the Coordination Contractor actively participated in the 4th, 5th, 6th, 7th, and 8th Annual SHRP 2 Summer Safety Symposia, each time updating status regarding the planning, implementation, data collection, and data sharing for the SHRP 2 NDS. This participation was of paramount importance given the overarching importance to SHRP 2 and the National Academy of Sciences of gathering and disseminating to the nation objective information related to precrashes, crashes, and exposure on the nation's highways.

Biannual SHRP 2 Committee Meetings

The Coordination Contractor staff provided technical input and presentations biannually to members of the SHRP 2 Technical Coordinating and Oversight Committees. General information about the NDS, which included study strategies as well as statistical assessments and metrics, was provided to inform the committees charged with technical and administrative oversight for the study. Strategic decisions made by the Safety TCC included revisions to the recruiting process to speed up enrollment (such as increasing the incentive) and the recommendation to extend the data collection period to achieve the overall participant-years exposure goal. All budget requests associated with these decisions were referred to the Oversight Committee for approval.

Reports

In addition to fulfilling the contractual obligation to provide comprehensive monthly and quarterly reports detailing study status and accomplishments, a variety of other reports were prepared on a regular basis by Coordination Contractor staff for a number of purposes. These included providing accountability to the project sponsor, guiding oversight of site contractor activities, assessing issues of specific concern, and serving as an engine to drive daily operations of Oversight Committee and site contractor staff. These reports provided crucial insights into study status and progress along a variety of dimensions, serving as key decision-making tools. They were designed with four objectives in mind:

1. Measure progress toward study goals;
2. Serve as a study management tool;
3. Guide protocol refinements and policy decisions in the interest of advancement of study goals; and
4. Serve as a resource for senior management in sharing study progress with external stakeholders and the wider research community.

Recruitment Reports

Recruitment reports were prepared by the VT CSR and disseminated weekly by the Coordination Contractor to site contractor PIs to provide insight regarding the success (or lack thereof) of various recruitment strategies, and to afford the PI an understanding of the size and age group/gender makeup of the latest slate of prospective recruits. The time period between a prospective recruit's first communication of interest in the study and a site contractor's receipt of his or her contact information was at times prolonged by eligibility screening and database processing. Providing the recruitment reports was therefore invaluable to site contractors in helping them anticipate future installation opportunities and allocating resources appropriately to attract additional recruits in accordance with the study sampling scheme or guidelines.

Sometimes, knowing why a potential recruit did not initially qualify proved to be an impetus to advance the study. For example, in the months preceding the expansion of the eligible vehicle list to include subprime, legacy, and basic vehicles, a number of prospective participants were rejected because their vehicles were not yet considered eligible for installation. See, for example, the graph taken from the April 28, 2011, recruitment report pictured in Figure 3.7. The majority of recruits initially rejected were disqualified due to vehicle eligibility issues. Reports like these helped study administrators identify impediments to full recruitment in all segments of the sample and spurred them toward remediation solutions, such as the decision to include vehicles previously excluded from the study fleet. This is illustrative of the way in which reports served not only a descriptive but also a prescriptive purpose.

Operations Metrics

An operations metrics report was prepared weekly and circulated among Coordination Contractor staff to present a glimpse into current study operations. The report encompassed all aspects of the study, including data quality, data ingestion progress, vehicle communications status, counts of participants and vehicles installed in the past week, solid-state drive status, outstanding maintenance items, inventory counts, and statistics pertaining to fleet issues of particular interest. The counts dictated the work activities of Coordination Contractor personnel each week; and the associated spreadsheets provided a road map for the completion of that work, identifying vehicles with communications issues or video quality problems, or in need of a solid-state drive

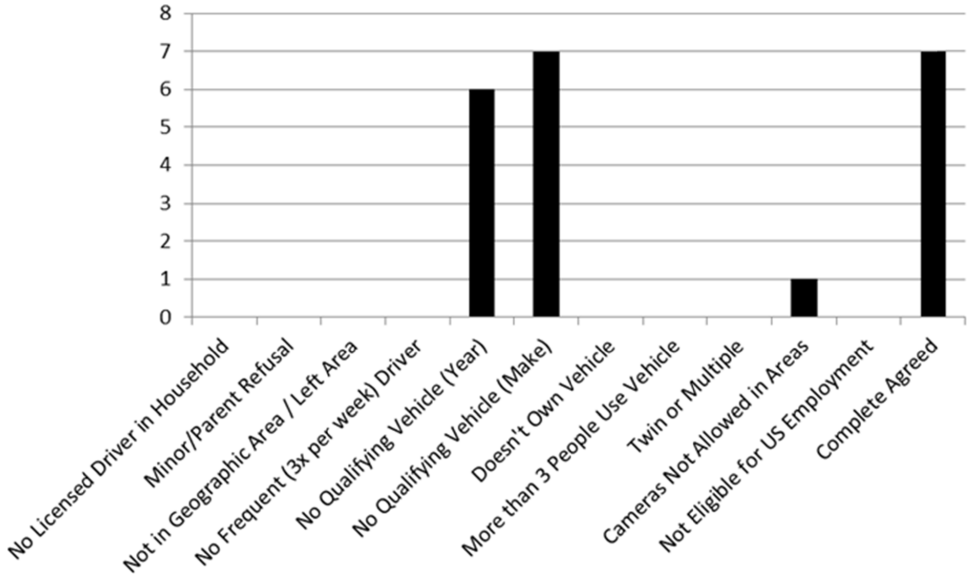


Figure 3.7. Reasons for recruit ineligibility in Florida, April 2011. ("Complete Agreed" means passed initial screening.)

swap. Access to a complete list of vehicles affected by a specific issue, such as faulty illumination of TPMS indicators, facilitated creation of maintenance request tickets in the RT software. This weekly snapshot of the state of the study was frequently upgraded to include additional data or data representations as requested by SHRP 2 staff or as necessitated by current issues. It allowed the Coordination Contractor and SHRP 2 staff to maintain a high level of scrutiny concerning all aspects of the SHRP 2 NDS.

Table 3.7 presents a snapshot of the vehicle metrics portion of the operations metrics report. The counts in the "No. Verified Good," "No. Verified Bad," and "Not Verified" columns refer to trip files taken from the ingested data pool. This segment of the report was of particular importance to Coordination Contractor staff. A glimpse into the quality of video and sensor data allowed for insight into the quality of collected data and provided a proactive approach to vehicle maintenance; files verified as bad could be correlated with specific vehicles, and appropriate remedies could be applied.

Data Volume Reports

One metric of the total quantity of data collected was the "vehicle-time period" (e.g., vehicle-month or vehicle-year).

Table 3.7. Vehicle Metrics Portion of Operations Metrics Report

	September 25, 2012			
Data Item	**No. Verified Good**	**No. Verified Bad**	**Not Verified**	**No. Verified Good/ Total Verified**
Network speed reported	1,325	36		97.35%
Accelerator position reported	541	13		97.65%
Turn signal status reported	528	32		94.29%
Brake pedal reported	525	21		96.15%
Usable face video (i.e., >80% per vehicle)	1,506	3	272	99.80%
Usable forward video (i.e., >80% for car)	1,496	2	283	99.87%
Usable rear video (i.e., >80% per vehicle)	1,351	154	276	89.77%
Usable lap video (i.e., >80% per vehicle)	1,405	104	272	93.11%
Usable inertial measurement unit (acceleration, *x*-axis)	1,489	11		99.27%
Usable GPS (speed only)	1,098	45		96.06%

According to this concept, each participant contributes one vehicle-month of data for each full month of participation in the study and one vehicle-year of data for each full year in the study, regardless of the actual number of driving miles or hours represented during that time period. It may be argued that driving distance and time are more accurate ways to determine overall data quantity, but these were also more difficult to accurately capture or estimate during the conduct of the study. The total number of vehicle-months collected, on the other hand, could much more readily be calculated at any given point in time for any desired subset of the data (e.g., by age group, gender, and/or data collection site).

In developing the vehicle-months/miles report and projections calculator, Coordination Contractors were seeking a tool that would (1) provide a metric for study progress toward the sample design goal of 3,900 DAS-years and (2) make it possible to project data acquisition for individual sample cells based on the allocation of future installations at both the individual data collection site and overall study levels. Generating the vehicle-months portion of the report involved calculating the number of vehicle-months collected by each vehicle in the study and projecting how many additional vehicle-months each participant was expected to accumulate. The projection was based on a set of guidelines and assumptions about how long each participant was expected to remain in the study and how future DAS resources would be allocated.

Projected vehicle-months resulting from extensions and from reinstallations were calculated separately, affording study administrators the flexibility to make choices about future study policy that would yield optimal data acquisition for every sample cell of the study. Figure 3.8 is taken from the vehicle-months report dated August 31, 2012, and was used by SHRP 2 program managers and the Coordination Contractor to assign reinstallation targets for older and younger sample cells such that progress toward study goals was optimized.

The concept of vehicle-miles was defined in a similar fashion as that of vehicle-months described above. Every mile driven by a participant represented a single vehicle-mile (regardless of duration or location of the trip). Total vehicle-miles acquired for in-study reporting purposes were calculated on a vehicle-by-vehicle basis factoring in data accumulation in megabytes (MB) since the last SSD swap. The calculation assumed data collection at a rate of 10 MB/min and an average speed of 30 mph. A participant's driving frequency since the most recent swap of the SSD was assumed to be representative of his or her driving frequency over the course of his or her tenure in the study. Calculation of projected vehicle-miles was based on the notion that the ratio of accumulated vehicle-miles to accumulated vehicle-months would be equal to the ratio of projected vehicle-miles to projected vehicle-months. In this way, vehicle-miles projections rested on the same set of assumptions about study term completion and extensions as did projections with regard to vehicle-months.

Site Priority Summary

The site priority summary, presented monthly to Coordination Contractor management and shared with SHRP 2 staff, provided a comprehensive assessment of the condition of the SHRP 2 NDS vehicle fleet and participant pool. An example report is included in Table 3.8. The insight afforded by the site priority summary assisted Coordination Contractor administrators in monitoring the effectiveness of the issue prioritization process described in the next section.

Site Priorities Process

As the study expanded to include close to 2,000 vehicles on the road, the challenge of ensuring the full functionality of installed DASs in such a sizable fleet necessitated a systematic, centralized approach to setting maintenance priorities. The Coordination Contractor assigned each maintenance item a priority level of 1, 2, or 3. Priority levels were defined as delineated in Table 3.9.

Priority levels were assigned based on the following criteria, listed here in decreasing priority order:

- *Communication status.* Vehicles not communicating within the past 30 days were flagged for maintenance.
- *SSD decrementing.* Discernible change in the fullness of the SSD was a strong indication as to whether the data acquisition system was collecting data as intended.
- *Delivery of Advanced Health Checks.* Vehicles failing to deliver an Advanced Health Check within the past 45 days were flagged for maintenance.
- *Excessive communication or history thereof.* Indication of potential power issues with the DAS were cause for concern.

The Coordination Contractor disseminated site priority spreadsheets listing all priority maintenance tickets to site contractors on a monthly basis.

Quality Metrics

The quality metrics report, submitted weekly by the Coordination Contractor to SHRP 2, provided an overview of study operations. These included vehicles on the road relative to study targets, sample cell population, vehicle installations by vehicle type, data ingestion and processing, data quality, status of components in the repair process, crash counts by category, percentage of trips in which a consented participant had been confirmed as the driver, and counts

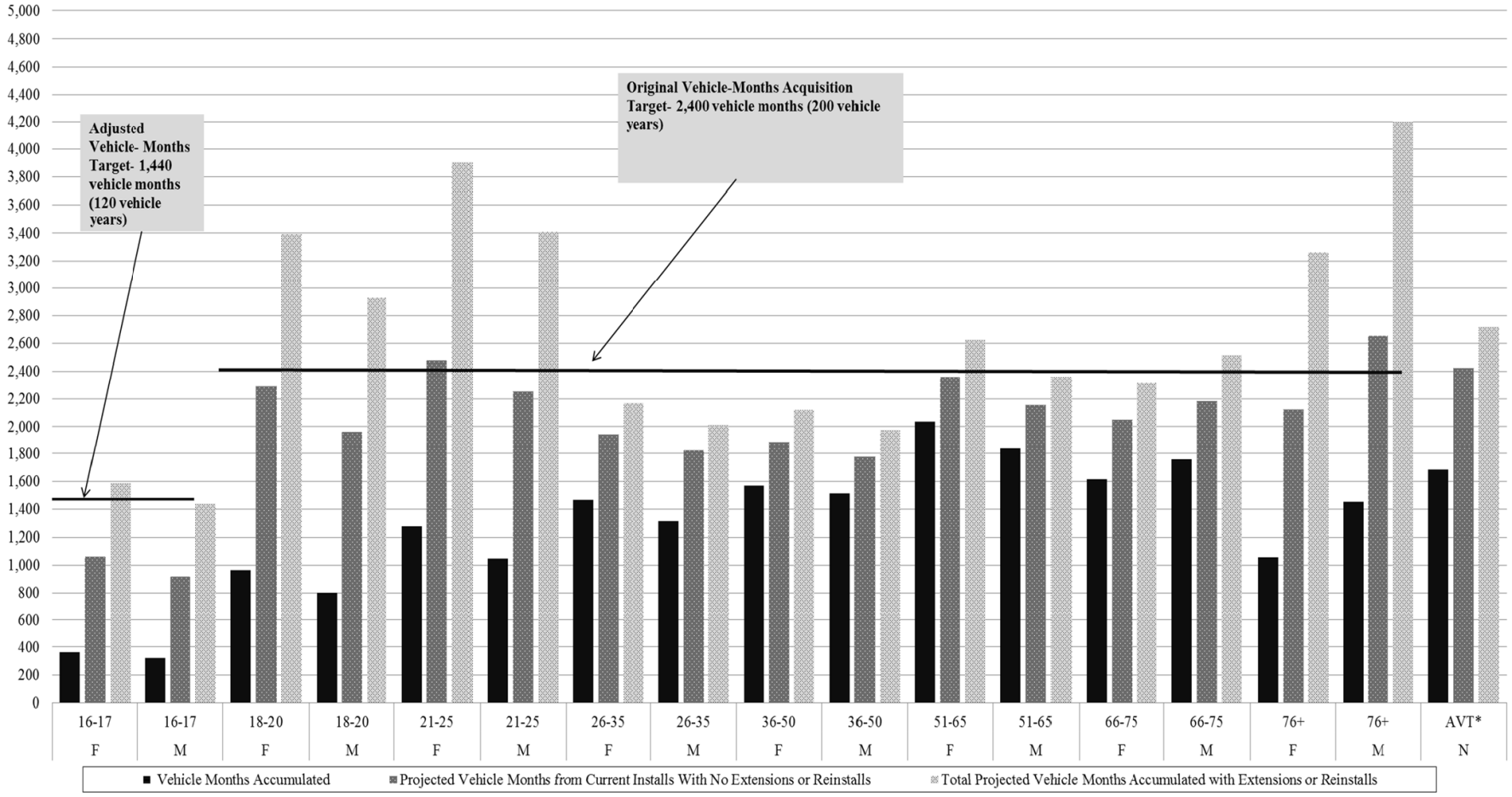


Figure 3.8. Vehicle-months report, August 31, 2012.

Table 3.8. Site Priority Summary, April 9, 2013

Issue	Buffalo	Tampa	Seattle	Durham	Bloomington	State College	Total
SHRP 2 Fleet Snapshot							
Vehicles on road	450	455	437	304	151	146	**1,943**
Communicating	446	454	434	302	150	145	**1,931**
Percentage of installed vehicles communicating	99.11%	99.78%	99.31%	99.34%	99.34%	99.32%	**99.00%**
SSDs recording data	445	453	437	304	149	146	**1,934**
Percentage of installed vehicles recording data	98.89%	99.56%	100.00%	100.00%	98.68%	100.00%	**99.54%**
Major Fleet Issues							
Not communicating	4	1	3	2	1	1	**12**
SSDs not decrementing/not recording data	5	2	0	0	2	0	**9**
Failing to deliver Advanced Health Checks	1	1	3	1	1	1	**8**
Communicating in excess	0	0	0	0	0	0	**0**
History of excessive communication requiring attention	1	15	6	7	3	5	**37**
SSDs >90% full	3	11	0	0	1	2	**17**
Percentage of vehicle fleet with SSDs exceeding 90%	0.67%	2.42%	0.00%	0.00%	0.66%	1.37%	**0.87%**
S07 Site Progress							
Priority 1 issues identified in previous report (2-22-13)	24	23	5	7	11	14	**84**
Priority 1 issues completed from previous report (2-22-13)	21	20	5	6	11	14	**77**
Percentage of Priority 1 issues completed from previous report (2-22-13)	87.50%	86.96%	100.00%	85.71%	100.00%	100.00%	**91.67%**
Priority 1 issues remaining from previous report	3	3	0	1	0	0	**7**
Action taken (e.g., participant called)	3	3	0	0	0	0	**6**
No action noted	0	0	0	1	0	0	**1**

Table 3.9. Maintenance Priority Levels

Priority Level	Definition	Examples
1	Data loss is imminent or participant is potentially exposed to danger; a visit to the vehicle is required within a week.	• SSD fullness exceeding 90% • Failure to communicate in more than 30 days • Failure to deliver Advanced Health Checks in more than 45 days • Dangling head unit • Front or face camera issues
2	Pertaining to data quality–related processes; a visit to the vehicle is required within 2 weeks.	• SSD fullness exceeding 70% • Non-DAS-related assessment needs to be repeated for currently installed participant
3	Not pertaining to a current installation or participant; a visit to the vehicle is required but may be delayed until a higher priority issue exists concurrently.	• Rear camera misalignment • NextGen anomalies not threatening acquisition of data

of SSDs reaching capacity at each data collection site. As the data collection period drew to a close, the focus turned from installation progress to the number of deinstallations accomplished at each site relative to targets designed to ensure that all study equipment was removed from subject vehicles by November 30, 2013. An example of the chart chronicling this progress is pictured in Figure 3.9. All of these inputs allowed Coordination Contractor management and study administrators to formulate sound study policies that maximized data collection and maintained a thriving vehicle fleet.

Ad Hoc Reports

The Coordination Contractor generated several periodic reports on weekly, monthly, or quarterly bases. In addition, many were produced on an ad hoc basis. These reports provided crucial information on the current and projected status of key progress metrics, which helped study leaders guide the research effort toward its ultimate goals.

Reports of note included TPMS/RF interference assessment, secondary driver Cell Phone Records Study eligibility assessment, and secondary driver data needs evaluation.

Reports Summary

Reports, both internal and external, played a vital role in the successful conduct of the SHRP 2 NDS. They proved invaluable, both as quantitative assessments of all aspects of the study as well as engines for generating the daily and weekly workflow of Coordination Contractor personnel and site contractor staff alike.

Inventory Exercises

In conjunction with inventory requirements established in the Project S12A DAS Procurement contract, the Coordination Contractor was required to perform routine inventory exercises to demonstrate that the DAS components were being adequately tracked throughout the course of the study. To this end, all inventoried components were labeled with a barcode, and a custom software tool placed them in the database when scanned. Four inventory exercises were conducted during the course of the project. The first one was conducted in fall 2012; the exercise was repeated in spring 2013 and fall 2013. At the conclusion of the SHRP 2 NDS and following the deinstallation of all study vehicles, a final inventory exercise

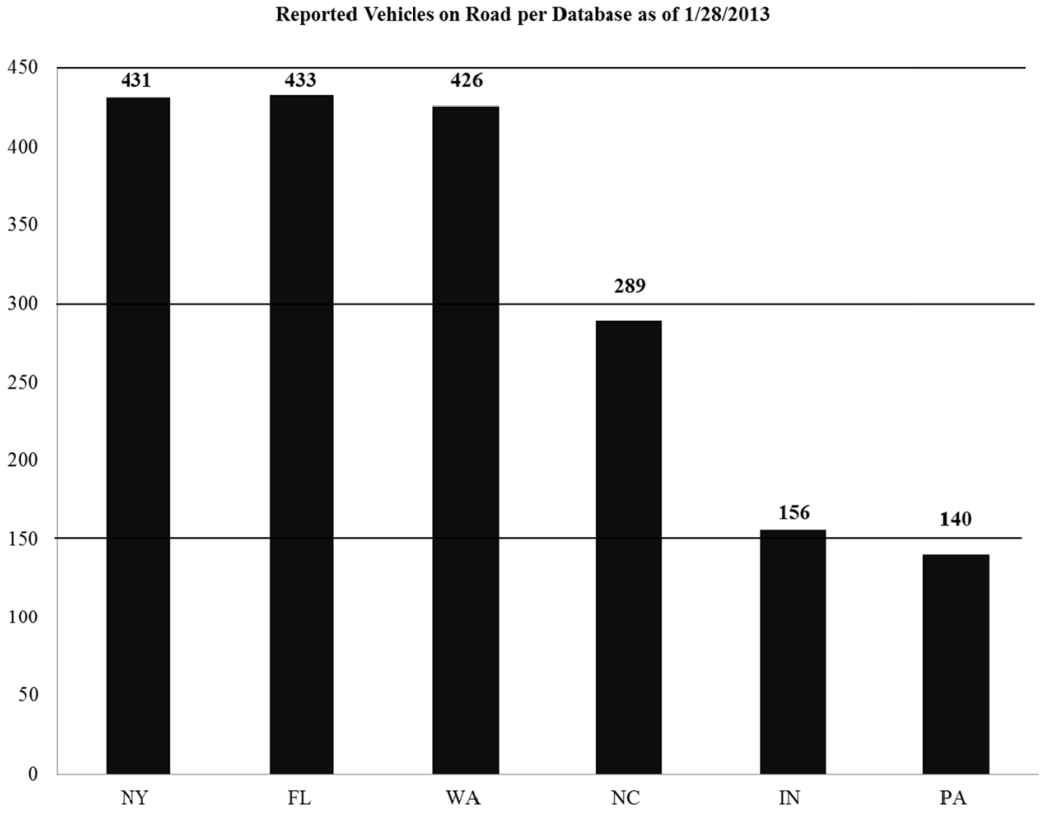


Figure 3.9. Quality metrics showing vehicles on road relative to nominal target for each site (i.e., 450 for Buffalo, Florida, and Seattle; 300 for Durham; and 150 for Bloomington and State College).

Table 3.10. Inventory Exercise Summary

Factor	Fall 2012	Spring 2013	Fall 2013	Final Accounting
Total purchased	12,902	12,902	13,152	13,152
Quantity missing	62	38	75	TBD
Percent missing	0.48%	0.29%	0.57%	TBD

was conducted. The outcomes of the fall 2013 inventory exercise are summarized in Table 3.10. The final inventory accounting will be conducted after delivery of this report and submitted later.

Detailed instructions were provided to the site contractors in advance of each inventory exercise. Following the exercise, components that were not located were rendered unusable in the database, thus making it impossible to install that component in a vehicle or otherwise use it until it was properly scanned and its status corrected. As components were found after the inventory, a manual adjustment to the database reset the functionality so that the components could be used again. Note that items labeled *Missing* were presumed to be temporarily missing or misplaced until the site contractor reported information that changed the status to *Stolen* or *Decommissioned*.

Additionally, components could have been unavailable for use for several other reasons due to theft/loss, damage, or needing repair. To date,

- 25 components have been stolen or documented as permanently lost (0.19%);
- 79 components have been decommissioned due to irreparable damage (0.60%); and
- 152 components remain out of service due to needed repairs (1.15%).

CHAPTER 4

Data Management and Processing

Data Collection/Ingestion Process

Data transfer began when the site contractors inserted a vehicle's data drive into the solid-state data drive bay apparatus attached to their respective site server, which provided the interface for the data to be transferred from the SSD to the staging server. The data transfer and subsequent processing through ingestion were controlled by a workflow system designed and implemented in the Coordination Contractor's high performance computing (HPC) data center.

Ingestion

Data ingestion involved the highly choreographed, workflow-driven movement of data from the vehicle to temporary residence on a site contractor's server, then transfer through a high-speed research data network to the Coordination Contractor, where it was processed (see Figure 4.1).

When data arrived at the Coordination Contractor's data center, the workflow engine generated a copy of the original encrypted data received from the site contractors for processing purposes. As soon as the "processing copy" was created and validated (as an exact copy), the original encrypted data file was sent to the Coordination Contractor's archival (magnetic tape) data storage. The processing copy resided on disk storage systems in its encrypted state until broken apart by the workflow agents for ingestion processing purposes. The workflow agents decrypted files and transformed the data into formats that could be loaded into the Coordination Contractor's video storage or database repository. As the workflow agents completed their tasks, they deleted the processing copies. At the end of the workflow processing steps, the original data received from the site contractors were stored in a tape archive; the finished files are available for analysis on the Coordination Contractor's video storage and database systems.

Archived data are safely stored and preserved in their original raw (encrypted) form for the duration of the lifetime of the data (i.e., for up to 30 years after the last participant left the study). Thus, if researchers or analysts for any reason need to return to the original, unaltered data to gain a deeper, truer understanding of any particular subset, the data in their original raw form will be available for such analyses.

Processing

At the point when data were ready to be analyzed by data reductionists or researchers, they were no longer encrypted. Instead, researchers and reductionists were assigned well-defined and strictly regulated roles that provided access to data based on their Active Directory (AD) domain credentials and their assigned AD group membership. The database and file servers implemented role-based security according to AD group membership, and group membership was granted (or removed) as needed by a select group of research scientists.

Data Protections

SHRP 2 data were protected from the moment they were collected through migration from vehicle to the final research repository. In addition, data were stored "as collected" in a modern peta-scale hierarchical storage management (HSM) system where an archival copy was maintained in the HSM system's tape library.

The first line of protection started on the DAS with a sophisticated data encryption process. Once data were transferred to the Coordination Contractor, decrypted, and ingested, they were protected by role-based security that limited a user's access to data based on their IRB approvals (in the case of access to personally identifying information) or on their need for access to data elements required to address research questions as guided by SHRP 2. Additionally, multiple copies of SHRP 2 data were maintained at separate facilities in

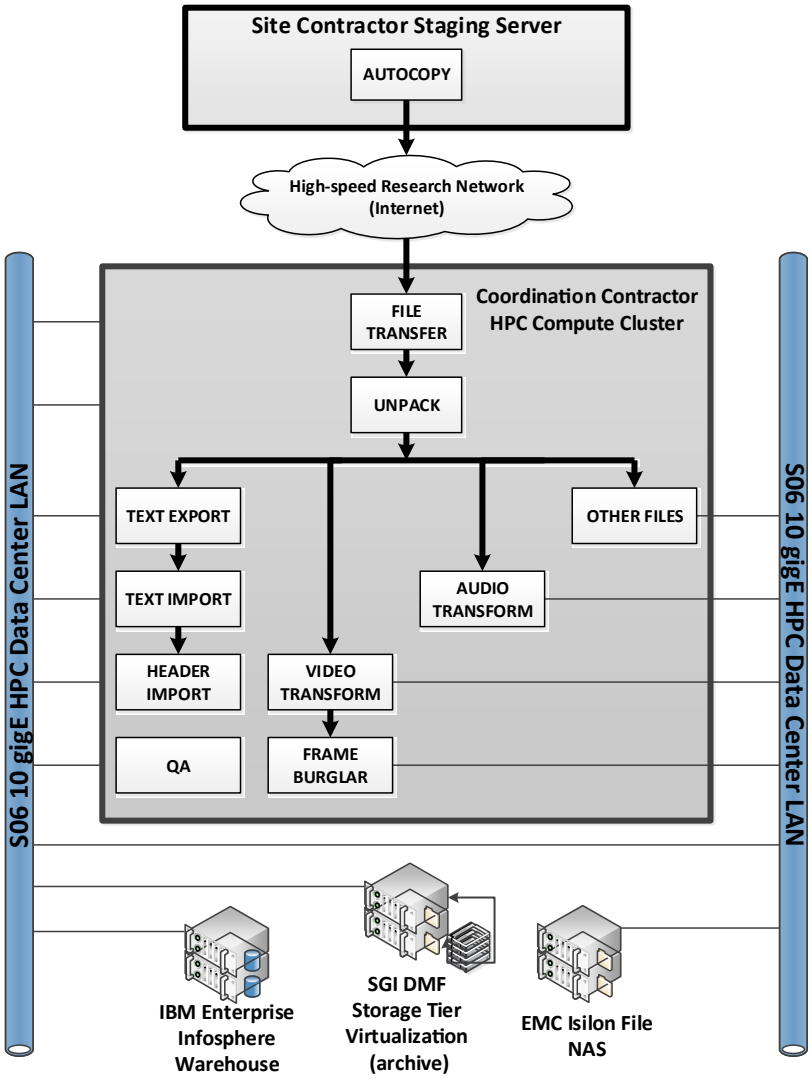


Figure 4.1. Data collection and ingestion workflow.

case one facility was to suffer a disaster of any sort (note that the facilities were in the same locality, which is not the ideal arrangement).

Encryption

Data encryption relied on two encryption methodologies: Advanced Encryption Standard (AES) and the Rivest, Shamir, Adleman (RSA) algorithm. To prevent the possibility of data decryption in a location other than the Coordination Contractor, the AES key was further encrypted with the public key of an RSA public/private key pair. RSA is an asymmetric encryption technique: a publicly available key was used for encryption; decryption required the paired private key, which was stored at the Coordination Contractor's location. A unique RSA public/private key pair was allocated to each DAS. The collected data (sensor and video) contained personally identifying information and were therefore necessarily guarded from exposure to users or hackers who were not IRB-approved to work with the data. Data security began at the point where data were collected and stored on the DAS hard drive.

PID Decoding Process

In preparation for the SHRP 2 NDS, the Coordination Contractor assessed U.S. light-vehicle sales from model years 2000 to 2007. By working in conjunction with the Alliance of Automobile Manufacturers and the Association of International Automobile Manufacturers, the Coordination Contractor pursued relationships with the major OEMs to obtain CAN PIDs. This effort served to enrich the database with additional data from the onboard vehicle network for high-volume models. The types of data made available included

speed, wiper usage, brake actuation, accelerator position, turn signal usage, and steering data.

Considerable effort was expended in mapping the network data elements in the database for each unique year/make/model combination. This activity required great care to ensure that proprietary information related to the PIDs could not be extrapolated for inappropriate use. Mapping the additional data elements to the database allowed vehicle-specific packages to be installed on the solid-state drive during installation.

Data Quality Processes

With any study, it is imperative to not only continually monitor, but also work to ensure that the data being collected are as high in quality as possible in terms of completeness and accuracy. These facets of data quality must be present to generate meaningful conclusions from the analyses. This section describes the quality processes applied to all study data, including driving sensor and video data collected via the DAS as well as a variety of nondriving data (e.g., participant demographics, driver functional assessments, vehicle characteristics and features, and post hoc crash analyses).

Sensor Data

Once data were ingested into the database, they underwent a standardization process and a subsequent battery of automated quality checks. These processes are described in more detail in this section. The processing of the data was aided by the development of a data dictionary table. This table provided the variable name, the expected units, a description of the variable, lower and upper limits, and expected data availability rate for each variable.

The first step in the standardization process was to map the collected variables for each vehicle into the existing set of standard variables as outlined in the data dictionary. Because of the wide variety of vehicles present in the data set and the proprietary nature of some of the code used to standardize the data, such standardization could not be performed on the DAS in real time, as DAS processing resources were deliberately minimized to the greatest extent possible to conserve size and power consumption. Consequently, samples of collected variable data for each vehicle were examined visually post hoc for each vehicle and assigned to appropriate standard variables. In some cases, there was a one-to-one match between collected data and the standard variable across the vehicle fleet, but this was not true in many other cases, especially those involving network variables. Once completed, these assignments were instantiated in the database.

The standardization process also included the definition of any necessary translation of the collected variable to comply with the units and/or categories available for the standard variables. For example, the network speed for a particular vehicle might have been collected in miles per hour units. The standard unit for network speed is kilometers per hour. Therefore, a unit translation would be necessary to convert the collected variable into the corresponding standard variable and make that value compatible with others from different vehicles. These translations were also instantiated into the database.

Automated quality checks were applied after standardization. They occurred at the file level, meaning that an independent set of checks was completed for each file collected. The checks for each variable were documented at the timestamp level so that segments of "good" data for a variable could be isolated from "bad" data within the same file. These checks were meant to flag any data that were out of expected bounds or were produced as a result of DAS malfunction. Note that not all of these checks were applicable to all standard variables; in some cases, a variable may only have been subjected to one or two of these checks as appropriate. The battery of automated checks is provided below:

- *Not present* indicates whether at least one data point was captured for a variable within a particular file. If a variable was not present for an entire file, no other checks for that variable were necessary.
- *Bounds* indicates whether the values recorded for a given variable were within the bounds defined in the relevant data dictionary. Boundary values (i.e., lower, upper, both) could be specified independently for each variable.
- *Simple dependency* indicates whether the dependent variable (i.e., the variable being checked) should be considered of questionable quality given that a "parent" variable had failed one or more of its quality checks. These comparisons were made on a timestamp-by-timestamp basis. Each simple dependency consisted of only one dependent and one independent variable, but more than one simple dependency could be applied to a single dependent variable. For example, one of the quality metrics for the processed accelerometer values considered whether the corresponding raw values exhibited good quality during the same time period.
- *Complex dependency* is similar to a simple dependency but with more complex conditions allowed. While a simple dependency was a function of the independent variable having "good" quality when the dependent variable was collected, a complex dependency could further refine what values of the independent variable indicated "good" quality for the dependent variable. Each complex dependency consisted of only one dependent and one independent variable, but multiple complex dependencies could be applied to a single dependent variable. For example, a check for any variable collected from the vehicle network modules

required that the last reported status for that module indicated a "recording" status to output a good quality score.
- *Duplicates* indicates whether a particular variable had two entries on the collected data under the same timestamp. If that was the case, the data quality for the timestamp in which this occurred was considered "bad."
- *Spike identification* indicates whether a data point that was otherwise within the expected bounds for the variable should be considered experimental noise, typically due to sensor noise. This particular check was used for longitudinal and lateral accelerations. The code examined preceding and following values around the suspected spike and assessed whether the overall pattern was feasible based on the expected physics of the scenario. Multiple metrics were used in this assessment, including the derivative of acceleration, the variance in the sample, and measures from basic principles of motion.

Results from the battery of checks were instantiated in the database for each file. The results were then aggregated by data drive to assess the overall quality of the data for each collected drive. Each of those aggregated sets of data quality profiles was examined by a data analyst. Problems that suggested systematic issues were further studied to determine whether corrective action was possible and the level at which it should occur (e.g., vehicle, database). Files without issues for further study, those for which corrective action had occurred, or those for which no corrective action was possible, were then released for subsequent analyses.

Video Data

Part of these subsequent analyses entailed a manual review of images transmitted via Advanced Health Checks, discussed previously, with an eye toward identifying specific vehicles in need of camera adjustment or replacement. Table 4.1 summarizes the standards to which each camera view was held for the purposes of this quality assurance and control process.

This review was undertaken by a team of trained data reductionists under the auspices of a protocol that elicited a quality assessment for each of the four camera views: face, forward, hands, and rear. The quality assessment for each view was selected from one of four options, defined as follows:

- Good quality: Video is clear, viewable, and correctly aligned.
- Misaligned video: Video is misaligned from target (i.e., pointing in the wrong direction).
- Distorted: Video is available but not usable for research purposes.
- Not available: Video is unavailable.

Figure 4.2 presents an example of an Advanced Health Check image that received an assessment of good quality for all four camera views. In such a case, no further action would be required.

A variety of video errors, caused by misplaced or malfunctioning head units or rear cameras, was detected through quality checks of images associated with Advanced Health Checks. These included unavailability of one or more of the video views, misalignment of one or more views, and distortion of one or multiple views to the extent that meaningful analysis could not be conducted. In such cases, once confirmed by the Coordination Contractor data integrity coordinator, referral would be made to the Coordination Contractor operations staff, who would review the images and subsequently issue the indicated maintenance request.

The process followed for the evaluation of images transmitted in conjunction with Advanced Health Checks was

Table 4.1. Camera Views—Ideal Descriptions and Purposes

Camera View	Ideal	Purpose
Face camera	Complete, clear view of the driver's face, including eyes and mouth. Camera should be positioned to exclude views of backseat passengers.	A clear view of the face facilitates eye-glance analysis and evaluation of distraction associated with secondary tasks of talking, eating, and singing.
Forward camera	High-quality, color video of the forward roadway. Forward road and traffic, traffic lights, and cars in front should be visible, with roadway centered horizontally and with the horizon just above the center line.	A clear view of the forward roadway facilitates evaluation of traffic density, visibility, road conditions, and time of day, as well as recognition of potential hazards posed by oncoming traffic and activities of drivers in surrounding vehicles.
Instrument panel	High-quality video of the distance from the driver's door to the center console, featuring a complete view of both of the driver's hands and steering wheel, radio/CD player/cigarette lighter, and center console.	A clear view of hands and center console facilitates analysis of distractions resulting from secondary tasks such as adjusting cabin temperature or radio, using a cell phone, and reaching for objects.
Rear camera	High-quality video of the traveled roadway. Traveled roadway, following traffic, and traffic lights should be visible, with roadway centered horizontally and with horizon just above center vertically.	A clear view of the traveled roadway facilitates analysis of traffic density and potential hazards posed by following traffic.

Figure 4.2. Example of good quality for all four video views (with participant's face hidden).

similar to the quality assurance protocol used to evaluate sample video files taken from the ingested data pool. The scope of the quality review undertaken for the sampled files extended beyond video quality assessment to include validation of network variables, including speed, throttle position, and radar accuracy. Despite this increase in complexity, both of these quality assurances reviews were part of the larger process of verification, documented in Figure 4.3, which ensured that all data collected were of optimal value and that all DASs installed in SHRP 2 vehicles were operating in an optimal fashion.

Non-DAS Data

Assuring the quality of the time series data and video collected via the DAS was a central focus of the overall quality efforts; but considerable effort was also devoted to assuring the quality of the many non-DAS sources of data, as described below. Several approaches were used, including applying basic knowledge of the data when applicable (e.g., for height and weight). In the absence of such baseline knowledge, a statistical outliers approach was employed such that extreme values were distrusted and discarded, except when independent verification suggested otherwise. With this interquartile range (IQR) approach, any value $\leq[Q1 - (1.5 \times IQR)]$ or $\geq[Q3 + 1.5 \times IQR]$ was considered an outlier, where Q1 = first quartile, Q3 = third quartile, and IQR = interquartile range or (Q3 – Q1) for the particular variable distribution in question.

Participant Demographics

When appropriate and possible, demographic information was validated to ensure accuracy and quality. The key variables that were validated and verified were date of birth, age of licensure, gender, years driving, and miles driven in

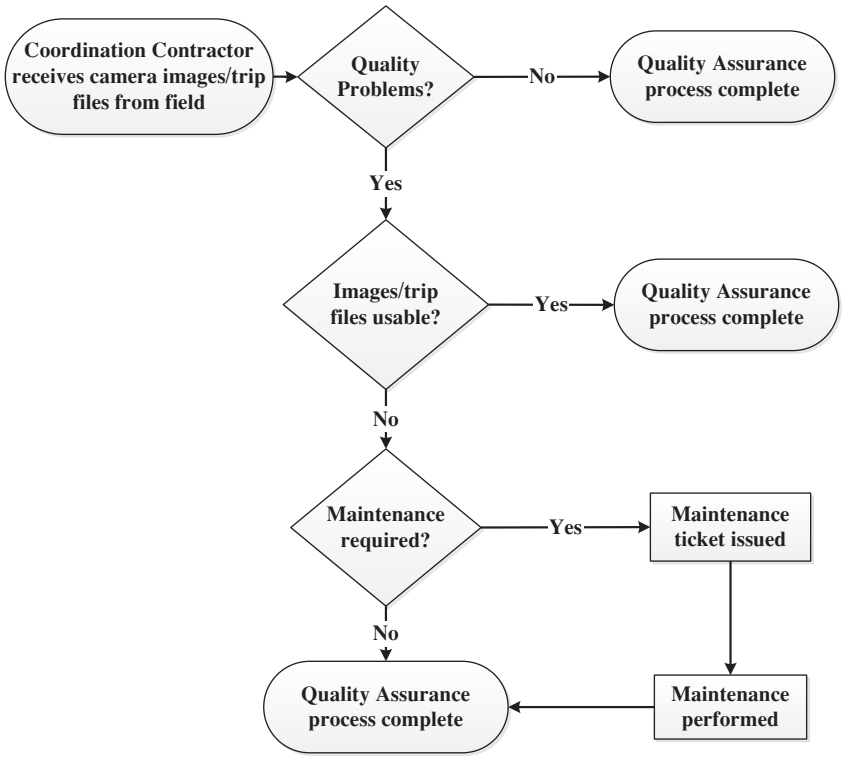


Figure 4.3. Process flow for quality assurance of video and sensor data.

Table 4.2. Participant Age, Licensure, and Years Driven Information Validation

Variable	Test
Number of years driving	Greater than the age of participant
Birth date	Less than 16 years from today's date
Miles driven in previous year	Greater than 150,000 miles a year
License age	Less than 14 years old

the most recent previous year. Validation techniques included employing general statistical testing such as normal distributions, cross tabulations, and box-and-whisker plots to identify outliers and anomalous values within the data collected. Validation efforts also used the application of general knowledge and logic such as literature review and considering the minimum licensure age in the United States as indicated in Table 4.2. When appropriate, requests were made to data collection sites to verify or update missing and anomalous data.

Participants with data entries that fell outside the identified ranges of a given variable were flagged for verification by the relevant site contractor. When participants could not be contacted for verification, a null value was assigned in place of the anomalous data. When participants could be contacted and the data for a given variable could be corrected or verified, amended data were inserted. Table 4.2 provides the test and rationale for age, age of licensure, years driven, miles driven in previous year, and date of birth.

Driver Functional Assessments

Functional assessments, as previously referenced, were collected from each primary participant, typically at the outset of each one's participation. Questionnaire responses were reviewed for completeness and accuracy. Validation efforts focused on identifying outliers, anomalous data points, and standardizing units of measure. It should be noted that participants did have the right to refuse to answer any particular question and to refuse or discontinue participation in any particular functional assessment with neither reason nor penalty.

Attitude and Behavior Questionnaires

The completion rate for the attitude and behavior questionnaires was roughly 99% (see Table 4.3). The completion verification process included creating a database of the completed or attempted questionnaires for each participant. If a participant was missing one or more questionnaires, the data collection site was contacted and a request made that the participant complete the missing questionnaires. Similarly, if a participant omitted a large majority of questions within a specific questionnaire, the data collection site was requested to ask the participant to complete the questionnaire.

Health- and Sleep-Related Questionnaires

The health- and sleep-related questionnaires included the Medical Conditions and Medications and the Sleep questionnaires. The Medical Conditions and Medications questionnaires (Appendix G) were primarily validated for anomalous data within three main variables: height, weight, and neck size.

Table 4.3. Completed Assessment and Related Surveys for Participants in the Study at Least 1 Day

Survey	Participants	Completed Surveys	Percentage Complete
Driver Demographics Questionnaire (Appendix V)	3,254	3,244	99.7
Driving History Questionnaire (Appendix W)	3,254	3,245	99.7
Barkley's ADHD Quick Screen Questionnaire (Appendix D)	3,254	3,245	99.7
Driving Knowledge Questionnaire (Appendix F)	3,254	3,240	99.6
Medical Conditions and Medications Exit Survey (Appendix G)	3,254	2,658	81.7
Frequency of Risky Behavior Questionnaire (Appendix C)	3,254	3,241	99.6
Hand Strength Assessment	3,254	3,239	99.5
Medical Conditions and Medications Survey (Appendix G)	3,254	3,243	99.7
Modified Manchester Driver Behavior Questionnaire (Appendix H)	3,254	3,237	99.5
Optec Assessment	3,254	3,244	99.7
Perception of Risk Questionnaire (Appendix C)	3,254	3,236	99.4
Sensation Seeking Scale Questionnaire (Appendix E)	3,254	3,235	99.4
Sleep Questionnaire (Appendix B)	3,254	3,232	99.3

Table 4.4. Participant Information Validation (Height, Weight, Neck Size)

Variable	Low Extreme	High Extreme	Rationale
Height (in.)			Cutoffs were determined by identifying data that appeared outside the normal distribution or were identified by cross-tabulating weight and height and identifying the anomalies.
Male	54	84	
Female	48	78	
Weight (lb)			
Male	100	525	
Female	80	525	
Neck size (in.)			
Male	10	25	
Female	8	25	

Other data quality efforts included the standardization of free-text answer entries. The sleep-related questionnaire was also validated for extreme and anomalous data. All of these questionnaires used statistical procedures to determine outliers.

Table 4.4 illustrates the statistical boundaries used in the validation and verification efforts of self-reported participant medical and medication data. These data included height, weight, and neck size. This information was collected twice using nearly identical Medical Conditions and Medications surveys: once at enrollment and once at the end of study participation. Data were verified using low and high extremes, and when appropriate, site contractors were contacted to verify.

Conners' Continuous Performance Test II (CPT II)

The verification procedures were used to process and validate participants' CPT II reports. Coordination Contractor personnel reviewed each CPT II to verify that the assessment had been attempted and was correctly uploaded to the database. The verification of CPT II reports included a visual inspection to confirm completeness and that the correct file had been uploaded to the database.

Participants were then tracked in a database with indications of whether or not the CPT II report had been completed. In the event that the document was not successfully uploaded, had been uploaded in the wrong format, or was incomplete, the site contractor was asked to readminister the assessment to that participant during the DAS deinstallation session, if possible.

Clock Drawing Test

Verification procedures were also used to process and validate participants' clock drawing tests. Trained data reductionists at the Coordination Contractor facility were tasked with reviewing each clock drawing to verify that it was correctly uploaded to the database and that the assessment had been attempted. Participants who did not complete the assessment were flagged and marked as needing to complete the assessment at deinstallation, if possible. For those that needed to complete the clock drawing exercise at deinstallation, the site was instructed to write on the assessment that it had been completed at deinstallation. The data reductionist scored each clock drawing test on a rating of 1 (perfect) to 6 (no reasonable representation). The scoring procedures are discussed in Chapter 6.

The visual-cognitive tests were administered using Driving Health Inventory (DHI) software. The DHI incorporated 10 tests. Three of its visual-cognitive tests were used in this study:

- Visualizing Missing Information;
- Useful Field of View (UFOV) (visual information processing speed); and
- Trail Making.

The scores for these DHI-based tests were computed and stored automatically on the hard drive of the site contractor's assessment computer. Once uploaded to the Coordination Contractor database, these results were reviewed for completeness. If a participant did not complete any of the DHI tests, data collection sites were contacted and asked to have the participants complete the series of tests at deinstallation, if possible.

Vision

Vision scores were reviewed for completeness. In the event that a participant did not complete any of the vision tests, data collection sites were asked to have the participants complete the test later, typically while exiting the study.

Physical Ability Assessments

Grip strength results were primarily reviewed for extreme values using the statistical outliers approach. Table 4.5 illustrates the high fence that was used.

Vehicle Characteristics and Features

A variety of vehicle characteristics was collected from each vehicle that was enrolled in the study. These characteristics encompassed a wide range of data, including but not limited to year, make, model, VIN, odometer reading, tire tread depth, tire pressure, battery amps and volts, and information on integrated vehicle technologies. The verification process included

- Validating year, make, and model of each vehicle;
- Validating VIN of each vehicle; and
- Applying statistical measures to tire pressure and tire tread depth, battery voltage, battery cranking amps, and battery date to identify anomalous data.

Table 4.5. Grip Strength Boundaries

Grip Variable	Low Extreme (lb)	High Extreme (lb)	Rationale
Male			Applied statistics (3 * IQR)
Right 1st attempt	0	186	
Right 2nd attempt	0	185	
Left 1st attempt	0	186	
Left 2nd attempt	0	185	
Female			
Right 1st attempt	0	114	
Right 2nd attempt	0	112	
Left 1st attempt	0	117	
Left 2nd attempt	0	115	

Table 4.6. Vehicle-Based Information Validation

Variable	Numerical Cutoff If Applicable
Odometer start	None unless extreme (e.g., 999,999)
Odometer end	Based on each vehicle and months in study
Left front tire pressure	Greater than 100 psi
Left rear tire pressure	Greater than 100 psi
Right front tire pressure	Greater than 100 psi
Right rear tire pressure	Greater than 100 psi
Battery voltage	More than 16 V
Battery cranking amps	More than 2,000 A
Battery date	Less than year/make of vehicle, or greater than date reviewed

The boundaries for outliers were determined by researching typical tire pressure measured in pounds per square inch (psi), battery voltage, and battery cranking amps. The anomalous battery dates were determined by flagging vehicles with a battery date older than the year of the vehicle or newer than the review date. Vehicle tire pressures were validated by inspecting the lower and higher extremes within the data. Vehicle battery voltage and cranking amps were determined by researching typical passenger vehicle battery voltage (12.6 V) and amps (<1000 A), and allowed for batteries that might be equipped with higher-cranking amps and voltage. The boundary of 100 psi was determined given that normal passenger vehicle tires require no more than 35 psi. The high extreme of 100 psi is typical in semitractor trailer tires; however, this high range allows for larger vehicles, such as large super-duty pickup trucks. Vehicle odometer readings were only screened for extreme values, such as no mileage or extremely high mileage. Table 4.6 illustrates the boundaries for identifying extreme outliers and anomalous data.

CHAPTER 5

Cell Phone Records Integration Study

The use of hand-held mobile devices (e.g., cell/smart phones) has skyrocketed in recent years, transforming our world in many ways. Corresponding to this increase, the impact on safety associated with the use of such technologies while driving has been the focus of much research discussion and advocacy efforts. The SHRP 2 NDS data set presents a unique opportunity to study this topic in an environment in which real-world, safety-related events can be observed in the context of associated metrics of usage and exposure.

To this end, the Cell Phone Records Study (CPRS) was commissioned as the first follow-on to the SHRP 2 NDS. This study was conceived as a follow-on study because the provision of cell phone records was not included in the original informed consent forms signed by participants. Therefore, participants had to agree to be contacted for future studies before they could be approached about participating in the CPRS. Those who did agree to be contacted were handed participation packets by site contractor staff as they exited the driving study. Those who granted consent were asked to provide access to specific aspects of their calling and texting records for the duration of their participation in the driving study. In this way, the driving and cell phone records can be more easily matched based on universal time syncs, indicating—with video verification—which trip files are accompanied by the simultaneous use of cell phones. To be eligible for the CPRS, participants had to be 18 years old or older, be able to access a minimum of 3 months of their cell phone records overlapping their participation in the driving study, and if not the authorized account holder of the wireless account, they had to be able to obtain permission from the authorized account holder to release the records. Use of minors in a study requires parental consent in addition to the minor's assent, both of which typically must be given in person to ensure freedom from parental coercion. The CPRS design called for consent to be provided remotely via mail. Therefore, including minors in the CPRS was deemed infeasible. However, younger participants who expressed a willingness to be contacted regarding participation in follow-on studies were invited to participate once they reached the age of consent. Those who had prepaid cell phones, borrowed cell phones, or cell phones issued by their employer were not eligible. No minimum cell phone usage volume was specified to qualify.

The two market-leading cell phone vendors, Verizon and AT&T Inc., provided authorized data for primary participants to the Coordination Contractor electronically. Primary participants with other providers and all secondary participants were invited to provide their own cell phone records, which were manually converted to the canonical format by Coordination Contractor personnel. Primary participants with Verizon or AT&T were compensated based on the amount of cell phone records authorized for release that overlapped with their driving records: 3–5 months of records were compensated $50. Those that provided 6 months of records or more were compensated $100. Participants who provided their own data were compensated based on the number of months of data they could provide that overlapped with their time in the study. For these individuals, compensation was provided at the rate of $10 per month for call records and an additional $10 a month for text records.

The data being collected include the date, time, and duration of calls; origin of the call (participant or other); and the date, time, and origin of text messages (including picture or video messages, as available). It is also important to note which aspects of the cell phone records were not collected as data. Neither call nor text message content was recorded or collected. In addition, the phone number of the other party was not collected, and no identifying information of any kind was collected. That is, cell phone data were associated with participant records via participant ID only.

Table 5.1. Data Retention Periods for Major Cell Phone Service Providers (as of Jan. 16, 2014)

Provider	Maximum Data Retention (months)		Records Obtained
	Call Data	Text	
Verizon	12	12	243
AT&T	24	24	67
Participant provided	Varies	Varies	70
Total	**—**	**—**	**380**

It is important to note that cell phone records are not indefinitely accessible. That is, each provider maintains such data for different durations, as indicated in Table 5.1. The number of cellular phone records collected of January 16, 2014, is also recorded in Table 5.1.

Thus, the amount of data collected from each individual varied based on a variety of factors, including the following:

- Duration of participation in study with overlapping cell phone use (a range of 24+ to 3 months);
- How much data could be accessed based on the estimated retention periods noted in Table 5.1;
- Whether or not text, picture, or video messages were included in each month of data; and
- The participant's ability to generate the data (i.e., those for whom a direct feed from the provider was not available as specified above).

Figure 5.1 shows the distribution of participants (as of January 16, 2014) by age range of participation in the NDS who consented to participate in the cellular phone records follow-on study.

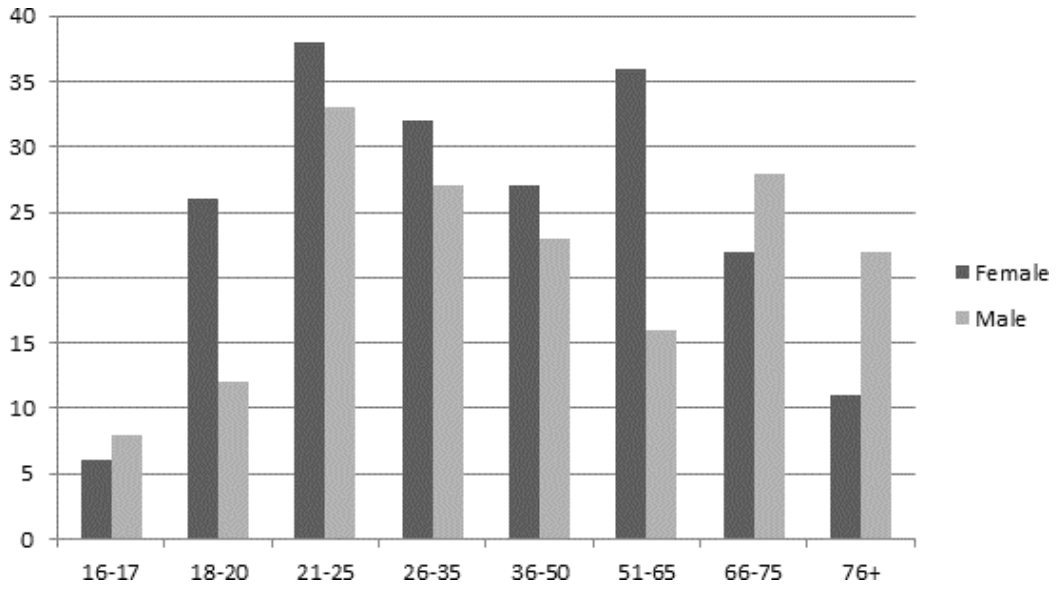


Figure 5.1. Age range and gender of cell phone study participants.

CHAPTER 6

Outcomes

Human Subjects Protections

Data Sharing and Data Access

One of the primary purposes of the SHRP 2 NDS was to collect data on contemporary drivers and vehicles that could be used by the next generation of transportation safety researchers in the same way that the Indiana Tri-Level study (Treat et al. 1977) served researchers for over 30 years. Based on this precedent, the IRBs approved a plan to allow for identifying data to be retained for up to 30 years after the last participant left the study, for deidentified and nonidentifying data to be retained for up to 40 years, and for deidentified summary data and reduced data sets to be kept indefinitely. Two competing principles were balanced in devising plans for data sharing and data access: one principle requires that we protect participant confidentiality and safeguard identifying data as strongly as possible, while the other principle requires that we share the data as widely as possible for the benefit of the general public. The IRB protocols and consent forms acknowledged these inherent conflicts from the beginning and included language indicating how each of these principles would be honored while maintaining the safety of any personally identifying information. The consent forms for the NDS require that any future follow-on studies will require IRB approval and that the level of protections provided by those IRB applications will be as great as or greater than those provided in the original NDS consent form.

Future Follow-On Studies

The study was designed from the beginning to allow for flexibility in conducting follow-on studies, either midstudy or after the completion of the NDS. It was anticipated that researchers might want to conduct additional, more longitudinally oriented research with either the entire cohort (e.g., to do a retrospective driving history analysis linked to the SHRP 2 NDS data) or a particular subset of the cohort (e.g., to conduct additional research with a subset of participants reporting a specific medical condition). However, participants could not be required to agree a priori to participate in future studies as a condition of their enrollment. Instead, participants were asked at deenrollment whether their names and contact information could be retained so that they could be contacted and invited to participate in follow-on studies. They were told that this was optional, and that any additional research opportunities would also be optional. Participants were also told that they could withdraw their names from this database at any point in time should they determine later that they no longer wished to be contacted.

Additional IRB approval was obtained late in the study for contacting secondary drivers for the same purpose. Per the consent form and IRB protocol, contact information for those not agreeing to further contact is to be deleted 1 year after the last participant leaves the study. It should be noted that participant willingness can only be accurately documented and tracked by means of a centralized database. The Coordination Contractor will maintain that database and distribute recruitment materials to willing former participants for formally vetted studies with a legitimate research purpose and IRB approval.

DAS Design and Procurement

As discussed earlier in this report, during the study design phase of the SHRP 2 NDS, VTTI designed the DAS system and associated software programs and testing modules so that the richest set of data could be collected that addressed the objectives of the study. To this end, a comprehensive set of specifications were developed. Once the design was finalized, VTTI, together with the SHRP 2 research coordinators and contract teams, developed a procurement plan. During this phase, it was determined that the purchase of the DAS components and build would be contracted separately under the Project S12A: DAS Procurement award. This award was restricted in its entirety to the purchase and building of data collection equipment and did not include labor of any kind, excepting that involved in the assembly of new systems.

Components Purchased

The final total number of components purchased for the SHRP 2 NDS was 13,152. Quantities of each of the main components are indicated in Table 6.1. Initially, just over 12,000 components were purchased; however, as the study progressed, it became evident that additional storage devices would be necessary to bridge the gap between installed DASs and those systems retrieved for data upload. Because the data upload was not an instantaneous process, it was necessary for site contractors to have an additional supply on hand. A surplus of 18% was purchased to accommodate the time delay of the process. Additionally, the front radar was the most vulnerable component; due to crashes (whether minor or significant), additional radars were needed during the latter half of the study. Lastly, as the sample design was refined and adjusted to capture the most useful data, the development of the legacy network box, described previously in this report, was most readily accommodated by the purchase of additional network boxes. While some existing network boxes were converted, an initial supply was purchased to jump-start the incorporation of legacy network boxes into the equipment supply. All of these additional procurement activities are reflected in the numbers in Table 6.1.

Repair Statistics

Equipment repairs were performed by either the Coordination Contractor or the contract manufacturer (CM), depending on a variety of factors, including warranty status and expediency. The Coordination Contractor performed 1,641—almost 79%—of the 2,088 repairs performed during the course of the study.

Study Metrics by Site

Progress at each of the six data collection sites was measured by a variety of metrics, including the number of primary and secondary participants enrolled and vehicles instrumented. The figures in this section characterize site progress according to these measures. Participant periods of study participation varied from as little as a single day to as long as 3 years. For the purpose of participant counts provided in this chapter, a criterion of at least 4 months has been applied.

Table 6.1. Quantity of Main DAS Components Purchased

Component	Study Quantity Purchased
NextGen	2,085
Storage devices	2,462
Head units	2,085
Network boxes	2,235
Radar	2,200
RIB	2,085
Total	**13,152**

Primary Participants

The total number of primary participants across the six data collection sites is presented in Figure 6.1.

Secondary Participants

In addition to primary drivers, secondary drivers were also enrolled as participants in the study. As outlined in detail in Chapter 3, to qualify as a secondary driver, an individual was required to sign an informed consent form and asked to provide a reference image to allow for confirmation that relevant trips were in fact associated with a consented driver. Figure 6.2 presents the number of secondary drivers at each of the six data collection sites who provided consent and the required reference image. Additional consented secondary drivers were enrolled, but no reference image has yet been received for those individuals.

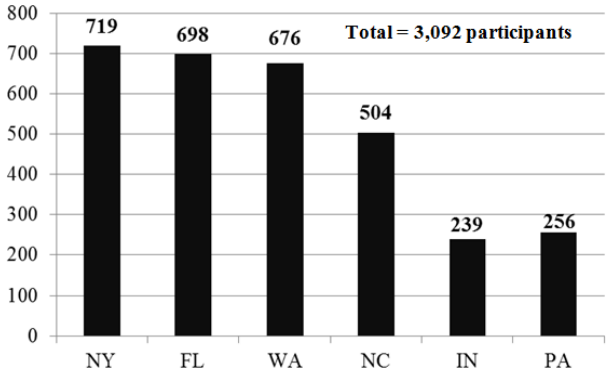


Figure 6.1. Number of primary participants enrolled across sites (4-month minimum enrollment criterion).

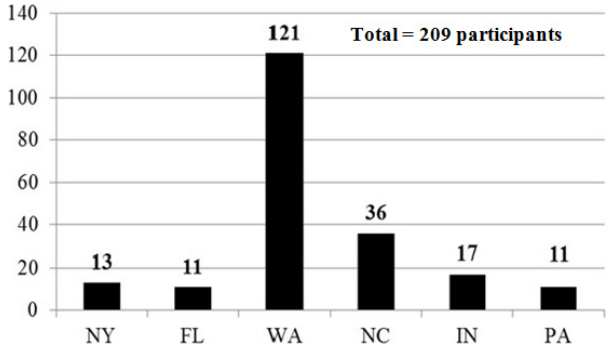


Figure 6.2. Enrolled secondary participants across sites.

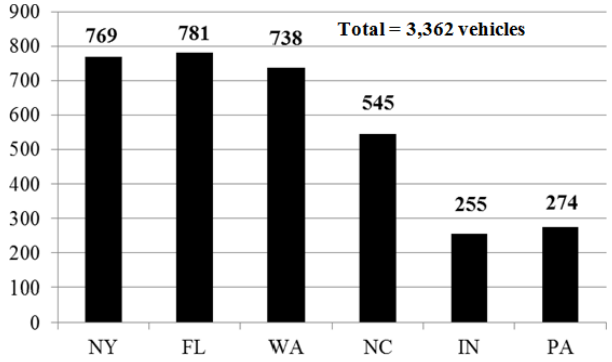


Figure 6.3. Total number of study vehicles across sites.

Total Vehicles Installed

Across the six data collection sites, 3,362 vehicles were instrumented, as presented in Figure 6.3. This number exceeds the number of primary participants, as Figure 6.1 includes only participants who were enrolled for a minimum of 4 months. The vehicles instrumented in Figure 6.3 include all vehicles that were installed for at least 24 hours. Additionally, some participants sold their original vehicle and participated in the study using their new vehicle, which explains, in part, the difference in the totals.

Vehicle Installations

Figure 6.4 depicts the growth of the SHRP 2 fleet over the course of 38 months of data collection. New installations ceased as of July 31, 2013, and vehicle deinstrumentation commenced in earnest in September 2013; some early deinstallations were accomplished in August of that year due to college students returning to school. The last vehicle was deinstalled on December 16, 2013. While some vehicles were installed for only 1 year, other vehicles were installed for 2 years. Because of this, the number of vehicle installations exceeds the number of available DAS kits, as nearly one-half of the DAS kits were reused during the second year of the study.

Participant-Related Outcomes

Primary Participants by Age

Figure 6.5 presents the total number of primary participants across age groups, with the horizontal line indicating the original study targets for each age group according to the original sample design. The difficulties experienced with the recruitment and enrollment of the youngest drivers are reflected in the graph.

Primary Participants by Gender

The NDS participant pool was divided fairly evenly along gender lines, with 1,603 female drivers (51.9%) and 1,488 male drivers (48.1%). This trend proved consistent across age groups, with the following exceptions: males outnumbered females by 3% in the 26–35 age group and by 10% among older drivers (Figure 6.6).

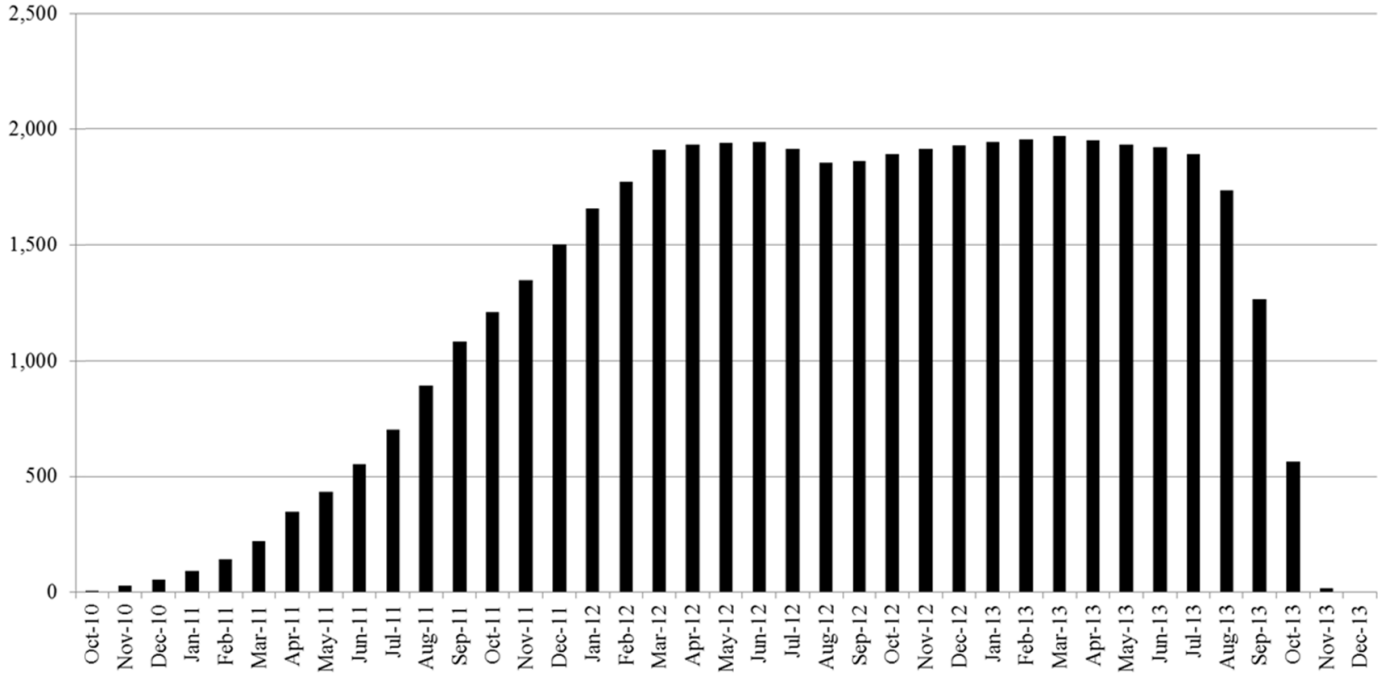


Figure 6.4. SHRP 2 installed vehicles over time.

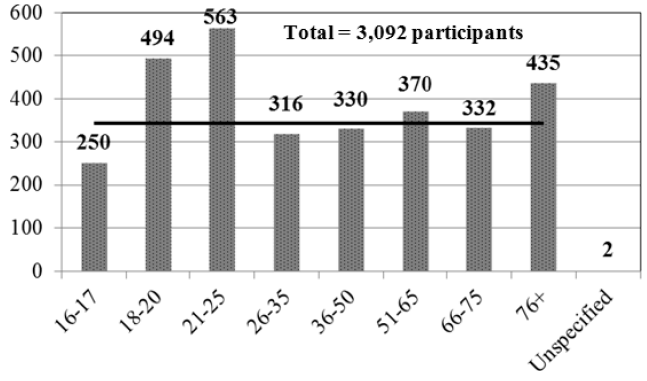


Figure 6.5. Primary participants across age groups relative to original target (horizontal line).

Primary Participants by Time in Study

As recruiting emphases varied during the recruitment process, some age groups may have spent, on average, different amounts of time in the study. For most analyses, this would not necessarily be relevant, as raw counts (e.g., crashes) are typically expressed in terms of exposure (i.e., crashes/hour of driving or crashes/mile driven). Even so, the distribution of average time in study across the recruitment age groups may be of interest and is shown in Figure 6.7. The figure shows that the average number was fairly consistent across the age groups with a slight but inconsistent upward trend with increasing age.

Vehicle-Related Outcomes

Vehicles composing the SHRP 2 fleet were further classified according to a number of parameters, including vehicle type, network data classification, and manufacturer.

Types

The vehicle fleet sampled from among the following light-vehicle types: passenger cars, sport utility vehicles (SUV), pickup trucks, and vans (including minivans). Figure 6.8 presents the distribution of vehicle types studywide. Notably, the proportions of all vehicle types were consistent at all sites, with cars constituting 72% of the total vehicle fleet.

Vehicle Network Data Classification

Figure 6.9 presents a view of the vehicle fleet broken down by network data classification. Prime vehicles are included in the Rich Network Data category, subprime and legacy vehicles in the Speed Accelerator Position Only grouping, and basic vehicles in the No Network Data designation. Note that 51% of the data collected as part of the SHRP 2 NDS was of the richest quality possible, and 87% of the data collected included information regarding at least speed and accelerator position. Only 13% of the data collected included video data only, evincing the assertion that introduction of older

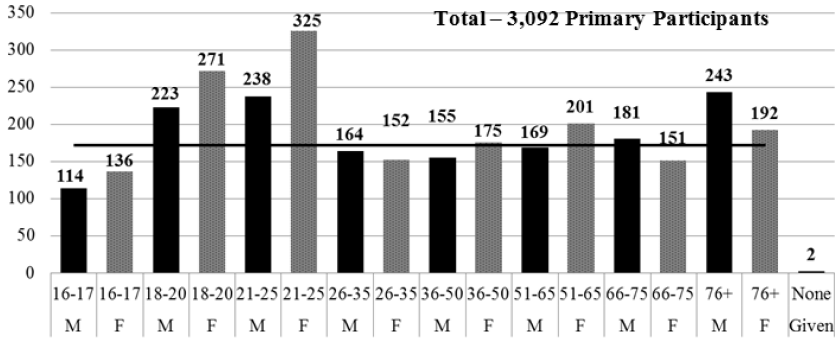


Figure 6.6. Primary participants by original sample cell compared with target number (horizontal line).

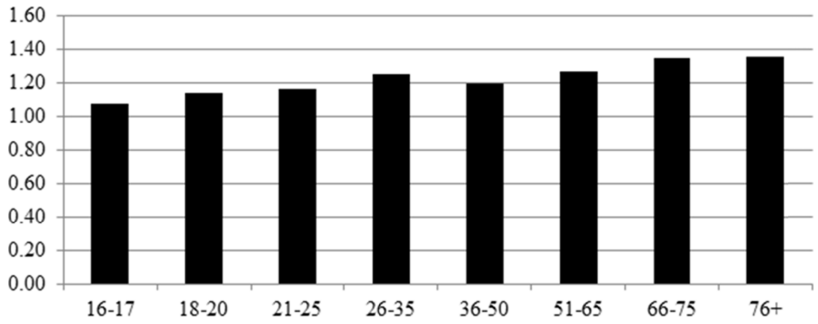


Figure 6.7. Average number of vehicle-years per participant across recruitment age groups.

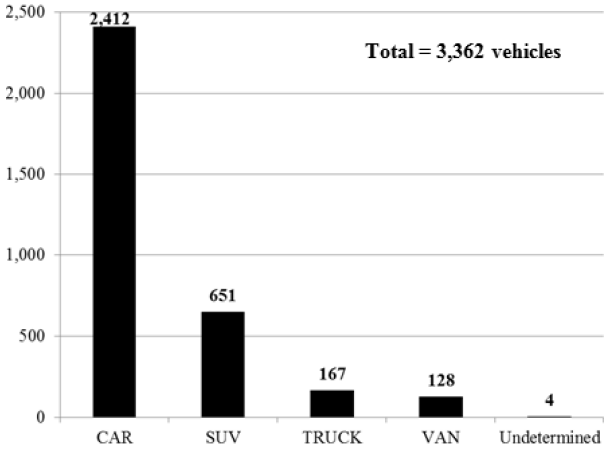


Figure 6.8. Vehicle distribution by type.

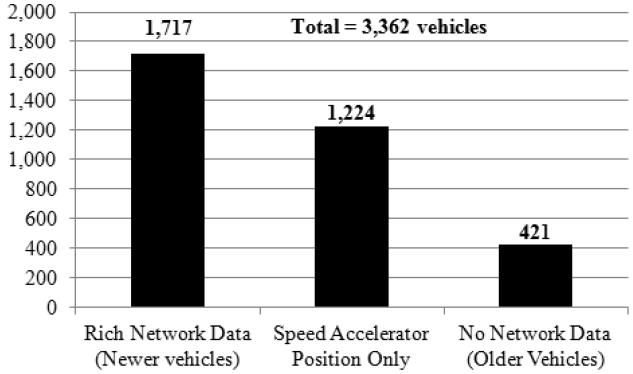


Figure 6.9. Vehicles by network data classification.

vehicles as a recruiting stratagem for older and younger drivers did not appreciably dilute the data set.

OEM Distribution

Figure 6.10 presents a view of the SHRP 2 vehicle fleet broken down by OEM. These data are presented in tabular form in Appendix T.

Vehicle-Years and Primary Participants by Site

The original study design called for the acquisition of 3,900 vehicle-years of data over the course of the data collection period. As was stated in the discussion of data volume reports in Chapter 3, a vehicle-year is defined as a period of 12 months of vehicle instrumentation without regard to the actual hours or miles of driving done during that period. Thus, the amount of data collected from different vehicles during a vehicle-year may vary widely. Figure 6.11 and Figure 6.12 show total vehicle-years acquired by site and by sample cell, respectively, for the data collection phase of the project, commencing in October 2010 and concluding in November 2013. In each figure, 3,958 vehicle-years are distributed across sites or sample cells that include 3,247 primary participants (based on the criterion of 1 day of participation or more).

One of the factors that greatly impeded the early success in recruiting younger drivers was the near complete lack of overlap between these individuals and the initial list of eligible (i.e., later-model) vehicles. Because this is the source of a possible confound, Figure 6.13 was constructed to characterize how the distributions of vehicle model year varied across recruitment age groups.

Request Tracker Summary Statistics

To manage numerous requests for repair and assistance from multiple parties throughout the SHRP 2 NDS, an open-source issue tracking system, Request Tracker (RT), developed by Best Practical Solutions LLC, was implemented to provide the

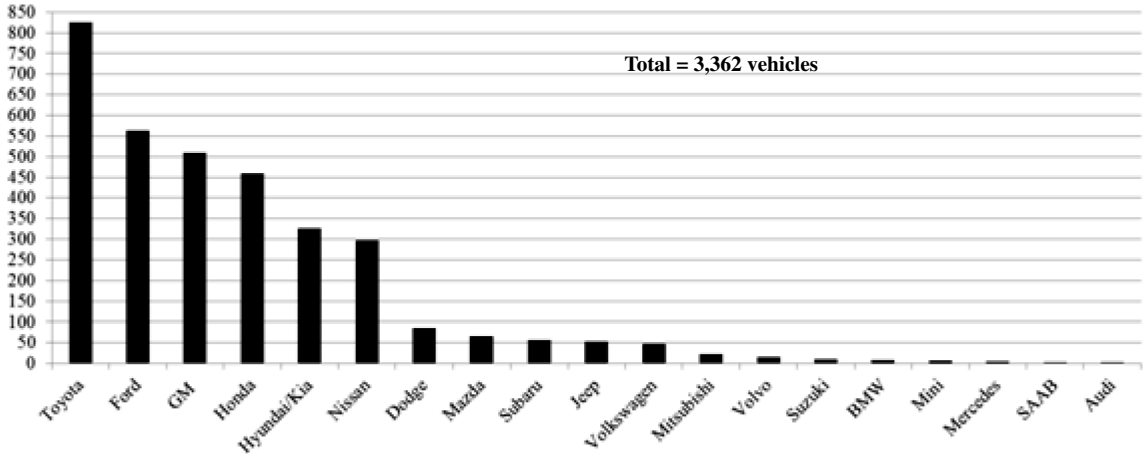


Figure 6.10. SHRP 2 fleet distribution by OEM.

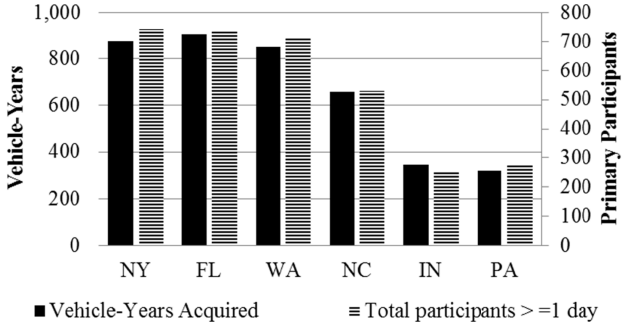


Figure 6.11. Vehicle-years acquired and primary participants by site.

infrastructure for a systematic approach to addressing issues. To that end, the following sections demonstrate the breadth of usage of this system and provide insight into the nature of the issues that were routinely addressed.

As of December 20, 2013, 58,836 tickets with unique issues had been created and over 57,141 tickets had been reasonably addressed and resolved. Fifty-nine unique queues were established to categorize tickets (Appendix U). Each queue was monitored by a unique set of individuals who were most capable of addressing the issues in that queue. The Coordination Contractor support staff monitored incoming tickets on a daily basis, assigning each ticket to the appropriate queue and following up as necessary.

Site contractors were responsible for generating approximately 11% of all tickets. The Coordination Contractor generated 11%. An additional 2% of tickets were generated for administrative functions unrelated to the data collection effort, including forum user responses and database access requests. Approximately 72% of all tickets were generated by the DAS. These generally fell into one of three high-level categories (see Figure 6.14):

- DAS onboard algorithm indicated possible crash;
- DAS reported status update indicating confidence metric as to whether or not it was properly functioning; and
- DAS was operating in a manner inconsistent with normal functions (e.g., excessively connecting, which might represent a loose cable).

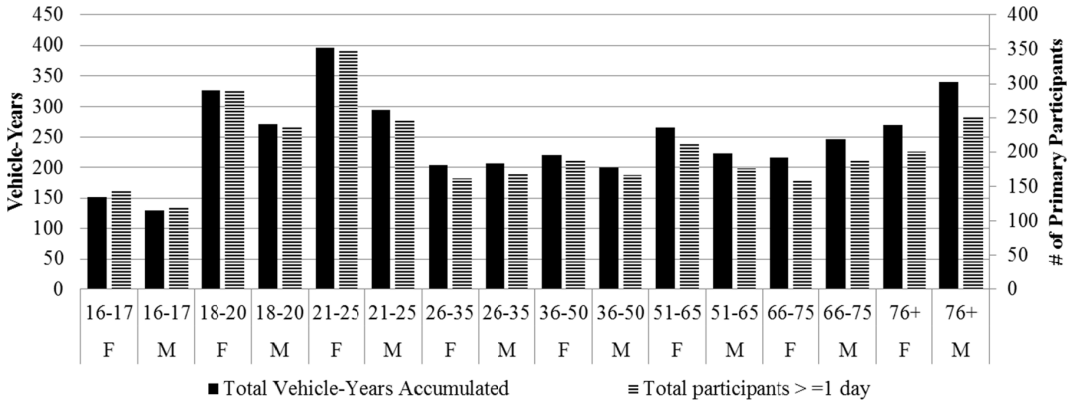


Figure 6.12. Vehicle-years acquired and primary participants by sample cell.

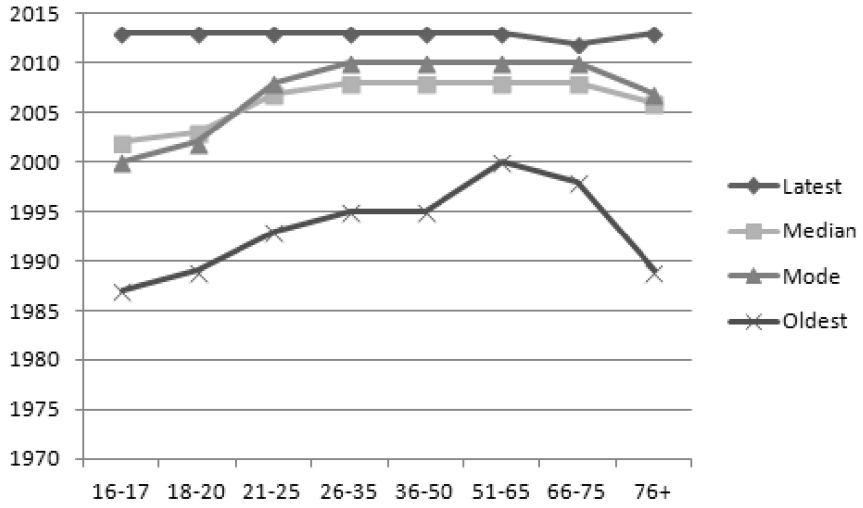


Figure 6.13. Distributions of vehicle model year across recruitment age groups.

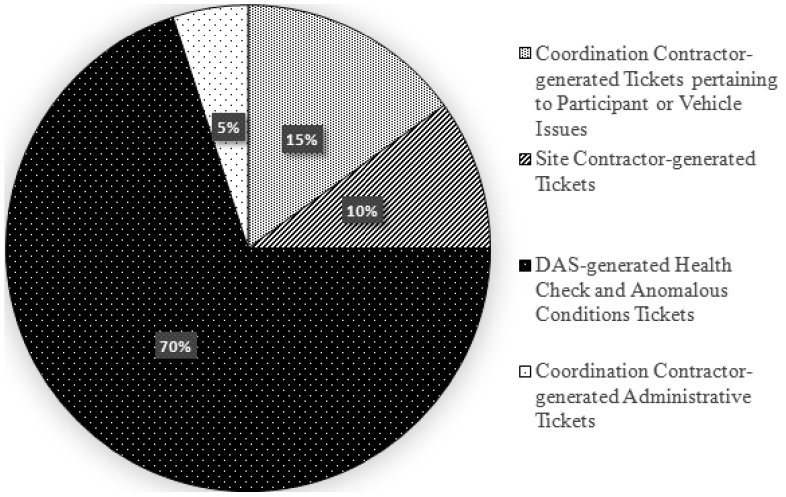


Figure 6.14. Breakdown of ticket request sources.

Type of Issue and Distribution Across Site Contractors

Of the tickets issued to site contractors, the tickets could be reduced to eight basic categories. By far, the greatest type of activity assigned to a site was a request to swap a data drive in a given study vehicle; this represented approximately 66% of the requests. Communications-based issues were the next highest, represented at approximately 13%. Communications issues were attributable to a variety of causes from excessive to no communications at all, or a problem with the telemetry for the vehicle. Camera and video issues represented approximately 11% of the requests. Administrative requests (5%) included items that generally did not require a trip to visit the vehicle, such as contacting a participant to remove an object hanging from the rear view mirror or providing follow-up related to a participant questionnaire. General maintenance issues (5%) required a visit to the vehicle to swap a component other than the data drive; regardless, on each visit to a vehicle, the solid-state drive was swapped to make most efficient use of the participant/vehicle/DAS contact. Other issues, such as installer laptop synchronizations and radio-frequency interference, all ranked at less than 1% each. While those issues were rare in occurrence, they were ranked high in terms of priority. Figure 6.15 shows the breakdown of the major issue categories.

In terms of how tickets were distributed to the site contractors, the percentage of tickets issued roughly corresponded to the size of the site (i.e., in terms of number of DAS kits allocated). Figure 6.16 shows the comparison of fleet size by site and percentage of tickets issued.

Clock Drawing Outcomes

As noted at the beginning of this report, the overarching goal of this project was to create a database to be accessed and analyzed by researchers for at least a generation, but

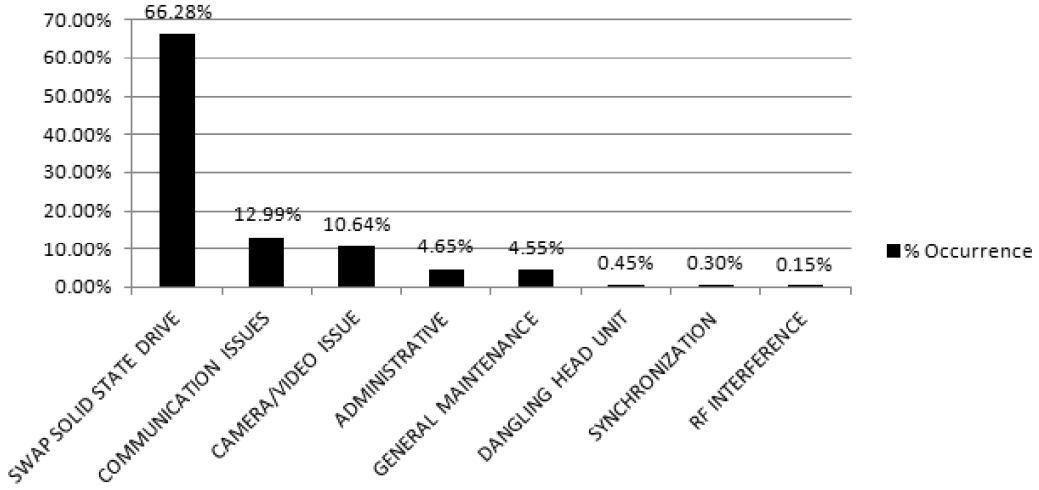


Figure 6.15. Nature and occurrence of issues assigned to site contractors.

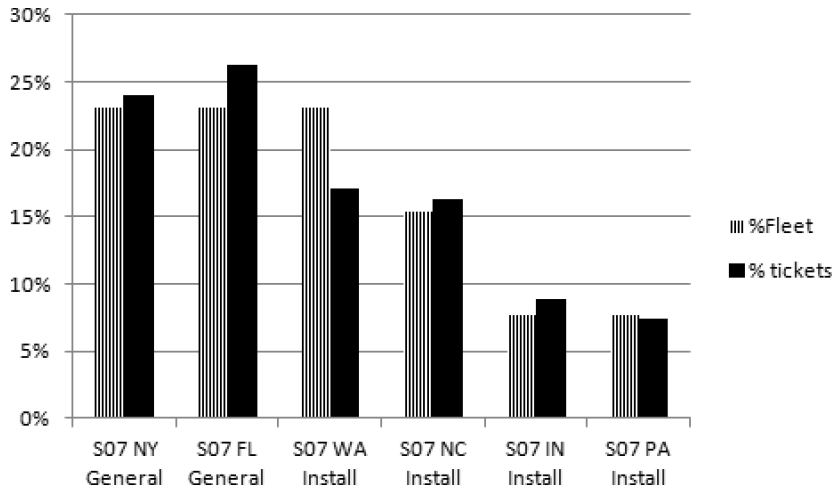


Figure 6.16. Comparison of tickets issued to site contractors relative to site size.

not primarily to analyze the data, per se. However, one aspect of the data set was analyzed and scored: the clock drawings. Coordination Contractor personnel were first trained as follows. Analysts were exposed to the scoring rubric, and then they were asked to score 10 drawings for training/calibration purposes. Their scores were compared with reference scores provided by Coordination Contractor researchers. The sample was selected to show that most drawings are expected to be very good or perfect and to illustrate the full range of drawings possible.

One analyst scored each drawing. A second analyst independently scored each one not determined to be in the "perfect" category, along with several other perfect drawings. Same scores were accepted. Any drawings that received different scores from the two analysts were further evaluated by research staff and used to calibrate the scoring procedures used by the analysts.

All drawings were then scored based on the rubric in Table 6.2. Within this rubric, higher scores reflect a greater number of errors or conceptual problems. Scores ≥3 indicate

Table 6.2. Clock Drawing Scoring Rubric

Score	Error Level	Examples
1	Perfect	(a) No errors in the task (will also accept well-placed tick marks for numbers other than 12, 3, 6, and 9 as perfect)
2	Minor visual-spatial errors	(a) Mildly impaired spacing (b) Draws at times outside circle (c) Turns page while writing so that some numbers appear upside down (d) Draws in lines (spokes) to orient spacing (e) Undetectable differentiation between minute and hour hands (f) Hour hand points directly to the 11
3	Inaccurate time, minor visual-spatial errors	(a) Minute hand points to 10 (b) Writes "10 after 11" (c) Unable to make any denotation of time
4	Moderate visual-spatial errors	(a) Moderately poor spacing (b) Omits numbers (c) Perseveration: repeats circle or continues on past 12 to 13, 14, etc. (d) Right-left reversal: numbers drawn counterclockwise (e) Dysgraphia: unable to write numbers accurately
5	Severe visual-spatial errors	(a) Severe levels of the types of issues resulting in a score of 4
6	No reasonable representation	(a) No attempt at all (b) No resemblance of a clock at all (c) Writes a word or name

Source: Adapted from Shulman et al. (1993).

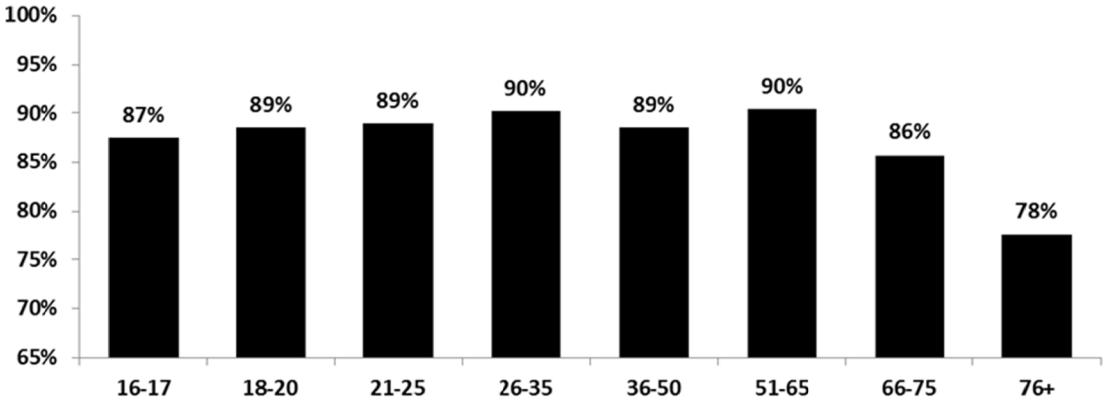


Figure 6.17. Percentage of clock drawing scores with no indication of cognitive deficit (scores of 1 to 2, meaning perfect or minor visiospatial errors).

a possible cognitive deficit (with increasing numbers representing possibly increased levels of deficit). Scores of 1 or 2 were considered not to represent any particular indication of a cognitive problem.

Based on the scoring rubric and procedures noted above, the percentage of participants for whom the clock drawings indicated no cognitive deficit is shown in Figure 6.17. It is surprising that no age group demonstrated higher than 90%, when we would expect to see very few individuals with cognitive deficits below the 76+ age group, especially for any of the five youngest age groups. Some younger participants may have had little experience with analog clocks, while others may have not taken this test seriously, as it is typically administered to seniors. Still, the age group with the lowest percentage of no-deficit individuals was the oldest group, as would be expected.

Crashes

All possible crash events were subjected to careful scrutiny by a team of trained analysts for confirmation that a crash had indeed occurred. For each instance that it was established a crash had occurred, the crash was then assigned to one of four categories which increased in severity from the lowest, Level 4, up to the highest, Level 1. Levels 1 and 2 were considered police-reportable. The crash severity levels were

- Level 1: Airbag/injury/rollover, high delta-V crash;
- Level 2: Police-reportable crash;
- Level 3: Physical contact with another object; and
- Level 4: Tire strike, low-risk.

Five hundred and thirty-two possible crash events were identified in the data set. As of January 15, 2014, 372 of these have been evaluated and assigned a level of severity. Figure 6.18 presents the number of assessed crash events across categories. The pyramidal shape in this figure is intended to help illustrate that the greater the severity of crash, the lower the frequency of such crashes observed in the data.

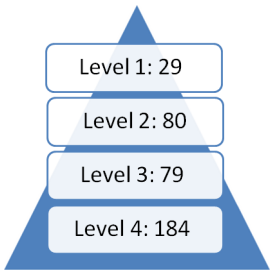


Figure 6.18. Evaluated crash events by crash severity level.

CHAPTER 7

Lessons Learned

Human Subjects Protections

One of the key lessons learned from this project was that the human subjects protection and IRB-related activities took far more time, effort, and coordination than was initially anticipated by some. In addition, in terms of total duration, this effort commenced several years before the first vehicle went on the road, involved continual attention throughout the data collection period, and will continue for as long as the data are being accessed and analyzed.

Coordinating the activities, including conducting consistency checks for each amendment and informed consent form, across the six sites and six actively involved IRBs proved a daunting effort. (At least 98 unique consent forms were approved and being used by the end of the study, with the number possibly reaching several hundred considering all site-based variations.)

Lengthy IRB Approval Processes

Large, complex, multisite studies require sufficient time to plan and prepare (not just for IRB tasks, but at every stage). Before any significant IRB tasks can be conducted, all sites and institutions must be known and under contract. Once this happens, a meeting should be held at the earliest possible opportunity with all involved IRBs in attendance. All institutions and IRBs should then work together to prepare acceptable documents and procedures before any official submissions. The simplest and most expedient approach is one in which all relevant IRBs and institutions designate a single IRB as their officially designated IRB of Record using Letters of Authorization, preferably with the IRB of Record having substantial experience with this sort of research effort. However, in reality it is likely that many will choose not to cede control in this way, and they certainly should not be forced or coerced to do so. The makeup and leadership of an IRB will change periodically, and this may affect the approval process even if all IRBs had seemed to be in agreement. Finally, not all IRBs meet monthly, and significant time lags are common when multiple institutions are involved. The main lessons learned were not to underestimate the effort and time required when developing the timeline and budget for a project of this magnitude.

Flexibility for Future Use of Data

Wide availability of the resulting data was given high priority from the beginning of SHRP 2 NDS discussions, while protection of participant confidentiality was also an important consideration. The participating IRBs cooperated in making sure that the research protocols and consent documents adequately protected participants while also allowing for flexible use of the data within those constraints. Nonidentifying and deidentified data are allowed to be widely shared, in some cases even becoming available on a data sharing website, while identifying data must be stored securely and viewed or analyzed via secure means (such as a secure data enclave). These levels of access and potential means of sharing data after the study was complete had to be designed and acted on long before the first participant enrolled in the study. This was a lesson learned from previous naturalistic driving studies such as the 100-Car Study (Dingus et al. 2006) in which the investigators originally underestimated the long-term interest in the data and did not allow for the same degree of flexibility.

General Flexibility During the Study

A similar lesson learned concerns general study flexibility. As can be seen from the amendments discussed in Chapters 2 and 3, study details were somewhat fluid, particularly in terms of compensation and length of enrollment. All the IRBs involved in the approval process reviewed the protocol with a full board review (the most stringent level of review) due to the presence of minors in the study. Most IRBs convene

once a month; others typically meet less often. Therefore, it was important to keep the amendment processes flowing as swiftly as possible to allow maximum study flexibility. Nevertheless, one important lesson learned was that a large, long-term, multisite study with numerous IRBs is something like a large ship at sea—once the iceberg is spotted, it takes a while to turn the ship. It is possible, but it takes a while.

Compensation Schemes

Recruitment was initially very difficult and inefficient for a variety of reasons, as previously discussed. As one aspect of addressing this area of concern, it was agreed early on to increase compensation from $300 per year to $500 per year in an attempt to attract more participants, especially younger ones, for whom level of compensation seemed to be higher on the list of motivating factors. Eventually, recruitment efficiency and numbers improved as strategies and tactics changed; however, it is difficult to attribute the reason for such improvements solely to the increased compensation. It did seem to all stakeholders that compensation has to be substantial to attract and fairly compensate participants for a study of this extent and nature—especially if the study hopes to attract younger participants, including teens.

Study Challenges

Border Crossing

As noted in the informed consent form, one of the risks that participants may have been exposed to was the risk of being detained or arrested or having their vehicle impounded if they drove in areas where cameras were not permitted, such as international border crossings, military or intelligence locations, or manufacturing plants. The Erie County, New York, site and the Seattle, Washington, site were located in close proximity to the Canadian border, and both sites reported that it is commonplace for many residents in those areas to visit Canada for business or leisure purposes. During the study design phase of the project, SHRP 2 staff and the Coordination Contractor worked together to communicate information about the study to both the U.S. Department of Homeland Security and Canadian border officials in an effort to alleviate their concerns about what images were captured by the DAS and to minimize any risk to participants who might travel between the two countries during the course of their participation in the study. However, no formal agreements could be reached with these government agencies, and as a result, individuals who admitted to routinely crossing the U.S.–Canadian border were deemed ineligible. It should be noted that the site contractors later learned that some participants did cross the border, perhaps repeatedly, and without incident. The Coordination Contractor did observe roaming charges for the DAS modems, providing corroborating evidence that some participants had traveled across the border.

Secondary Driver Consent

The primary obstacle in successful management of participation of secondary drivers was the lack of appreciable contact between Coordination or site contractors and these individuals. Most often, these drivers were approached about involvement in the study by the primary driver handing them a packet of informed consent and related materials. This posed a formidable challenge in obtaining all the documentation required, namely a signed consent form and a reference image, because the degree of relationship between these individuals and study personnel was limited at best. It is important to note that the minimum and sufficient documentation required to be considered a secondary participant was a properly signed and dated consent form. However, when reviewing and analyzing actual data, a reference image for the secondary driver is also necessary, because this image definitively links the consented secondary participant with his/her trips in the data record. Without a reference image, there is no way to determine who the driver is; so these otherwise valid trips have to be excluded from the database until such time, if ever, that a reference image can be found or procured. Of the 398 consented secondary drivers, 209 provided a reference image. An attempt to facilitate procurement of a greater number of secondary driver reference images was made by allowing secondary drivers to self-identify using the incident button (i.e., the secondary participant was asked to press the incident button, look toward the head unit, and say something close to "My name is [first name only] and I am a secondary participant"). Amendments late in the data collection period eased this burden somewhat, with direct contact permitted between site contractors and secondary drivers and incentives established for primary drivers who were able to provide a reference image for their secondary drivers. These efforts produced only modest results; however, current IRB protocols allow follow-up contact with secondary drivers who have completed their enrollment in the study.

Participant Video/Data Requests

Throughout the study, several participants asked to view or obtain a copy of their data, generally in reference to an isolated event such as a crash or other incident. While servicing such requests was not directly a part of the project, both site contractor and Coordination Contractor personnel felt obliged and were happy to attempt to help when the seriousness of the situation warranted (i.e., in legal, financial, or ethical terms).

Protocols were established such that the relevant video clips could be shown to the participant and others authorized by the participant (e.g., lawyers, police officers, insurance adjusters, family members) without releasing the video to anyone. First, the data drive in question had to be sent to the Coordination Contractor or its data extracted as per usual (though this sometimes took longer). Then, the drive's data had to be processed and the video reviewed. Sometimes, the Coordination Contractor's notes on the video would be relayed to the participant via the site contractor and this sufficed; no further actions were requested or required.

Other times, when the participant still wanted to review the video, a secure WebEx meeting was established with the site contractor managing the other login. Further, it was the responsibility of the site contractor to make certain that only those individuals who were supposed to view the video were present and that no one was recording the information in any way. Video requests were generally rejected when the request originated with a stated intent to prosecute other parties. Throughout the study, over 30 requests for video data were received. The effort involved in this "good citizen" activity took much more time than originally anticipated, as each request took up to several hours to isolate the data within the database, review the data, and share the data with the participant one or more times depending on the nature of the event.

Equipment Issues

There were three significant interdependent milestones pertaining to the equipment in the study, and thus the biggest challenge was timing. These milestones included completing the DAS design, establishing a new CM partnership featuring a new product line, and starting installations. There were substantial difficulties with successfully performing all three at once. The following is a discussion of each of the three issues.

Design

The DAS was a significant development in the evolution of technology for the collection of naturalistic driving data. Though the design was conducted independently of this contract, it also involved a departure from the way that VTTI had developed equipment in the past. Rather than designing it entirely in-house, an outside design firm was contracted to design and lay out the main unit. This proved more difficult than expected, as first one design firm and then a second were unable to fulfill the needs of the DAS design. Ideally, the design would have been complete when the RFP was released for the CM selection. This would have allowed the production prototype phase of the CM selection to be used as beta testing of the system and the new CM. This, in turn, would have allowed additional testing time with the systems to identify possible flaws and weakness that could have been engineered out of the system; instead, work-arounds had to be applied.

Launch of New Product and CM

Moving a product from prototype to production has its own set of challenges. Small design changes, which are often required to allow for effective manufacturing in a production environment, may not be apparent in one-off production. Launching a new CM relationship also requires additional time for both parties to learn to work efficiently with each other. Each company has its unique set of strengths and weaknesses and its standard operating procedures that have been implemented to aid in the production process. Learning to work within these structures while at the same time launching a new product added complexity to this project since there was no prior knowledge of business processes or the manufacturing process for this specific product. Consequently, working with a new CM on a new product added significant effort and time.

Start of Installations

Ideally, at the start of the installation phase at the site contractor facilities, the manufacturing process and product would have had a few months to work out the issues mentioned above, allowing a minimum amount of final inventory to be in stock. Since this was not possible, the demands placed on the supply chain simply had to be managed. Toward that end, concessions were made to try to ensure systems were available to support the installation schedule (which had its own constraints). This amplified some of the inherent weakness in both the design cycle and the CM and its processes, with little time to address root causes.

Some of the concessions made to try to mitigate the effect on the study as a whole included using prototype parts to compensate for design delays as well as significant delays in the delivery of parts from vendors. Older board revisions were released for production to backfill demand while new revisions were completed. In addition, VTTI personnel spent significant time on site at the CM to work through issues in real time to try to reduce the learning cycle and to ensure that the project was suitably prioritized by the CM. This last point was probably the key to getting kits delivered in time and with sufficient quality to support project needs and constraints.

Once the manufacturing supply caught up with the demand, oversight of the CM was primarily done remotely through weekly status calls, supplemented by visits to the manufacturing facility every 4 to 6 weeks. During the manufacturing phase of the study, it was determined at different times that the CM's level of effort being applied to the manufacturing and the repair of the product was less than desired. On two

occasions, the CM chose to reallocate resources away from SHRP 2 NDS activities. At one point, there was a significant turnover in personnel, including the production manager. The next run of boards had a yield rate of approximately 20%, when previously it had been greater than 95%. On another occasion, at the conclusion of a large contract, a significant layoff occurred, which reduced the number of people who were trained and available to work on the DAS. This required VTTI to spend additional time at the CM to retrain new personnel. This was particularly detrimental to the return merchandise authorization (RMA) process as a working knowledge of the design is necessary for effective troubleshooting of problems.

Component Availability

Component availability became a problem when the supply chain was disrupted. This factor also had a major impact on the manufacturing process and kit delivery. One effect that was already mentioned was the shift in the industry standard from the PATA to SATA interface, which created a supply shortage of data drives and necessitated a design change to the system. Board-level components are used as building blocks by all electronics designs. Each component manufacturer has its own unique product offerings that, once designed into a system, can only be supplied by that manufacturer. All the companies that use that particular part are dependent on the supply from the manufacturer. If anything happens to disrupt this supply chain, it can affect production schedules. Following are four examples of things that disrupted the supply chain:

- *Demand fluctuations.* On two separate occasions, a component for which there was a large supply of stock on the market had its supply depleted in less than a month. One of those instances was precipitated by Apple's announcement of the release of the next iPhone model, which happened to use (and utterly consume) one of the same components as the DAS.
- *Business strategy.* Component manufacturers occasionally reduce production levels to free up resources for other products or to decrease supply to drive up price. One of the key suppliers did this during the early phase of production.
- *Plant emergencies.* Like board-level components, availability of raw materials can also affect supply chain. Early during the initial release, the one plant that supplied the raw material used in some of the plastic parts was destroyed in a fire. This particular material was used heavily in the automotive industry. As such, the raw material supply to the project vendor was cut to a fraction of the normal supply, as the plant had to distribute its limited supply across all of its customers. This affected both delivery times and quantities available to support the SHRP 2 NDS.
- *Natural disaster.* This was the least likely event to affect the project; however, the tsunami that hit the coast of Japan in March 2011 severely damaged the plant that makes the standard connectors used on the PCBs in the DAS. That was the only supplier, and overnight the supply chain was broken with no means to repair it quickly or find another source.

The standard lead time was pushed out by 8+ weeks for each of the above cases. By using brokered stock or leveraging our relationship with suppliers and vendors to obtain limited stock, impacts to the project were mitigated to the greatest extent possible. In the case of the connectors, the study team was able to redistribute current inventory to meet immediate demands while waiting for the supply chain to be restored to its normal capacity.

Design Adjustments

As discussed previously, a number of design modifications occurred during the manufacturing and installation period. This was to be expected given the timing of the completion of the design cycle, the launch of a new CM relationship, and the start of DAS installations on a scale which had never been done before. For all of these, the more experience staff have with the product (the DAS and the large scale of the study) and the process (manufacturing), the fewer changes are typically required. Since all three had aspects that were new, it was expected that changes would be needed.

Repair Challenges

The primary challenges with developing a consistent method for processing repairs efficiently at the CM fell into three main categories:

- *Leverage.* When the contract started, the study had significant leverage due to the size of the order; it was beneficial to the CM to complete the order from a financial perspective. However, in the case of warranty work, there is no payment; and with repair work being performed at a fixed, prenegotiated level, the potential for return is significantly less than that for new contracts. Consequently, as the project moved from new production to support mode, the CM's priorities naturally shifted to new manufacturing contracts. Thus, additional negotiations were required to get the CM to clear the remaining RMA backlog.
- *Limited resources.* This problem affected the repair process in two unique ways. First, because of the total duration of the production run, warranty work was being requested before the completion of production. Since there were a limited number of test stations and a limited number of

personnel at the CM working on the product, the choice had to be made between applying resources to making new product or repairing existing product. Since new production almost always nets more systems per hour than repair, it was decided to let the resources be applied to new production until that was completed. This decision, however, created a larger backlog of repair items, which took significant time to clear.

- *High turnover.* In the past 3 years, American Computer Development, Inc. (ACDI) has had at least three RMA managers and floor managers in addition to two known layoffs that affected personnel working directly on the DAS. Each time management changed, a change in procedure had to be accommodated. Each time floor personnel changed, training on the product was required, which caused delays in the repair process since the knowledge base was lost with the people that had been involved in production.

For all these delays caused by business practices outside the project's control, VTTI made significant efforts to support the manufacturing process and leverage the business relationship, past and future, to try to mitigate the impact on the study.

DAS Supply and Inventory

A major challenge facing the Coordination Contractor in providing requisite equipment was the lack of real-time information regarding the site contractor schedules. As discussed in Chapter 3, a weekly installation schedule request was sent to the site contractor to elicit information regarding planned activities. However, these activities were dynamic in nature. A schedule could conceivably look very different mere hours after the reply was sent, and the site contractor staff had more important priorities, such as installing vehicles and managing participants. Table 7.1 illustrates the discrepancy between planned and actual installation and deinstallation activities during March 2013. This month marked the height of the full installation period, a time during which the value of effective allocation of equipment was at a premium. The Coordination Contractor would have benefitted greatly from a real-time mechanism for viewing changes to the schedule at each site as they occurred.

Table 7.1. Scheduled Versus Actual Activities, March 2013

Site	Scheduled	Performed	Percentage of Scheduled Actually Performed
Installations			
Buffalo	19	16	84%
Tampa	21	19	90%
Seattle	25	17	68%
Durham	22	12	54%
Bloomington	0	1	NA
State College	8	10	125%
Deinstallations			
Buffalo	7	16	228%
Tampa	8	19	237%
Seattle	4	17	425%
Durham	2	12	600%
Bloomington	0	1	NA
State College	3	10	333%

Site-Based Facilitation

Staffing the Study

The Coordination Contractor provided highly complex technical and logistic support to the site contractors. In addition, the Coordination Contractor provided data collection equipment, data management tools, and data storage systems. Over 100 different Coordination Contractor staff worked throughout the course of the project from study design through the coordination effort. Table 7.2 summarizes the percentage of staff that worked to accomplish various roles during the study. It should be noted that for most who contributed to the SHRP 2 effort, only a portion of their time was required. However, for a handful of individuals, their full-time devotion to the project was required to administer the study logistics and reporting. This administrative function served as a hub role through which most other functions were coordinated.

Table 7.2. Full-Time Equivalent (FTE) Personnel Assigned to Various Roles

Role/Function	FTE Staff
Validation of consented driver images	44
DAS-focused maintenance, troubleshooting, training with installation focus; software upgrades for vehicles	27
Quality control of DAS-based and participant-based variables	20
Maintenance and technical support to computer operations, database	16
Purchase, monitoring, and supply of DAS equipment inventory	7
Administration of study logistics and reporting	6
Study oversight and IRB	4
Total	**124**

Technical Support

The Coordination Contractor established a separate trusted domain (shrp2nds) and provisioned SHRP 2 users under that domain to share designated network resources at the Coordination Contractor's facility. This arrangement allowed the Coordination Contractor technical support staff to access shrp2nds domain resources (e.g., desktops, laptops, site servers) without having to establish a separate set of domain credentials just to support SHRP 2 issues.

The Coordination Contractor also worked with network engineers at each of the site contractor locations to facilitate network traffic in support of the SHRP 2 study. This effort was critical to establish communication on the high-speed research networks used to send collected driving data from the site contractors to the Coordination Contractor.

S06 implemented Request Tracker (RT) as a ticketing system to track (and work) any SHRP 2 support issues that arose.

Currently, the separate facilities that serve as data retention facilities are all located on the campus of Virginia Tech. Ideally, they should be geographically distant from one another in case a large-scale disaster (e.g., flood, hurricane, tornado, earthquake) was to strike in the general vicinity of the campus. This was not the result of poor planning but rather due to budget constraints imposed on S06.

The initial infrastructure design was a cooperative process between the Coordination Contractor system administrators and the university's system administrators. Implementation of the new environment followed with both teams sharing installation and management responsibilities, although the university retained root control until the Coordination Contractor's technical resources gained sufficient experience to assume full control. While the architecture contemplated significant investment in file server storage and database storage, the estimates turned out to be too low: file server storage doubled in capacity and database storage tripled over the course of the data collection phase. The shortfall was primarily the result of the study duration being extended beyond its initially planned period. The Coordination Contractor's technical staff had significant cumulative experience with networking, hardware, software, and database architecture, implementation, configuration, maintenance, and troubleshooting; but those skills were focused within a few key individuals. Over the course of this project (and as a matter of necessity), widespread cross-pollination of the expertise was required to support this effort from an information technology perspective. Staff headcount was five full-time equivalents, although the resources working on the project at any one time changed to focus on different aspects of the project, as needed. The personnel involved comprised system architects, network engineers, data center engineers, system administrators, developers, and statisticians.

The need for an efficient workflow system to manage the processing and tracking of the huge volume of files generated during this project should not be underestimated. Workflow agents can be thought of as simple robots that specialize in a single task, with the workflow providing oversight of the status of each discreet step. The workflow engine is as critical as any other component of the entire architecture.

Participant Management

Effectiveness of Recruiting Methods

Recruiting Teens and Older Drivers

As early as 2011, an analysis of the recruited cohort reflected deficiencies in attracting both younger and older drivers to the study. By August 2011, the Coordination Contractor had put a protocol in place to include teen children of primary drivers as additional primary drivers even though they shared a household with an existing primary driver. This strategy enjoyed limited success, as Figure 7.1 portrays.

Ultimately, the biggest obstacle to success with these groups was the exclusive nature of the initial eligible vehicle list. Younger and older drivers alike were less likely to drive these newer vehicles. The Coordination Contractor addressed this issue by expanding its vehicle fleet to include older vehicles, conceding that the data set for the younger and older segments of the study population would be less robust due to impoverished or nonexistent vehicle network configurations. Figure 7.2 depicts the composition of the group of vehicles driven by participants ages 16–25 and 76 and older.

Figure 7.3 shows the number of installations among younger and older drivers throughout the course of the study. Note the increase in installations among all four sample cells in this cohort with the introduction of legacy and basic vehicles to the vehicle fleet. Installations increased 166% for these

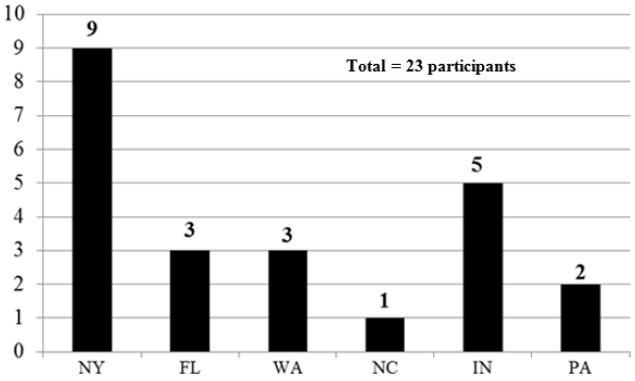


Figure 7.1. Additional primary participants, ages 16–20, contributing at least 4 months of data, by site.

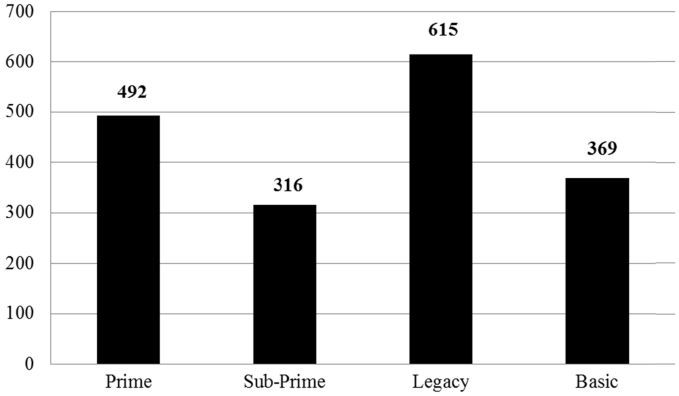


Figure 7.2. Vehicles driven by younger and older drivers contributing at least 4 months of data, by class.

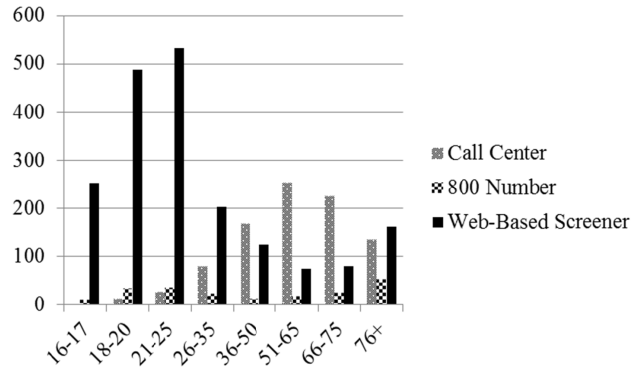


Figure 7.4. Breakdown of mode of expression of interest in participation, by age group.

groups between August and December 2011. Of all older and younger drivers in the study, 93% were instrumented *after* the decision to include legacy and basic vehicles.

To a lesser extent, both method of recruitment and mode of enrollment varied by age group. Similarly, the mode of communication employed by recruits in expressing their interest in the study differed by age group, as shown in Figure 7.4. The overwhelming majority of participants age 35 and under accessed the study via the web-based screener, while participants ages 36–75 favored contact through the call center. Clearly, future studies will need to maintain a strong online presence if there is the goal to attract younger recruits.

Participant Issues

No-Shows

When planning the study, each site was thoughtfully provisioned and staffed to fulfill the desired level of throughput of installations and related activities each day. However, it was not fully anticipated how no-shows, especially among the younger participants, would affect overall study progress. When considering the impact of participants who fail to show up for an appointment, it is important to note that it costs virtually as much in terms of staff resources for a nonreplaced no-show as for an actual installation. Thus, no-shows were a significant drain on study resources.

Future studies should probably factor some proportion of no-shows into the overall schedule, especially if a more substantial proportion of younger participants are targeted. Alternatively, or in conjunction with building in such allowances, future planners of similar studies should consider including incentives for participants to show up at their scheduled time slots. In this study, one incentive was the offer of additional compensation for participants who showed up on time for their initially scheduled visit, which produced modest results. Other options explored included having recruits "on call" for installation (i.e., those who agreed to be called on short notice to fill scheduling voids). All sites provided Saturday hours to accommodate schedules, as many recruits worked or attended school during the week.

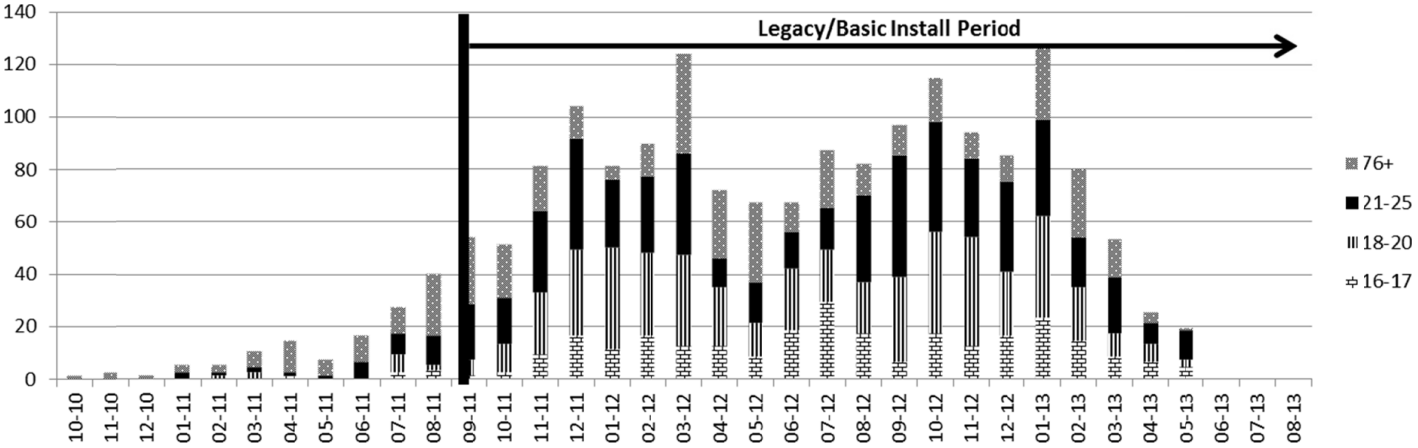


Figure 7.3. Installations among younger and older drivers with addition of legacy and basic vehicles, over time.

Missing Participants

During the conduct of the SHRP 2 NDS, there were a few occasions when a participant was characterized as "missing." This condition generally occurred when a participant was not responsive to the site contractor or when his or her vehicle's DAS modem suddenly, with no obvious technical reason, stopped communicating. When these conditions were noted, participants who were identified as missing were sought by both site contractors and the Coordination Contractor in a variety of ways. Tracking software was often used to review recent GPS coordinates to determine if the participant was routinely parking his or her vehicle at a particular address. As needed, other news and social media were reviewed to assess whether a participant was believed to be deceased. As additional information was exchanged between the site and Coordination Contractors, study personnel were often able to attempt contact after normal business hours or travel to remote locations to retrieve or service the DAS. Ten participants were reported to the Coordination Contractor as missing. In many cases, participants were located; however, at study end, four participants remained missing, with little to no hope of recovering the equipment and data. The most common reason for a participant/vehicle pairing to go missing was that the vehicle was sold or repossessed without the site contractor's knowledge.

Supporting Data Analyses During Data Collection

Concurrent with the data ingestion phase, the initial data analysis efforts (Project S08) were also under way. Although the S08 analyses added some visibility to the data set and its potential applications, supporting these analyses while actively engaging in data collection and processing activities proved very difficult. These difficulties existed particularly when exposure had to be assessed and when sampling criteria had to be developed and applied. In both cases, priorities in the processing queue may have introduced some unwanted biases, which will not be fully understood until the data set becomes static. Furthermore, satisfying the needs of analysis projects in some cases reduced the efficiency with which data could be processed (e.g., when particular events were searched for within trips whose processing was not complete). Any similar efforts in the future should consider avoiding supporting data analysis efforts until a static data set has been developed, or consider processing approaches that are sequential in nature (although these are much less efficient).

CHAPTER 8

Study Summary and Future Research Implications

Summary

This study was undertaken as one of the major research initiatives supporting the Safety area of the second Strategic Highway Research Program (SHRP 2), authorized by Congress in the Safe, Accountable, Flexible, Efficient Transportation Equity Act. The idea of conducting a large-scale naturalistic driving study was underpinned by the success of the 100-Car Study (Dingus et al. 2006), a landmark study in its own right. That study not only demonstrated the feasibility of conducting a study of this nature but also showed that the resulting highly complex data set could be successfully mined and analyzed by a variety of researchers from a variety of perspectives.

S06 study design parameters were based on the plan devised in the planning project (Antin et al. 2011), and all aspects of that plan were based on the identification, generation, and collection of several hundred research questions that guided all subsequent decisions and actions. Study sites were selected based on organizations that responded to an initial request for qualifications (RFQ); those responding were then down-selected to the final six organizations (and their respective sites) that study sponsors determined were best suited to successfully conduct the study with the best possible geographical diversity. The goal was to have 1,950 cars on the road simultaneously collecting naturalistic driving data for 2 years or more. Study sites and the nominal number of DAS kits managed at each site are depicted in Figure 2.11 in Chapter 2.

To address the breadth of the assembled research questions, the DAS had to be designed to

- Be robust enough for long-term field deployment in climates that exposed them to extremes of heat, cold, and moisture;
- Be robust enough to continuously collect data not only in the presence of the vibrations, accelerations, and decelerations experienced in the automotive environment, but even under crash conditions;
- Automatically begin continuous data collection when the vehicle was started and stop when the vehicle was turned off;
- Collect data from the vehicle's onboard network, as available;
- Be installed and deinstalled in a way that would not permanently damage or change the vehicle in any way;
- Be installed so that it would not cause a safety hazard, even in the event of a serious crash;
- Be able to communicate via cell technology automated health checks, programs, and a variety of video and data snippets;
- Be integrated in such a way that it would neither affect nor interfere with the vehicle's operation or handling in any way;
- Be unobtrusive enough that participants could largely ignore it; and
- Collect a broad range of data over a period of months without attention or maintenance.

The data collected included four video channels (face, forward, rear, and center stack interactions). In addition, the DAS integrated the following sensors: accelerometers in three dimensions, front radar, GPS, and vehicle network data, among others.

The study resulted in the successful collection of 2 petabytes of real-world driving video and sensor data from more than 3,000 participants over a 3-year period beginning in fall 2010. This data set includes some 50 million miles and well over a million hours of naturalistic driving data. Participants represented an approximately equal mix of males and females ranging in age from 16 to 98. With a study of this nature and scope, there was a substantial concomitant effort to

- Ensure that ethical procedures were implemented at every stage and site;
- Ensure that human subjects protections (including a Certificate of Confidentiality) were in place; and
- Work with all active stakeholder IRBs (six in all, as two site contractors chose to formally rely on the Virginia Tech IRB) to secure not only initial study approval but also approvals

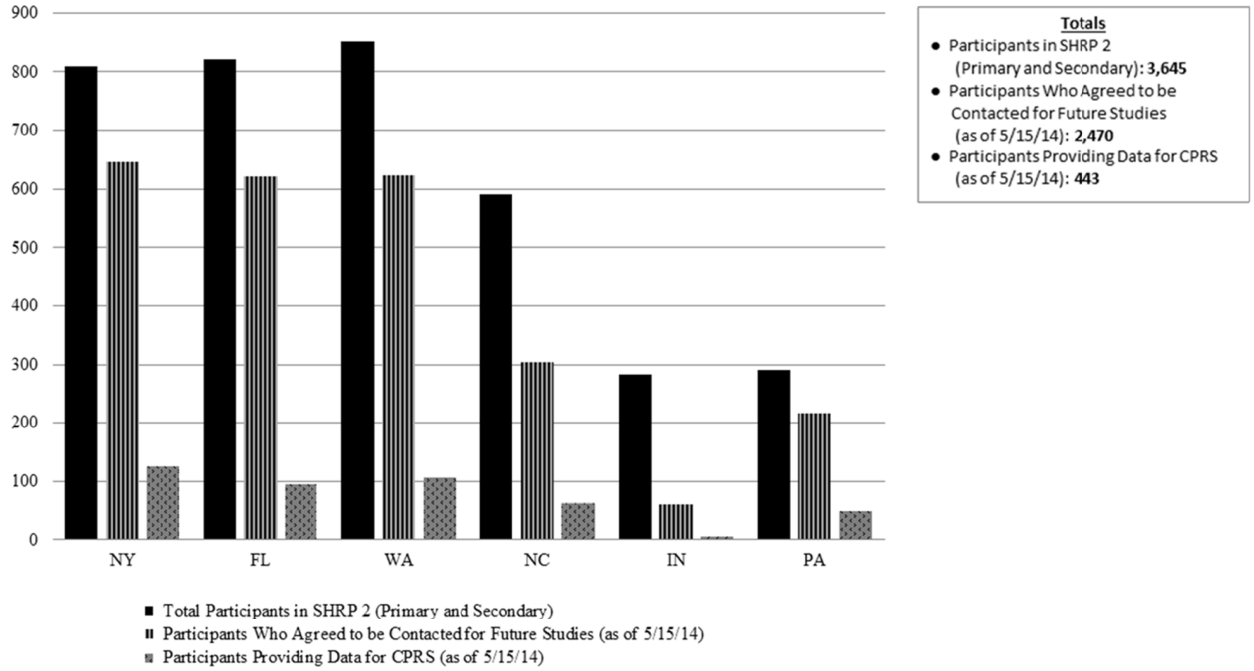


Figure 8.1. Total participants versus participants who agreed to be contacted for future studies.

for a series of amendments that continued virtually to the end of the data collection period.

It was the Coordination Contractor's role to oversee and coordinate the entire study, developing, procuring, and configuring all the hardware and software elements required, both onboard the vehicle and otherwise. The Coordination Contractor also provided training in a wide variety of areas for the site contractors with whom there was close collaboration throughout the duration of the study.

Another major role of the Coordination Contractor was to manage the secure flow of data from the onboard data drives through several stages all the way to storage on servers at its location. Checks and redundancies were built into this largely automated process at each step to ensure no data would be lost in transmission. Key to the data management and storage process was a continual process of assessing the quality of not only the DAS data, but also all other types of data collected in the study (e.g., demographics, driver assessments, and post hoc crash investigations). Data anomalies were identified and corrected when possible, and quarantined when no remediation was possible.

Future Research Implications

This project entailed very little data analysis per se, as virtually the entire effort was founded on the notion of future research. The overarching goal was to collect a very large, extremely rich and detailed store of data to be mined and analyzed by a generation of transportation safety researchers and others to answer many of the key traffic safety–related questions of today and well into the future, just as data from the 100-Car Study have been mined and analyzed for the past decade.

Follow-On Studies

Each participant was asked when exiting the study if he or she would permit his or her name to be included on a list of those who may be contacted for follow-on studies, studies in which additional data might be collected on the participant. Inclusion on the list in no way obligates individuals to participate in any such future study, and they can opt to have their names removed from this list at any point. It is expected that policies for use of the list by researchers will be developed under the guidance of an oversight committee managed by TRB.

Cell Phone Records Study

The first follow-on study has already been initiated: the Cell Phone Records Study (CPRS). As participants exited the driving study, they were given the opportunity to participate in this follow-on effort. The CPRS entailed acquiring as much participant cell phone data as possible—voice and text only—for the period covering the individual's participation in the driving study. Once acquired, the data will be integrated into the larger naturalistic database to give researchers additional insights as to participants' cell phone usage behaviors while driving, and the safety-related implications thereof.

Figure 8.1 presents the total number of SHRP 2 NDS participants, both primary and secondary, versus the number who agreed to be contacted for future studies and the number who agreed to participate in the CPRS.

References

Antin, J., S.E. Lee, J. Hankey, and T.A. Dingus. 2011. *SHRP 2 Report S2-S05-RR-1: Design of the In-Vehicle Driving Behavior and Crash Risk Study.* Transportation Research Board of the National Academies, Washington, D.C.

Dingus, T.A., S.G. Klauer, V.L. Neale, A. Petersen, S.E. Lee, J. Sudweeks, M.A. Perez, J. Hankey, D. Ramsey, S. Gupta, C. Bucher, Z.R. Doerzaph, J. Jermeland, and R.R. Knipling. 2006. *The 100-Car Naturalistic Driving Study, Phase II—Results of the 100-Car Field Experiment.* DOT-HS-810-593. National Highway Traffic Safety Administration, Washington, D.C.

Guo, F., Klauer, S.G., Hankey, J.M., and T.A. Dingus. 2010. Near Crashes as Crash Surrogate for Naturalistic Driving Studies. *Transportation Research Record No. 2147: Journal of the Transportation Research Board,* Transportation Research Board of the National Academies, Washington, D.C., pp. 66–74.

Liang, Y., J.D. Lee, and L. Yekhshatyan. 2012. How Dangerous Is Looking Away from the Road? Algorithms Predict Crash Risk from Glance Patterns in Naturalistic Driving. *Human Factors: The Journal of the Human Factors and Ergonomics Society,* Vol. 54, pp. 1104–1116.

McLaughlin, S.B., J.M. Hankey, and T.A. Dingus. 2008. A Method for Evaluating Collision Avoidance Systems Using Naturalistic Driving Data. *Accident Analysis & Prevention,* Vol. 40, pp. 8–16.

Shulman, K.I., D.P. Gold, C.A. Cohen, and C.A. Zucchero. 1993. Clock Drawing and Dementia in the Community: A Longitudinal Study. *International Journal of Geriatric Psychiatry.* Vol. 8, No. 6, pp. 487–496.

Treat, J.R., N.S. Tumbas, S.T. McDonald, D. Shinar, R.D. Hume, R.E. Mayer, R.L. Stansifer, and N.J. Castellan. 1977. *Tri-Level Study of the Causes of Traffic Accidents: Final Report.* DOT-HS-034-3-535. National Highway Traffic Safety Administration, Washington, D.C.

Zuckerman, M. 1994. *Behavioral Expressions and Biosocial Bases of Sensation Seeking.* Cambridge University Press, New York.

APPENDIX A

Assessment Protocols

SHRP 2 Driver Assessment Protocol

Required Materials:

- Paper with participant-specific barcode
- CD or DVD (or same-sized object)
- Pen, pencil, and fine point sharpie for Clock Drawing test
- Clock Drawing Test
- Username and Log-On for participant portal
- Site Specific Log ins
- Computer login: username and password specific to each user
- MCS login and password

NOTE: Research staff conducting the assessment tasks, must have successfully completed the Assessment Training Module and be familiar with the corresponding procedures for using the Jamar Hand Dynamometer, the Optec 6500.

Text in italics should be read aloud by the experimenter. It is recommended that experimenters closely follow these scripts. If text is in italics and underlined, it should be read verbatim.

Check Box	Item
❑	Clock Drawing Test paper w/ participant ID bar code
❑	Provided Assessment Computer with Conner's Continuous Performance Test (CPT II) and Driving Health Inventory software
❑	Optec 6500P Vision Test Apparatus
❑	Jamar Grip Strength Test Apparatus
❑	Computer with Internet connection to access questionnaires

1. **Greet Participant:**

Thank you for coming here today. My name is [experimenter name] and I am a [job title] at [location]. I will be administering a set of driver assessments which will include some tests and questionnaires on a computer, some on paper, and some physical tests including some vision tests, a hand grip test, and a walking test. These assessments may take anywhere between 1–3 hours, and some may be completed at home at your discretion. I will be offering breaks between certain tests; however, if you need to take a break or use the restroom at any other time just let me know.

2. **Clock Drawing Test**

- Provide participant with the Clock Drawing Test form.
- Provide participant with a fine point Sharpie.

Please draw the face of a clock using the circle provided and put in the numbers so that it looks like a clock. Then, add hands to the clock so that it indicates the time "ten minutes after eleven."

<participant draws clock; indicates s/he is finished>

Thanks, you're all done with this task.

- If necessary, experimenter may repeat the instructions up to 2 times (for a total maximum of 3).
- If participant asks to hear instructions a 4th time, experimenter response should be, ***"Just do the best you can."***
- Set clock drawing sheet aside for now.

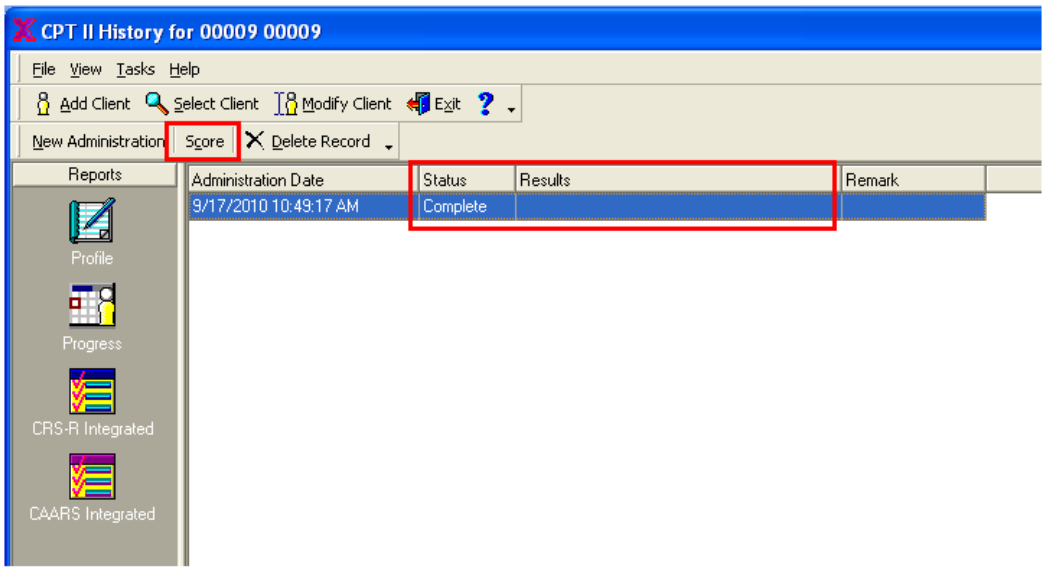
3. Conners' Continuous Performance Test II (CPT II)

Now I'd like you to perform a standard computerized test—remember, no particular computer skill or knowledge is required. The computer program displays letters of the alphabet on the screen and responses are to be made depending on the letter that appears. The entire test takes about 15 minutes.

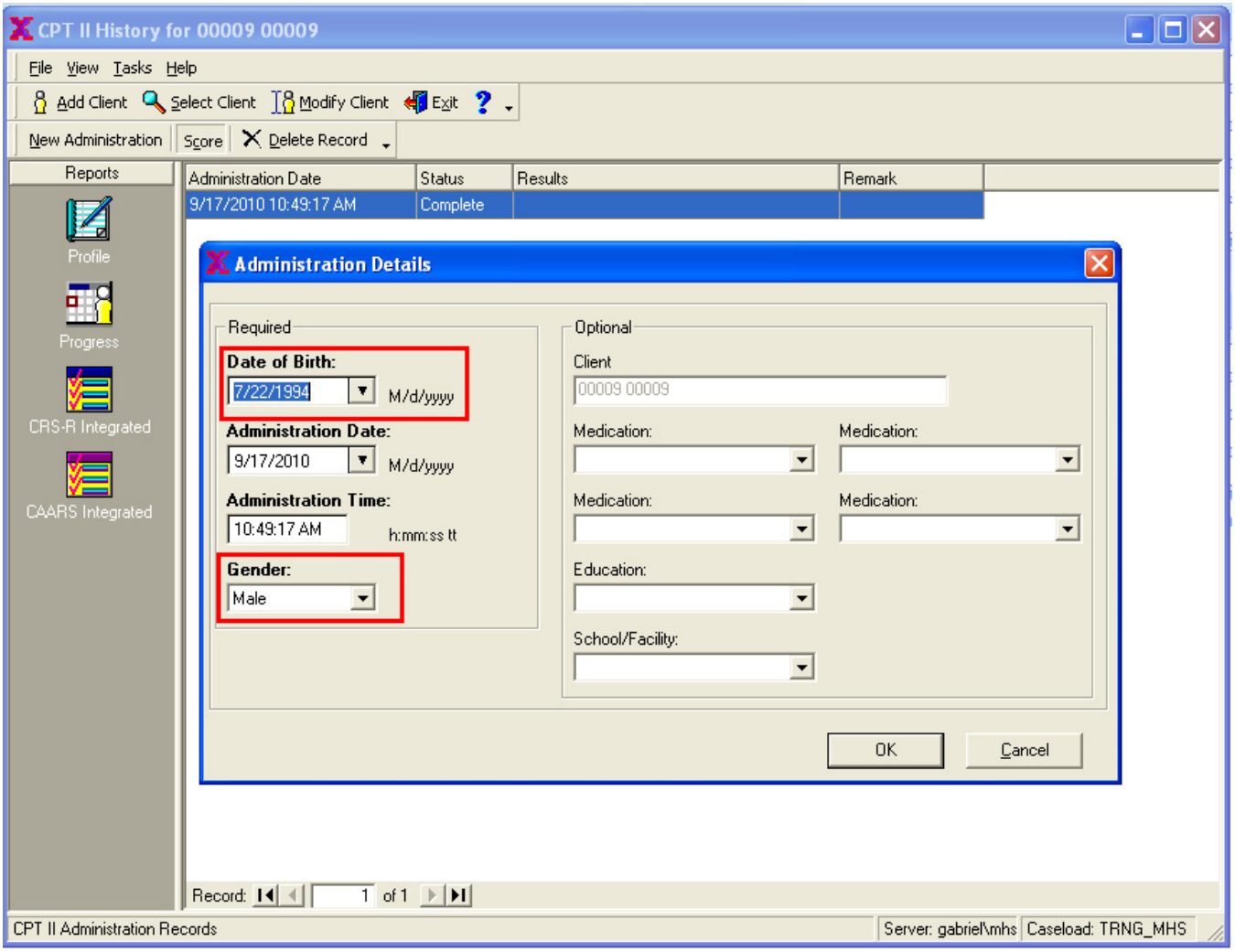
- Open the CPT II program (X-shaped icon) located on the computer desktop and click past the pop up windows.
- Log in using the site-specific logins.
- Click on "select client" at the top of screen.
- Choose to search by "File ID."
- Place the cursor in the search field and scan the participant's bar code by holding the button down on top of the scanner and sliding the paper with the barcode under the laser.
- Click "Find now" to execute search.
- Single click the appropriate participant from the search return box below.
- Click the select button
- After selecting your client, select "New Administration" at the top of the screen.
- Read instructions on the screen to participant and allow participant to practice until participant is comfortable with the process.
- Click "okay" after verifying participant ID in the pop-up box. Do **not** fill in any of the other information in the pop up box.

I want you to be able to fully concentrate on this test, so while it is running, I will not be talking with you. Now let's start the full program.

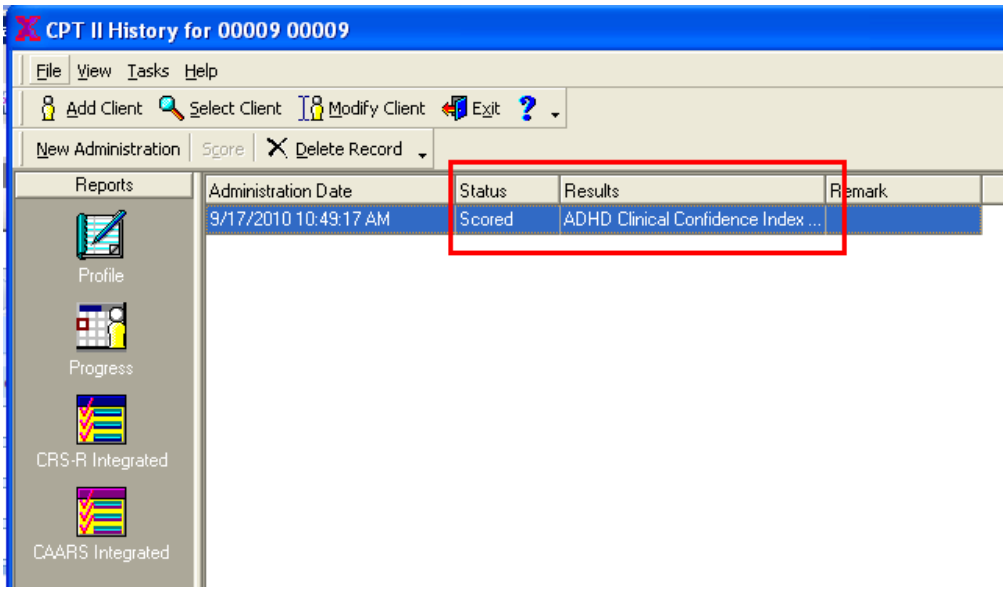
- Click on the prompts to get to the full program instructions.
- Read instructions for full program written on the screen.
- Sit quietly out of the way so that you are out of the participant's field of view.
- If participant asks questions after the program starts, please respond quickly and shortly with: ***I can answer that after you are finished, please continue.***
- If participant gets distracted, you can verbally prompt him/her **one, and only one, time** during the test to continue, with ***Please be sure to press the space bar when you see any letter other than X***
- Note that no instructions or redirection should take place if a participant simply commits errors.
- If participant wants to stop, simply sit back and allow program to continue on its own without input.
- When CPT II is finished, a screen prompting a password will pop up
- Use site specific username/password to proceed.
- The participant should still be selected, if not, search for the participant and select them.
- The status of their assessment will indicate complete, and the row will be highlighted



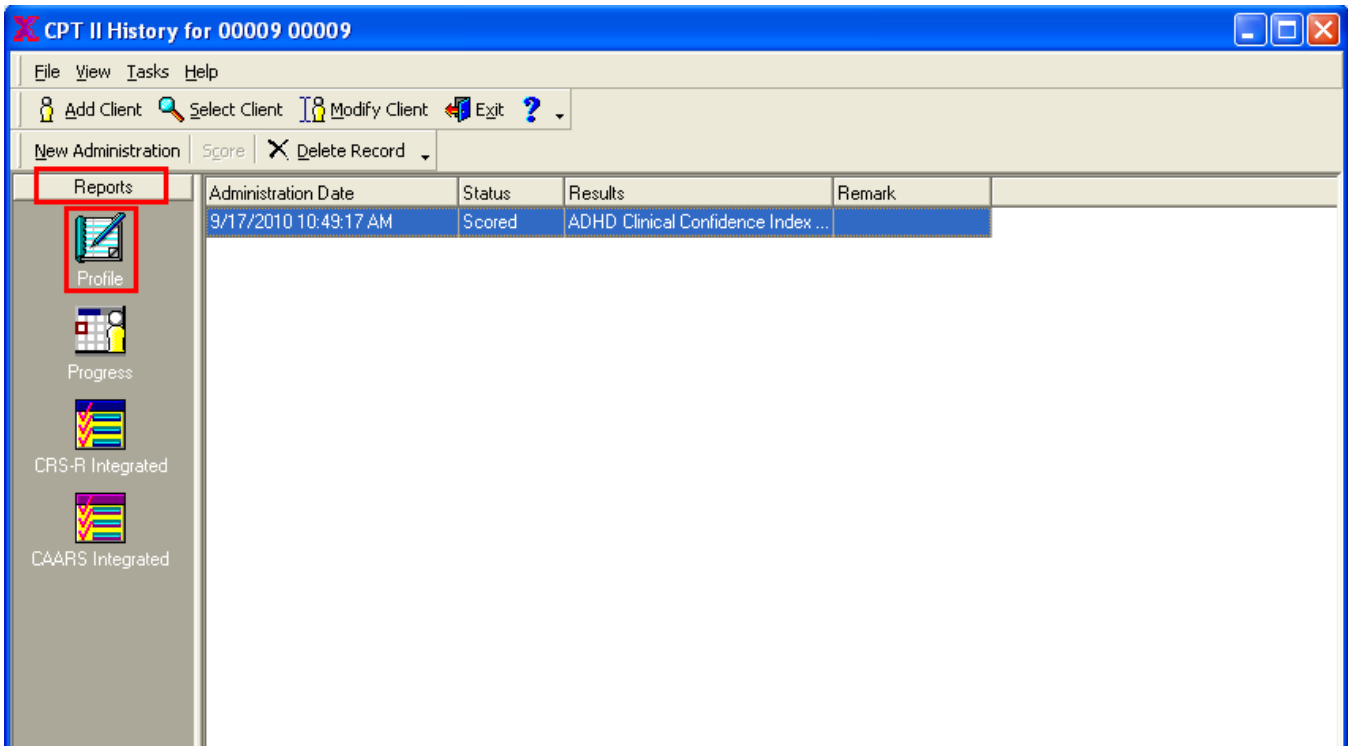
- Click "Score" at the top of the screen
- The administrations details box will appear
- Click "okay" after verifying the participant's DOB and gender in the pop up box.



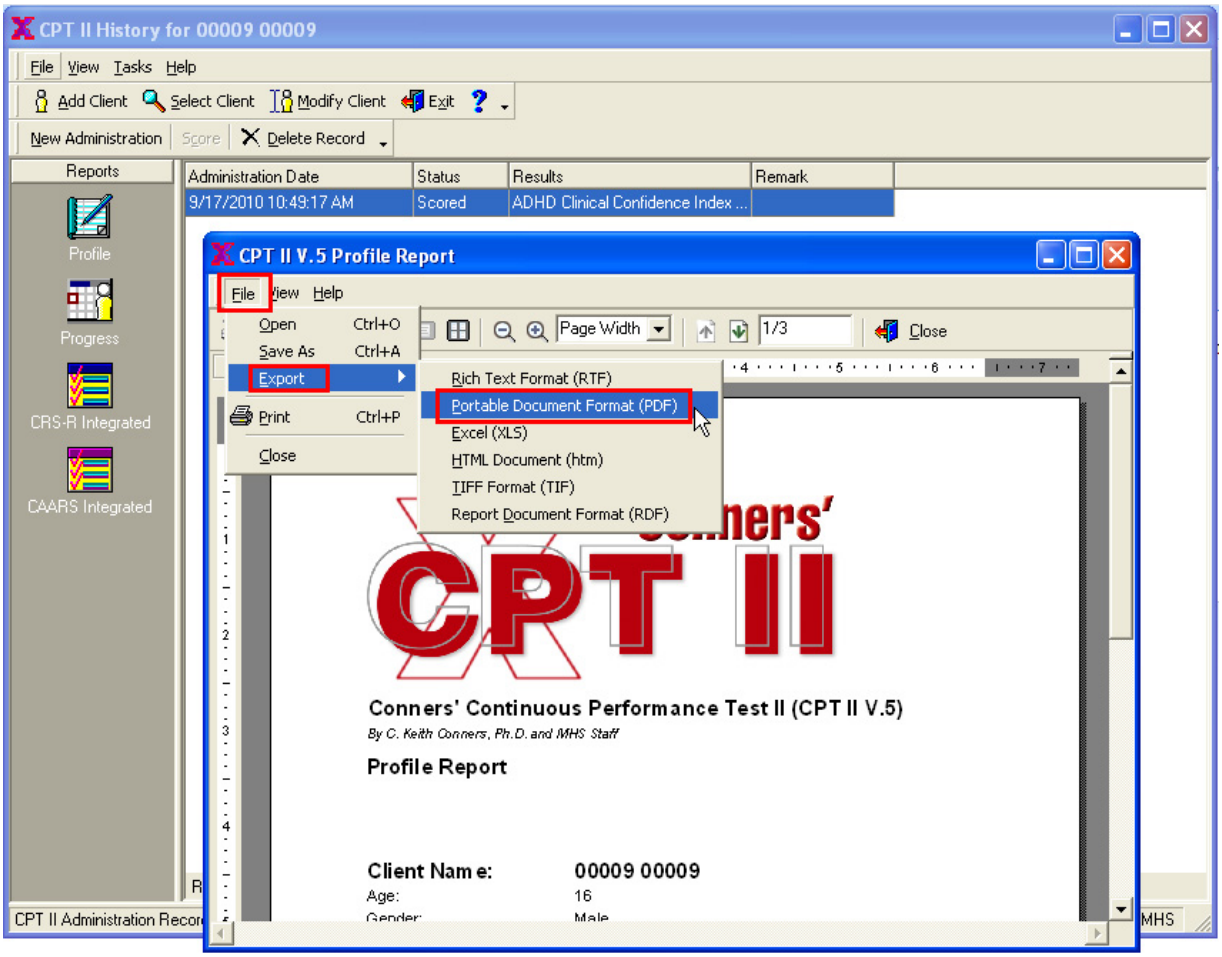
- The assessment will indicate "scored" and the results column is no longer blank.



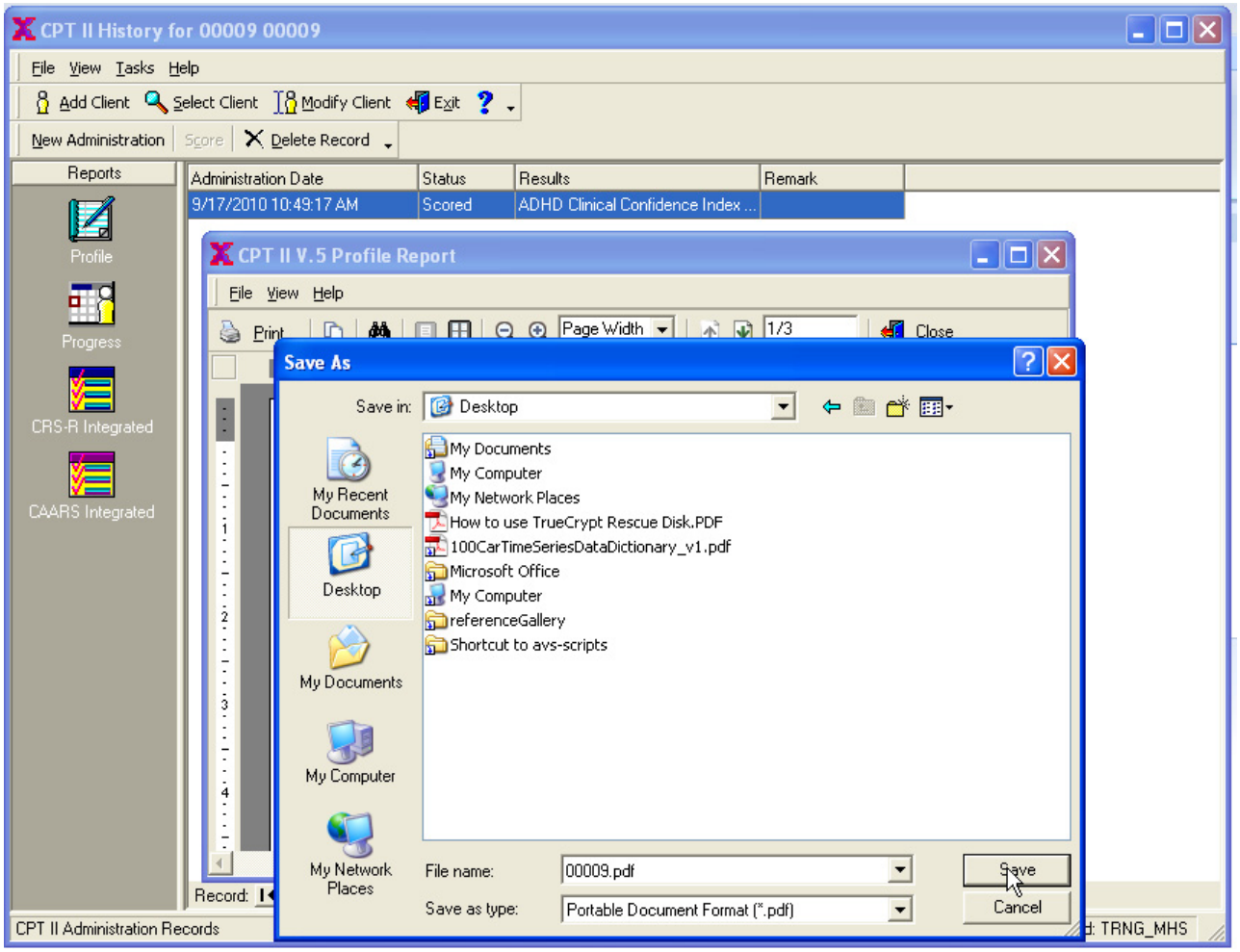
- In the Reports (left side) menu, click the "Profile" icon to generate the report



- The report will appear in a separate window. In the report window's menu bar, select File- Export- Portable Document Format (PDF)



- Select a location to save the file, and barcode the ParticpantID into the Filename field, click “Save”
- Attach the saved (.pdf) document on the Participant’s Detail Page in Mission Control (MCS).
- When the report has been attached in MCS, DELETE the file from its location on the PC.



- Close CPT II program.

Thank you, this portion of the assessment is now finished.

4. <5 MINUTE BREAK>

- Show participant the restroom if needed, or escort outside if participant would like to go outside for a few minutes.

5. Set Up the Optec 6500 and the Optec Scoring Sheet Survey

Now I'd like to give you some vision assessments. It'll just take a moment while I set up the equipment.

- Turn on machine
- Remove forehead strip
- Navigate tomcs.shrp2nds.us
- Enter your login/password
- Click on "participants" on the left side of the screen
- Scroll down and select the appropriate participant number from the list at the bottom of the screen.
- Select the "test Optec Scoring Sheet" from the list of tests on the right side of the screen
- Click on "next"
- Angle the computer monitor away from the participant so they cannot see the answers prior to completing a test.

This device will be used to test your vision. Please lean forward and adjust the machine to your height.

- Help participant adjust OPTEC by pressing the button on the right hand side and allowing the participant to move the machine to the correct height.
- Vision Correction During Vision Tests:
  - Note that participants should wear vision correction that they typically would wear when driving while performing tests.
  - Since drivers don't typically wear reading glasses while driving, participants should <u>not</u> wear them while performing any of the tests.
  - If the participant indicates that s/he wears specific glasses for night driving, s/he <u>should</u> wear them for the night condition vision tests.
  - Participants should <u>not</u> wear sunglasses for any of the vision tests.

6. Test Far Visual Acuity

- Set up OPTEC
  - Right eye on
  - Left eye on
  - Far switch
  - Day lighting
  - Glare off
  - Dial 2

This first test measures your "Far" visual acuity—how well you see things far away. I will test both of your eyes together. Lean forward and look into the viewfinder. <u>What is the lowest line you can read? Please read the letters on that line to me</u>

- Note that if the participant has progressive lenses, s/he may need to readjust to clearly see the slides on the Optec.
- Refer to the online OPTEC scoring sheet for the correct responses.
- Participant chooses initial line to read:
  - If fewer than 3 errors on initial line
    - Continue to read smaller lines until 3 or more errors on a single line
    - Record last line read with fewer than 3 errors on that line
  - If 3 or more errors on initial line
    - Read previous line(s) until fewer than 3 errors on a single line
    - Record last line read with fewer than 3 errors
- Final score is the acuity level of the last line read with fewer than 3 errors
- Enter the final score on the OPTEC scoring sheet

7. Test Near Visual Acuity

- Set up OPTEC
  - Right eye on
  - Left eye on
  - Near switch
  - Day lighting
  - Glare off
  - Dial 4 -Near (you should not need to turn the dial, it should be at the correct setting from previous test)

Now I will test your "Near" visual acuity—how well you can see things that are close. I will test both of your eyes together. Please lean forward and look into the viewfinder. <u>What is the lowest line you can read? Please read the letters on that line.</u>

- Note that participants should **<u>not</u>** be wearing reading glasses for this test.
- Refer to the online OPTEC scoring sheet for the correct responses

- Participant chooses initial line to read:
  - If fewer than 3 errors on initial line
    - Continue to read smaller lines until 3 or more errors on a single line
    - Record last line read with fewer than 3 errors on that line
  - If 3 or more errors on initial line
    - Read previous line(s) until fewer than 3 errors on a single line
    - Record last line read with fewer than 3 errors
- Final score is the acuity level of the last line read with fewer than 3 errors
- Enter the final score on the OPTEC scoring sheet

8. Test Contrast Sensitivity—Night Testing. No Glare. Right Eye.

These contrast sensitivity assessments will test your ability to differentiate an object from the background.

- Set Up OPTEC
  - Right eye on
  - Left eye off
  - Far switch
  - Night lighting
  - Glare off
  - Dial 5
- If participant indicates that s/he uses special glasses for night driving, s/he should wear them for this test.
- Show participant sample patch and indicate examples of left, right, and up.
- Instruct participant to lean into the OPTEC again.

Please look at ROW A, starting with the first circle, state which way the top of the lines point, until you get to a circle that you cannot see lines in.

- Refer to the online OPTEC scoring sheet for the correct responses
- Mark the last correct response on the online OPTEC scoring form.
- Repeat procedure for dials 6–9.

All tests set on FAR for RIGHT eye, Night Testing		
Setting		**Frequency**
Dial 5	**Row A**	**1.5**
Dial 6	**Row B**	**3**
Dial 7	**Row C**	**6**
Dial 8	**Row D**	**12**
Dial 9	**Row E**	**18**

9. Test Contrast Sensitivity—Night Testing. No Glare. Left Eye

- Set Up OPTEC
  - Right eye off
  - Left eye on
  - Far switch
  - Night lighting
  - Glare off
  - Dial 5

- If participant uses special glasses for night driving, s/he should wear them for this test.
- Repeat above procedure in #8 for **left** eye.

All tests set on FAR for LEFT eye, Night Testing		
Setting		**Frequency**
Dial 5	**Row A**	**1.5**
Dial 6	**Row B**	**3**
Dial 7	**Row C**	**6**
Dial 8	**Row D**	**12**
Dial 9	**Row E**	**18**

10. Test Stereo Depth Perception

- Set up OPTEC
  - Right eye on
  - Left eye on
  - Far switch
  - Day lighting
  - Glare Off
  - Dial at 10

Study target #1. Do you see four rings, top, bottom, left and right? Does the bottom ring seem to be floating towards you?

- If response is NO, document this on OPTEC scoring sheet and move on to next test.
- If response is YES, proceed with following instructions

In target #2, which ring is floating toward you?

- Continue with all circles until participant can no longer see the floating rings.
- When participant can no longer identify which ring is floating towards them, the last correct answer is the score.
- Enter the final score on the online OPTEC scoring sheet.

11. Test Contrast Sensitivity—Day. No Glare. Right Eye

- Set Up OPTEC
  - Right eye on
  - Left eye off
  - Far switch
  - Day lighting
  - Glare Off
  - Dial at 5

Now we will do another exercise looking at the circles with parallel lines.

Please look at ROW A. Starting with the first circle, state which way the top of the lines point (left, up/down, or right). Continue until you get to a circle where you can no longer see the lines.

- Refer to the online OPTEC scoring sheet for the correct responses
- Mark the last correct response on the online OPTEC scoring form.
- Repeat procedure for dials 6–9.

All tests set on FAR for RIGHT eye, Day Testing		
Setting		**Frequency**
Dial 5	**Row A**	**1.5**
Dial 6	**Row B**	**3**
Dial 7	**Row C**	**6**
Dial 8	**Row D**	**12**
Dial 9	**Row E**	**18**

12. Test Contrast Sensitivity—Day. No Glare. Left Eye

- Set Up OPTEC
  - Right eye off
  - Left eye on
  - Far switch
  - Day lighting
  - Glare Off
  - Dial at 5
- Repeat above procedure in #11, but for **left** eye.

All tests set on FAR for LEFT eye, Day Testing		
Setting		**Frequency**
Dial 5	**Row A**	**1.5**
Dial 6	**Row B**	**3**
Dial 7	**Row C**	**6**
Dial 8	**Row D**	**12**
Dial 9	**Row E**	**18**

13. Test Color Perception

- Set Up OPTEC
  - Right eye on
  - Left eye on
  - Far switch
  - Day lighting
  - Glare off
  - Dial at 11

Please identify the numbers in each circle, beginning with A.

- Refer to the online OPTEC scoring sheet for the correct responses
- Select whether participant identified the correct number, other number, or could not see a number on the online Optec scoring sheet.

14. Test Contrast Sensitivity—Night testing. With Glare. Right Eye

- **Set Up OPTEC**
  - Right eye on
  - Left eye off

  - Far switch
  - Night lighting
  - Glare on
  - Dial at 5
- If participant uses special glasses for night driving, s/he should wear them for this test.
- **INFORM THE PARTICIPANT THAT THIS NEXT TEST WILL INCLUDE SOME ADDITIONAL LIGHTING.
- Instruct participant to lean into the OPTEC again.

There is one last set of exercises with the circles with lines in them. Please look at ROW A, starting with the first circle, state which way the top of the lines point, until you get to a circle that you cannot see lines in.

- Refer to the online OPTEC scoring sheet for the correct responses
- Mark the last correct response on the online OPTEC scoring form.
- Repeat procedure for dials 6–9.
- Participants may **not** wear sunglasses to mitigate the glare. If they are uncomfortable, they may choose to skip this test.

All tests set on FAR for RIGHT eye, Night with Glare Testing		
Setting		**Frequency**
Dial 5	Row A	1.5
Dial 6	Row B	3
Dial 7	Row C	6
Dial 8	Row D	12
Dial 9	Row E	18

15. Test Contrast Sensitivity—Night testing. With Glare. Left Eye

- Set Up OPTEC
  - Right eye off
  - Left eye on
  - Far switch
  - Night lighting
  - Glare on
  - Dial at 5
- If participant uses special glasses for night driving, s/he should wear them for this test.
- Participants may **not** wear sunglasses to mitigate the glare. If they are uncomfortable, they may choose to skip this test.
- Repeat above procedure in #14 but for left eye.

All tests set on FAR for LEFT eye, Night with Glare Testing		
Setting		**Frequency**
Dial 5	Row A	1.5
Dial 6	Row B	3
Dial 7	Row C	6
Dial 8	Row D	12
Dial 9	Row E	18

16. Test Peripheral Vision-Right Eye

- Set Up OPTEC
  - Right eye on
  - Left eye off
  - Far switch
  - Day lighting
  - Glare off ** Make sure to turn this off from the previous test
  - Any dial
- Ask the participant to let you know when/if they see a light
- Press the following buttons on the OPTEC control box one at a time
  - Nasal
  - 55
  - 70
  - 85
- Check all angles that participant responds "yes" to on the online OPTEC scoring sheet.

17. Test Peripheral Vision-Left Eye

- Set Up OPTEC
  - Right eye off
  - Left eye on
  - Far switch
  - Day lighting
  - Glare off
  - Any dial
- Repeat procedures as noted above in #16- but for the left eye
- Click "Submit" on the OPTEC scoring sheet and close the window (tab if using Firefox).

18. Set up for the Jamar Hand Dynamometer Test

- Jamar should always be set on the second to narrowest grip distance (see figure 2)
  - Go to mcs.shrp2nds.us
  - Enter your login/password
  - Click on "participants" on the left side of the screen
  - Scroll down and select the appropriate participant number from the list at the bottom of the screen.
  - Select the "test Hand Strength Questionnaire" from the list of tests on the right side of the screen
  - Click on "next"
- Ask participant to sit in chair. The standard position requires that the participant:
  - Sit in a straight-backed chair
  - Feet flat on the floor
  - Upper arms down by side of body
  - Arms unsupported
  - Elbows flexed at 90 degrees
  - Forearm rotation neutral (i.e., in a relaxed rotational position)
  - Wrist straight
- Demonstrate to participant how to perform the Jamar assessment

Figure 1. Standard grip strength testing position.

Variations from this position significantly influence results.

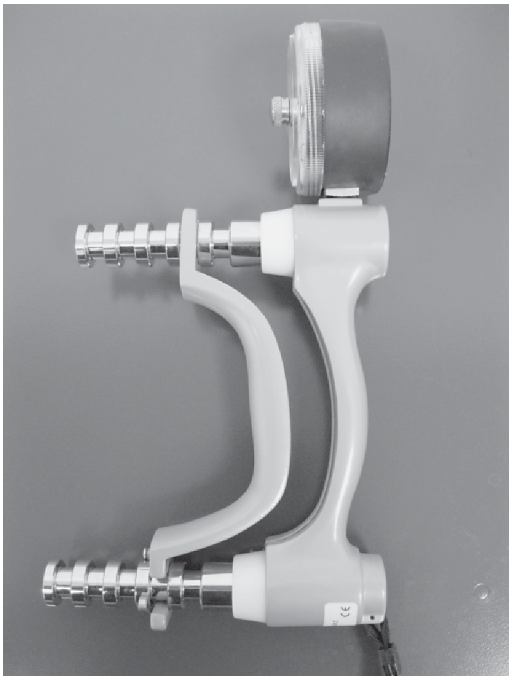


Figure 2. Use the second narrowest grip distance for all participants, as illustrated above.

Note that the apparatus Jamar should be recalibrated once per year (i.e., prior to the second round of installations)—see VTTI for details.

I'd like to measure your hand strength. This is a hand dynamometer. When you squeeze it like this (*DEMONSTRATE*) it measures the strength of your hand. <u>You need to squeeze it as hard as you can for me to get an accurate reading, l</u>ike this, with your arm and hand positioned like mine are. **(DEMONSTRATE)**

- Ask the participant if they would like to remove any jewelry (rings).
- Reset the red indicator to "0" by turning the silver dial on the face of the Jamar.
- Ask the participant if they are right or left handed and enter this data in the online Jamar Scoring form.
- Hand the participant the Jamar and ask them to use the wrist strap.

19. Perform Jamar Test on Right Hand

- You will need to encourage the participant for approximately 5 seconds of exertion.

Let's start with your right hand. <u>Squeeze it as hard as you can..... harder, harder,</u> <when you, the experimenter, see the needle begin to move in the other direction, say> ***<u>good, now you can relax.</u>***

- Record measurement on hand dynamometer, as noted by the red indicator needle, into the online Jamar scoring form using U.S. Standard Units (pounds, lbs).

20. Perform Jamar test on the left hand.

- Wait at least 15 seconds between trials.
- Remember to reset the red indicator to "0" between each trial.

I'd like you to do this again with your left hand—Ready? <u>Squeeze it as hard as you can.... harder, harder,</u> <when you, the experimenter, see the needle begin to move in the other direction, say> ***<u>good, now you can relax.</u>***

- Record measurement on hand dynamometer, as noted by the red indicator needle, into the online Jamar scoring form using U.S. Standard Units (pounds, lbs).

21. Perform Jamar Test on Right Hand (2nd Time)

- Follow protocol in #19 above

22. Perform Jamar Test on Left Hand (2nd Time)

- Follow protocol in #20 above
- Click on submit in the online survey and close the Hand Strength Questionnaire

23. Set up the DrivingHealth Inventory Program

- Open DrivingHealth Inventory program located on the computer desktop
- This program will be used to perform the Touch Screen Practice, Rapid Pace Walk, Visualizing Missing Information, Visual Information Processing Speed, and the Trail Making Tests

The next part of the study includes 3 standardized, computer-based tests and a walking test – remember, no particular computer skill or knowledge is required. This computer is equipped with a touch screen. This means you will give your answers by touching the screen. After each test is complete, a "continue" button will appear. Please do not touch the "continue" button. Sit back, and allow the experimenter to press it, when ready.

- Make sure "respond via touch screen" is selected on the welcome screen to the DHI program.
- Select begin
- Put cursor in participant name field and then scan barcode

- Put cursor in participant ID field and scan barcode again
- Perform adjustments to screen calibration as specified in the program.
- Note that throughout the assessments that use the Driver Health Inventory Program, the experimenter can abort tests and navigate through the suite of tests by holding down both mouse buttons until the navigation screen appears.

24. Administer Touch Screen Practice Session

This first exercise gives you an opportunity to practice using the touch screen.

- Go to Mouse/touch Practice and read instructions to participant.
- Allow participant to practice touching the dots until the participant is proficient.
- Because the next test is not used, abort it by holding down both mouse buttons until the "Abort This Test" option pops up

25. Administer Rapid Pace Walk (20 ft total distance—10 ft there and 10 ft back)

- Program moves on automatically to the Rapid Pace Walk
- Read onscreen instructions to participant

Please stand here <@ start/end tape marking>***. When I tell you to start, I'd like you to walk as quickly as you safely can to that line*** <@ 10 ft tape>***, turn around, and then walk back to this spot*** <@ start/end tape>***. Please keep in mind that we don't want you to trip or fall, so don't walk more quickly than you feel is safe for you. Please start when you are ready.***

- Click the "begin timer" on the screen when participant begins walking.
- Stop the timer by clicking the "stop timer" button when participant returns to the starting point.
- Data is stored automatically.
- The next two tests are not needed, so abort them by holding down both mouse buttons until the Abort This Test option pops up

26. Administer the Visualizing Missing Information Test

- Open Visualizing Missing Information Test
- Read onscreen instructions to participant exactly as printed on screen.
- Clarify if necessary.
- Let participant know we do not use the "sounds" in the assessments
- Begin test by hitting continue
- Data is recorded automatically.

27. Administer the Visual Information Processing Speed (UFOV®) Test

- The monitor needs to be roughly 18 inches away from the participant
- Note that the UFOV® part of the program advances on its own through the instruction pages. Experimenters need to be ready to read the instructions as soon as it has been opened. If participant asks questions or is distracted and the experimenter needs to start again, press both mouse buttons to get to the navigation page and restart the test.
- Open Useful Field of View and read instructions to participant exactly as printed on screen- though clarify that the sound will not be on.
- Begin practice session.
- If more practice is suggested by the program, a screen will appear after practice suggesting a repeating of the instructions
  - If participant chooses to repeat the instructions/practice, click "Repeat Instructions"
  - If participant chooses to continue in spite of the suggested repeated instructions/practice, click "continue"
- Participant may go through the practice session up to 3 times as desired by the participant.
- Click "continue" to begin the test

28. Administer Trail Making Tests

- Open Trail Making Tests
- Read instructions to participant exactly as printed on screen. Clarify if necessary.

You may only use one hand and one finger to perform this test.

- Begin test.
- Permit participant to take the full time to complete the test which will automatically time out after 5 minutes if not completed by then.
- **At end of test have participant stop before pressing the continue button.** Pressing this button will move on to the next screen which presents the scores. **If participant does hit continue, turn the monitor off right away** so that participant does not see his/her scores.
- Exit the program.

29. 5 Minute Break

- Show participant the restroom, walk participant outside, get participant water, etc.

30. Log into Participant Portal

- Go to www.shrp2nds.us
- Have participant log in to the participant portal using their User ID and their password as shown on the sheet in the participant packet.
- Indicate to participant where to change password within the participant portal.

31. Have Participant Complete Questionnaires

During the third and final part of the study, you will be answering a series of questionnaires. As noted in the Informed Consent form, your answers on these questionnaires and all your data in this study will be treated as confidential and will never be associated with your name or identity. For these questionnaires, you will be reading the instructions on your own and following the directions.

- Onsite—On computer (OPTION 1)
  - Navigate to www.shrp2nds.us
  - Have participant log in to the participant portal using their User ID and their password as shown on the sheet in the participant packet.
  - Note that in Windows 7, clicking on a link for a new questionnaire opens the questionnaire in a new window accessed by hovering the mouse over the Internet Explorer icon in the task bar and selecting the appropriate window.
  - Have participant complete questionnaires
- If participant requires the use of paper surveys (OPTION 2)
  - Give them the printed out versions and ask them to fill them in—disregard onsite computer surveys.
  - If questionnaires are not finished while participant is present on-site, give participant an addressed and stamped envelope along with the unfinished questionnaires so that they can be easily returned.
  - Remind participant that compensation for this study will begin when all of the questionnaires have been completed and received by the testing site.
  - These surveys will need to be later transcribed by a researcher into the online versions by proxy.
- **Offsite—On computer (Option 3)**

We have a set of online questionnaires for you to complete after you leave here today. You will be provided a link to the questionnaires. The link will take you to a website where you can put in your participant number and a password of your choice. This website will give you the list of questionnaires to complete. You do not have to complete them all at the same time, as

you will be able to save what you have completed and then return later to finish them. The website is secure so that no one else will be able to access your questionnaires after you complete them except the experimenters in the study. As noted in the Informed Consent form, your answers on these questionnaires and all your data in this study will be treated as confidential and will never be associated with your name or identity.

Remember, your compensation for this study will begin when you complete all questionnaires.

Do you have any questions?

32. Contact Installation Tech

- Arrange to meet Installation Tech at the vehicle with the participant

33. Installation Tech will collect simulated night/dark reference images of participant in the vehicle using the provided blankets for occlusion in the darkened vehicle

34. Installation Tech reviews vehicle installation and vehicle checklist with the participant.

35. Review Instrumentation in vehicle with participant

- Point out incident button
- Show the glove box letter

36. Dismiss the participant and offer thanks for their time and participation.

37. Scan and upload the clock drawing test using the provided scanner and MCS software

- www.mcs.shrp2nds.us
- Delete clock drawing scan from hard drive after verifying it was uploaded

38. Upload the CPT score sheet using the MCS software

Check Box	Item
	Questionnaires to complete
❑	Sensation Seeking Scale
❑	Barkley's Quick Screen
❑	Demographics Questionnaire
❑	Perception of Risk
❑	Driving History
❑	Driving Knowledge
❑	Frequency of Risky Behavior
❑	Integrated Features Identification
❑	Medical Conditions and Medications
❑	Modified Manchester Driver Behavior
❑	Sleep Questionnaire

APPENDIX B

Sleep Questionnaire

Sleep Questionnaire

There are 80 questions in this survey

SLEEP 1

1 What is your current work status? (Choose all that apply)

Please choose **all** that apply:

- ☐ Full Time employment outside the home
- ☐ Part Time employment outside the home
- ☐ Full Time employment, work from home
- ☐ Part Time employment, work from home
- ☐ Full Time stay at home parent
- ☐ Disabled
- ☐ Unemployed
- ☐ Full Time student
- ☐ Part Time student
- ☐ Other: _____

2 On days you are working outside of the home, are your sleep habits:

Only answer this question if the following conditions are met:
°

-------- Scenario 1 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 2 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

Please choose **only one** of the following:

- ○ Regular
- ○ Highly variable

3 On days you are working outside of the home, what time do you usually go to bed?

Only answer this question if the following conditions are met:
°

-------- Scenario 1 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 2 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

Please choose **only one** of the following:

- ○ Midnight
- ○ 12:30 AM
- ○ 1:00 AM
- ○ 1:30 AM
- ○ 2:00 AM
- ○ 2:30 AM
- ○ 3:00 AM
- ○ 3:30 AM
- ○ 4:00 AM
- ○ 4:30 AM
- ○ 5:00 AM
- ○ 5:30 AM
- ○ 6:00 AM
- ○ 6:30 AM
- ○ 7:00 AM
- ○ 7:30 AM
- ○ 8:00 AM
- ○ 8:30 AM
- ○ 9:00 AM
- ○ 9:30 AM
- ○ 10:00 AM
- ○ 10:30 AM
- ○ 11:00 AM
- ○ 11:30 AM
- ○ NOON
- ○ 12:30 PM
- ○ 1:00 PM
- ○ 1:30 PM
- ○ 2:00 PM
- ○ 2:30 PM
- ○ 3:00 PM
- ○ 3:30 PM
- ○ 4:00 PM
- ○ 4:30 PM
- ○ 5:00 PM

- ○ 5:30 PM
- ○ 6:00 PM
- ○ 6:30 PM
- ○ 7:00 PM
- ○ 7:30 PM
- ○ 8:00 PM
- ○ 8:30 PM
- ○ 9:00 PM
- ○ 9:30 PM
- ○ 10:00 PM
- ○ 10:30 PM
- ○ 11:00 PM
- ○ 11:30 PM

4 On days you are working outside of the home, what time do you usually wake up?

Only answer this question if the following conditions are met:
◦

-------- Scenario 1 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 2 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

Please choose **only one** of the following:

- ○ Midnight
- ○ 12:30 AM
- ○ 1:00 AM
- ○ 1:30 AM
- ○ 2:00 AM
- ○ 2:30 AM
- ○ 3:00 AM
- ○ 3:30 AM
- ○ 4:00 AM
- ○ 4:30 AM
- ○ 5:00 AM
- ○ 5:30 AM
- ○ 6:00 AM
- ○ 6:30 AM
- ○ 7:00 AM

- 7:30 AM
- 8:00 AM
- 8:30 AM
- 9:00 AM
- 9:30 AM
- 10:00 AM
- 10:30 AM
- 11:00 AM
- 11:30 AM
- NOON
- 12:30 PM
- 1:00 PM
- 1:30 PM
- 2:00 PM
- 2:30 PM
- 3:00 PM
- 3:30 PM
- 4:00 PM
- 4:30 PM
- 5:00 PM
- 5:30 PM
- 6:00 PM
- 6:30 PM
- 7:00 PM
- 7:30 PM
- 8:00 PM
- 8:30 PM
- 9:00 PM
- 9:30 PM
- 10:00 PM
- 10:30 PM
- 11:00 PM
- 11:30 PM

5 On days you are working from home, are your sleep habits:

Only answer this question if the following conditions are met:
°

-------- Scenario 1 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 2 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

Please choose **only one** of the following:

- ○ Regular
- ○ Highly variable

6 On days you are working from home, what time do you usually go to bed?

Only answer this question if the following conditions are met:
◦

-------- Scenario 1 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 2 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

Please choose **only one** of the following:

- ○ Midnight
- ○ 12:30 AM
- ○ 1:00 AM
- ○ 1:30 AM
- ○ 2:00 AM
- ○ 2:30 AM
- ○ 3:00 AM
- ○ 3:30 AM
- ○ 4:00 AM
- ○ 4:30 AM
- ○ 5:00 AM
- ○ 5:30 AM
- ○ 6:00 AM
- ○ 6:30 AM
- ○ 7:00 AM
- ○ 7:30 AM
- ○ 8:00 AM
- ○ 8:30 AM
- ○ 9:00 AM
- ○ 9:30 AM

- ○ 10:00 AM
- ○ 10:30 AM
- ○ 11:00 AM
- ○ 11:30 AM
- ○ NOON
- ○ 12:30 PM
- ○ 1:00 PM
- ○ 1:30 PM
- ○ 2:00 PM
- ○ 2:30 PM
- ○ 3:00 PM
- ○ 3:30 PM
- ○ 4:00 PM
- ○ 4:30 PM
- ○ 5:00 PM
- ○ 5:30 PM
- ○ 6:00 PM
- ○ 6:30 PM
- ○ 7:00 PM
- ○ 7:30 PM
- ○ 8:00 PM
- ○ 8:30 PM
- ○ 9:00 PM
- ○ 9:30 PM
- ○ 10:00 PM
- ○ 10:30 PM
- ○ 11:00 PM
- ○ 11:30 PM

7 On days you are working from home, what time do you usually wake up?

Only answer this question if the following conditions are met:
◦

-------- Scenario 1 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 2 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

Please choose **only one** of the following:

- ○ Midnight
- ○ 12:30 AM
- ○ 1:00 AM
- ○ 1:30 AM
- ○ 2:00 AM
- ○ 2:30 AM
- ○ 3:00 AM
- ○ 3:30 AM
- ○ 4:00 AM
- ○ 4:30 AM
- ○ 5:00 AM
- ○ 5:30 AM
- ○ 6:00 AM
- ○ 6:30 AM
- ○ 7:00 AM
- ○ 7:30 AM
- ○ 8:00 AM
- ○ 8:30 AM
- ○ 9:00 AM
- ○ 9:30 AM
- ○ 10:00 AM
- ○ 10:30 AM
- ○ 11:00 AM
- ○ 11:30 AM
- ○ NOON
- ○ 12:30 PM
- ○ 1:00 PM
- ○ 1:30 PM
- ○ 2:00 PM
- ○ 2:30 PM
- ○ 3:00 PM
- ○ 3:30 PM
- ○ 4:00 PM
- ○ 4:30 PM
- ○ 5:00 PM
- ○ 5:30 PM
- ○ 6:00 PM

- ○ 6:30 PM
- ○ 7:00 PM
- ○ 7:30 PM
- ○ 8:00 PM
- ○ 8:30 PM
- ○ 9:00 PM
- ○ 9:30 PM
- ○ 10:00 PM
- ○ 10:30 PM
- ○ 11:00 PM
- ○ 11:30 PM

8 Do you keep a fairly regular sleep schedule?

Please choose **only one** of the following:

- ○ Yes
- ○ No

9 On average, how much sleep do you get in 24 hours on days when you are working?

Only answer this question if the following conditions are met:
°

-------- Scenario 1 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 2 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 3 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 4 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

-------- or Scenario 5 --------

Answer was at question '1 [1]' (What is your current work status? (Choose all that apply))

Please write your answer(s) here:

hours: ☐

minutes: ☐

10 On average, how much sleep do you get in 24 hours on days when you are not working?

Please write your answer(s) here:

hours:

minutes:

11 How much sleep do you feel you need every 24 hours to feel well rested?

Please write your answer(s) here:

hours:

minutes:

12 How would you characterize yourself as a sleeper?

Please choose **only one** of the following:

- ○ Light
- ○ Normal
- ○ Heavy

13 Do you ever choose to sleep sitting up or in a recliner?

Please choose **only one** of the following:

- ○ Yes
- ○ No

14 How often do you nap (any sleep in addition to your major daily sleep period)?

Please choose **only one** of the following:

- ○ Nearly every day
- ○ 3-4 times per week
- ○ 1-2 times per week
- ○ 3-4 times per month
- ○ 1-2 times per month

- ○ Rarely
- ○ Never

15 On average, how long do your naps last?

Only answer this question if the following conditions are met:
° Answer was greater than 'Never' at question '14 [12]' (How often do you nap (any sleep in addition to your major daily sleep period)?)

Please write your answer(s) here:

hours: ____

minutes: ____

16 Do you feel uncomfortably sleepy during the day or find that you fall asleep in unusual or inappropriate situations?

Please choose **only one** of the following:

- ○ Every day
- ○ More than once per week
- ○ About once a week
- ○ A few times a month
- ○ About once a month
- ○ Rarely
- ○ Never

17 In the LAST MONTH, how many times did you nod off or fall asleep

Please write your answer(s) here:

while stopped in traffic: ____

while driving: ____

18 In the LAST YEAR, how many times did you nod off or fall asleep

Please write your answer(s) here:

while stopped in traffic: ____

while driving: ____

19 In the LAST WEEK, *on average*, how many servings of caffeine did you consume per 24 hour period?

Please choose **only one** of the following:

- ○ None
- ○ 1/2 serving per day
- ○ 1-2 servings per day
- ○ 3-4 servings per day
- ○ 5-6 servings per day
- ○ 7-8 servings per day
- ○ More than 8 servings per day

Count:

- 12 ounces of cola as 1/2 serving
- 8 ounces of energy drink as 1 serving
- 8 ounces of tea as 1/2 serving
- 8 ounces of home brew coffee as 1 serving
- 1 shot of espresso as 1 servings
- 1 Grande Starbucks as 3 servings
- 1 dose of NoDoz or Vivarin as 2 servings
- 1 dose of medicine containing caffeine as 1 serving

20 In a TYPICAL WEEK, *on average*, how many servings of caffeine do you consume per 24 hour period?

Please choose **only one** of the following:

- ○ None
- ○ 1/2 serving per day
- ○ 1-2 servings per day
- ○ 3-4 servings per day
- ○ 5-6 servings per day
- ○ 7-8 servings per day
- ○ More than 8 servings per day

Count:

- 12 ounces of cola as 1/2 serving
- 8 ounces of energy drink as 1 serving
- 8 ounces of tea as 1/2 serving
- 8 ounces of home brew coffee as 1 serving
- 1 shot of espresso as 1 servings
- 1 Grande Starbucks as 3 servings
- 1 dose of NoDoz or Vivarin as 2 servings
- 1 dose of medicine containing caffeine as 1 serving

21 In the LAST WEEK what is the pattern of your caffeine consumption?

Please choose **only one** of the following:

- ○ Drink or take it all at once (e.g., at the beginning of the work shift)
- ○ Drink or take it throughout the day
- ○ Varies considerably

22 In a TYPICAL WEEK what is the pattern of your caffeine consumption?

Please choose **only one** of the following:

- ○ Drink or take it all at once (e.g., at the beginning of the work shift)
- ○ Drink or take it throughout the day
- ○ Varies considerably

23 In the LAST WEEK how many alcoholic beverages did you consume?

Please choose **only one** of the following:

- ○ None

- ○ 1-2 servings per week
- ○ 3-5 servings per week
- ○ 6-7 servings per week
- ○ 8-14 servings per week
- ○ more than 14 servings per week

One serving equals:

- 1 glass, bottle, or can of beer
- 4 ounces of wine
- 1 mixed drink or shot of liquor

24 In a TYPICAL WEEK how many alcoholic beverages do you consume?

Please choose **only one** of the following:

- ○ None
- ○ 1-2 servings per week
- ○ 3-5 servings per week
- ○ 6-7 servings per week
- ○ 8-14 servings per week
- ○ more than 14 servings per week

One serving equals:

- 1 glass, bottle, or can of beer
- 4 ounces of wine
- 1 mixed drink or shot of liquor

25 Do you use tobacco products (e.g., smoke cigarettes, cigars, or a pipe or chew or snuff tobacco)?

Please choose **only one** of the following:

- ○ Yes
- ○ No

26 If "yes", how much or how often (e.g., a pack/day, a pouch/week, etc.)?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '25 [25]' (Do you use tobacco products (e.g., smoke cigarettes, cigars, or a pipe or chew or snuff tobacco)?)

Please write your answer here:

27 Have you used any sleep aids in the LAST MONTH?

Please choose **only one** of the following:

- ○ Yes, regularly
- ○ Yes, intermittently (i.e. - during times of stress or illness)
- ○ Yes, rarely
- ○ No, never

28 How frequently do you use sleep aids in a TYPICAL MONTH?

Please choose **only one** of the following:

- ○ Regularly use
- ○ Intermittently use (i.e. - during times of stress or illness)
- ○ Rarely use
- ○ Never use

29 Which of the following sleep aids do you use? (Choose all that apply)

Please choose **all** that apply:

- ☐ None, I don't ever use sleep aids.
- ☐ Sleeping Pills, Over the Counter (OTC)
- ☐ Sleep Pills, Prescription
- ☐ Continuous Positive Airway Pressure (CPAP) Machine
- ☐ Nasal opening strips (e.g., Breathe Right®)
- ☐ White background noise (e.g. fan, noise machine, humidifier)
- ☐ Other:

30 In the LAST MONTH, what was the number of times that you have been awake in the following categories:

Please write your answer(s) here:

Awake 30 or more continuous hours:	
Awake 24 or more continuous hours (but less than 30 hours):	
Awake 20 or more continuous hours (but less than 24 hours):	

31 What is your occupation?

Please write your answer here:

32 For approximately how many nights in the PAST YEAR did you work overnight or a "night shift" (*any 8-10 hour shift between approximately 10pm and 8am or any 12 hour shift between approximately 7pm and 9am*)?

Please write your answer here:

33 Do you have children that currently live in your home at least half of the time?

Please choose **only one** of the following:

- ○ Yes
- ○ No

34 How many of those children are in the following age groups? (Fill in all that apply)

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '33 [34]' (Do you have children that currently live in your home at least half of the time?)

Please write your answer(s) here:

0-2 years:	
3-5 years:	
6-10 years (elementary school aged):	
11-13 years (middle school aged):	
14-18 years (high school aged):	

Over 18 years:

35 In the LAST MONTH, how often have you been awakened in the night by any of your children?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '33 [34]' (Do you have children that currently live in your home at least half of the time?)

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often
- ○ Every night

36 On nights when you were awakened by your children in the LAST MONTH, how long in total were you awake over the course of the night, on average?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '33 [34]' (Do you have children that currently live in your home at least half of the time?) *and* Answer was 'Rarely' or 'Sometimes' or 'Often' or 'Every night' at question '35 [35]' (In the LAST MONTH, how often have you been awakened in the night by any of your children?)

Please write your answer(s) here:

hours:

minutes:

37 On nights when you were awakened by your children in the LAST MONTH, how many times per night, on average, were you awakened?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '33 [34]' (Do you have children that currently live in your home at least half of the time?) *and* Answer was 'Rarely' or 'Sometimes' or 'Often' or 'Every night' at question '35 [35]' (In the LAST MONTH, how often have you been awakened in the night by any of your children?)

Please choose **only one** of the following:

- ○ Once
- ○ 2-3 times
- ○ More than 3 times

38 The following questions ask about your actual work hours in the LAST MONTH. Please use the following definitions as a guide for the questions below:

Day shift: *occurs anytime between 6am and 7pm*

Evening shift: *occurs anytime between 3 pm and midnight*

Night shift: *is any 8-10 hour shift between approximately 10pm and 8am or any 12 hour shift between approximately 7pm and 9am*

If your work schedule doesn't exactly fit into one of these categories, please use the shift category that *most closely resembles* your shift.

To your best recollection: Please describe your activity during each week. Note that there are 168 hours in one week (7days x 24 hours)

39 For the PAST WEEK, select all of the activities that apply:

Please choose **all** that apply:

- ☐ Not working
- ☐ Day shift
- ☐ Evening shift
- ☐ Night shift
- ☐ Other, (please specify): _____

40 For the PAST WEEK:

Please write your answer(s) here:

Hours spent working (include *all* time working at your regular job, overtime, second job, etc.): {NOT EMPTY}

Hours of sleep (Sum hours of sleep for all seven days of the week) : _____

41 For the PAST WEEK, indicate the number of days off (include vacation, sick days, and other full days off):

Please write your answer here:

_____

42 For the PAST WEEK, was this week typical for you?

Please choose **only one** of the following:

- ○ Yes
- ○ No

43 For the week, the PAST WEEK, why wasn't this week typical for you?

Only answer this question if the following conditions are met:
° Answer was 'No' at question '42 [42]' (For the PAST WEEK, was this week typical for you?)

Please write your answer here:

44 For the week, TWO WEEKS AGO, select all of the activities that apply:

Please choose **all** that apply:

- ☐ Not working
- ☐ Day shift
- ☐ Evening shift
- ☐ Night shift
- ☐ Other, (please specify):

45 For the week TWO WEEKS AGO:

Please write your answer(s) here:

Hours spent working (include *all* time working at your regular job, overtime, second job, etc.):	{NOT EMPTY}
Hours of sleep (Sum hours of sleep for all seven days of the week) :	

46 For the week, TWO WEEKS AGO, indicate the number of days off (include vacation, sick days, and other full days off);

Please write your answer here:

47 For the week, TWO WEEKS AGO, was this week typical for you?

Please choose **only one** of the following:

- ○ Yes
- ○ No

48 For the week, TWO WEEKS AGO, why wasn't this week typical for you?

Only answer this question if the following conditions are met:
° Answer was 'No' at question '47 [47]' (For the week, TWO WEEKS AGO, was this week typical for you?)

Please write your answer here:

49 For the week, THREE WEEKS AGO, select all of the activities that apply:

Please choose **all** that apply:

- ☐ Not working
- ☐ Day shift
- ☐ Evening shift
- ☐ Night shift
- ☐ Other, (please specify):

50 For the week, THREE WEEKS AGO:

Please write your answer(s) here:

Hours spent working (include *all* time working at your regular job, overtime, second job, etc.):	{NOT EMPTY}
Hours of sleep (Sum hours of sleep for all seven days of the week) :	

51 For the week, THREE WEEKS AGO, indicate the number of days off (include vacation, sick days, and other full days off):

Please write your answer here:

52 For the week, THREE WEEKS AGO, was this week typical for you?

Please choose **only one** of the following:

- ○ Yes
- ○ No

53 For the week, THREE WEEKS AGO, why wasn't this week typical for you?

Only answer this question if the following conditions are met:
° Answer was 'No' at question '52 [52]' (For the week, THREE WEEKS AGO, was this week typical for you?)

Please write your answer here:

54 For the week, FOUR WEEKS AGO, select all of the activities that apply:

Please choose **all** that apply:

- ☐ Not working
- ☐ Day shift
- ☐ Evening shift
- ☐ Night shift
- ☐ Other, (please specify): _____

55 For the week FOUR WEEKS AGO:

Please write your answer(s) here:

Hours spent working (include *all* time working at your regular job, overtime, second job, etc.): {NOT EMPTY}

Hours of sleep (Sum hours of sleep for all seven days of the week) :

56 For the week, FOUR WEEKS AGO, indicate the number of days off (include vacation, sick days, and other full days off):

Please write your answer here:

57 For the week, FOUR WEEKS AGO, was this week typical for you?

Please choose **only one** of the following:

- ○ Yes
- ○ No

58 For the week, FOUR WEEKS AGO, why wasn't this week typical for you?

Only answer this question if the following conditions are met:
° Answer was 'No' at question '57 [57]' (For the week, FOUR WEEKS AGO, was this week typical for you?)

Please write your answer here:

59 In the LAST MONTH, what was the greatest number of continuous hours you worked?

Please write your answer here:

(Consider hours continuous even if there was a break of up to 4 hours. Include primary job, mandatory overtime, voluntary overtime, second job, and any additional employment.)

For this question only, include your commute time to and from your home and work and commute time between jobs.

60 In the LAST MONTH, how often did your daytime work hours begin at or before 5 AM?

Please choose **only one** of the following:

- ○ Nearly every day
- ○ 3-4 times per week
- ○ 1-2 times per week
- ○ 3-4 times per month
- ○ 1-2 times per month
- ○ Never
- ○ Not applicable - I don't work during the day

61 How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired?

Please choose the appropriate response for each item:

	No chance of dozing	Slight chance of dozing	Moderate chance of dozing	High chance of dozing
Sitting and reading:	○	○	○	○
Watching tv:	○	○	○	○
Sitting inactivein a public place (e.g. a theater or a meeting):	○	○	○	○
As a passenger in a car for an hour without a break:	○	○	○	○
Lying down to rest in the afternoon when circumstances permit:	○	○	○	○

	No chance of dozing	Slight chance of dozing	Moderate chance of dozing	High chance of dozing
Sitting and talking to someone:	○	○	○	○
In a car, while stopped for a few minutes in traffic:	○	○	○	○
While at work during a night shift:	○	○	○	○
While at work during a day or evening shift:	○	○	○	○

This refers to your usual way of life in recent times. Even if you have not done some of these things recently try to work out how they would have affected you.

62 Have you been told that you snore?

Please choose **only one** of the following:

- ○ Yes
- ○ No
- ○ Don't know

63 You've been told that your snoring is:

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '62 [62]' (Have you been told that you snore?)

Please choose **only one** of the following:

- ○ Slightly louder than breathing
- ○ As loud as talking
- ○ Louder than talking
- ○ Very loud, can be heard in adjacent room
- ○ Don't know

64 You've been told that you snore:

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '62 [62]' (Have you been told that you snore?)

Please choose **only one** of the following:

- ○ Nearly every night
- ○ 3-4 times per week
- ○ 1-2 times per week
- ○ 1-2 times per month

- ○ Rarely
- ○ Never
- ○ Don't know

65 Have you been told that your snoring ever bothered other people?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '62 [62]' (Have you been told that you snore?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

66 Has anyone told you that you quit breathing during your sleep?

Please choose **only one** of the following:

- ○ Yes
- ○ No

67 If you quit breathing in your sleep, how often does this occur?

Please choose **only one** of the following:

- ○ Nearly every day
- ○ 3-4 times per week
- ○ 1-2 times per week
- ○ 1-2 times per month
- ○ Rarely
- ○ Never
- ○ I don't quit breathing in my sleep
- ○ Don't know

68 I feel tired or fatigued immediately upon awakening:

Please choose **only one** of the following:

- ○ Nearly every day
- ○ 3-4 times per week
- ○ 1-2 times per week
- ○ 1-2 times per month

- ○ Rarely
- ○ Never

69 During my waking hours, I feel tired or fatigued

Please choose **only one** of the following:

- ○ Nearly every day
- ○ 3-4 times per week
- ○ 1-2 times per week
- ○ 1-2 times per month
- ○ Rarely
- ○ Never

70 I have nodded off or fallen asleep while driving a vehicle.

Please choose **only one** of the following:

- ○ Yes
- ○ No

71 If you have nodded off or fallen asleep while driving a vehicle, how often does this occur?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '70 [70]' (I have nodded off or fallen asleep while driving a vehicle.)

Please choose **only one** of the following:

- ○ Nearly every day
- ○ 3-4 times per week
- ○ 1-2 times per week
- ○ 1-2 times per month
- ○ Rarely
- ○ Never

72 This scale is intended to record your own assessment of any sleep difficulty you might have experienced.

For each of the following questions, please select the answer that describes your sleep experiences/difficulties that have occurred AT LEAST 3 TIMES PER WEEK during the PAST MONTH.

73 *Tme it takes you to fall asleep after turning off the lights*

Please choose **only one** of the following:

- ○ No problem
- ○ Slightly delayed
- ○ Markedly delayed
- ○ Very delayed or did not sleep at all

74 *Awakenings after having fallen asleep*

Please choose **only one** of the following:

- ○ No problem
- ○ Minor problem
- ○ Considerable problem
- ○ Serious problem or did not sleep at all

75 *Final awakening earlier than desired*

Please choose **only one** of the following:

- ○ Not earlier
- ○ A little earlier
- ○ Markedly earlier
- ○ Much earlier or did not sleep at all

76 *Total sleep duration*

Please choose **only one** of the following:

- ○ Sufficient
- ○ Slightly insufficient
- ○ Markedly insufficient

- ○ Very insufficient or did not sleep at all

77 *Overall quality of sleep (no matter how long you slept)*

Please choose **only one** of the following:

- ○ Satisfactory
- ○ Slightly unsatisfactory
- ○ Markedly unsatisfactory
- ○ Very unsatisfactory or did not sleep at all

78 *Sense of well-being during the time you are awake*

Please choose **only one** of the following:

- ○ Normal
- ○ Slightly decreased
- ○ Markedly decreased
- ○ Very decreased

79 *Functioning (physical and mental) during the time you are awake*

Please choose **only one** of the following:

- ○ Normal
- ○ Slightly decreased
- ○ Markedly decreased
- ○ Very decreased

80 *Sleepiness during the time you are awake*

Please choose **only one** of the following:

- ○ None
- ○ Mild
- ○ Considerable
- ○ Intense

Submit Your Survey.
Thank you for completing this survey.

APPENDIX C

Perception of Risk and Frequency of Risky Behavior Questionnaires

Cards and Dejoy Risk Perception Questionnaires Combined

	In the past 12 months while driving, how often did you …	Never	Rarely	Sometimes	Often	Crash Risk* (1-7)
1	run a red light?	0	1	2	3	
2	drive when sleepy and find it hard to keep your eyes open?	0	1	2	3	
3	take risks while driving because it's fun, such as driving fast on curves or "getting air"?	0	1	2	3	
4	change lanes suddenly to get ahead in traffic?	0	1	2	3	
5	speed for the thrill of it?	0	1	2	3	
6	not yield the right of way?	0	1	2	3	
7	make illegal turns?	0	1	2	3	
8	follow a car very closely or "tailgate"?	0	1	2	3	
9	follow emergency vehicles when the siren is on?	0	1	2	3	
10	take more risks because you are in a hurry?	0	1	2	3	
11	drive at your normal speed during bad driving conditions such as road construction, rain, ice, or snow?	0	1	2	3	
12	pass other cars on the right side or on the shoulder of the road?	0	1	2	3	
13	try to be the first off the line when a light turns green?	0	1	2	3	
14	accelerate when a traffic light turns yellow?	0	1	2	3	
15	drive shortly after drinking alcohol or using recreational drugs?	0	1	2	3	
16	drink alcohol or use recreational drugs while driving?	0	1	2	3	
17	cut off, honk or yell at other drivers who drive too slowly or cut you off?	0	1	2	3	
18	get very angry at other drivers?	0	1	2	3	
19	drive to reduce tension?	0	1	2	3	
20	do other things while driving, like use cell phone, eat or drink, put on makeup, read things, or smoke cigarettes?	0	1	2	3	
21	take your eyes off the road to adjust the CD player or pick something up from the floor?	0	1	2	3	
22	take your eyes off the road to talk to passengers?	0	1	2	3	
23	race other cars or drivers?	0	1	2	3	
24	not check the rearview mirror when passing another car or merging onto the highway?	0	1	2	3	

(continued on next page)

	In the past 12 months while driving, how often did you …	Never	Rarely	Sometimes	Often	Crash Risk* (1-7)
25	drive 10-20 mph over limit?	0	1	2	3	
26	drive more than 20 mph over limit?	0	1	2	3	
27	not yield to pedestrians?	0	1	2	3	
28	drive too fast for conditions?	0	1	2	3	
29	drive without wearing a safety belt?	0	1	2	3	
30	turn without signalling?	0	1	2	3	
31	drive with badly worn tires?	0	1	2	3	
32	pass where visibility was obscured?	0	1	2	3	
33	not make a full stop at stop sign?	0	1	2	3	

*** Crash Risk Rating Scale**

1 No Greater Risk

4 Moderately Greater Risk

7 Much Greater Risk

Frequency of Risky Behavior Questionnaire

A note on privacy
This survey is anonymous.
The record kept of your survey responses does not contain any identifying information about you unless a specific question in the survey has asked for this. If you have responded to a survey that used an identifying token to allow you to access the survey, you can rest assured that the identifying token is not kept with your responses. It is managed in a separate database, and will only be updated to indicate that you have (or haven't) completed this survey. There is no way of matching identification tokens with survey responses in this survey.

There are 32 questions in this survey

In the past 12 months while driving, how often did you ...

1 **run red lights?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

2 **drive when sleepy and find it hard to keep your eyes open?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

3 **take risks while driving because it's fun, like driving fast on curves or "getting air"?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

4 **change lanes suddenly to get ahead in traffic?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

5 **go through a stop sign without stopping?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

6 **speed for the thrill of it?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

7 **not yield the right of way?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

8 **make illegal turns?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

9 **follow a car very closely or "tailgate"?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

10 **follow emergency vehicles when the siren was on?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

11 **take more risks because you are in a hurry?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

12 **drive at your normal speed during bad driving conditions, like road construction, rain, ice, or snow?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

13 **pass other cars on the right side or on the shoulder of the road?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

14 **try to be the first off the line when a light turns green?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

15 **accelerate when a traffic light turns yellow?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

16 **drive shortly after drinking alcohol or using recreational drugs?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

17 **drink alcohol or use recreational drugs *while* driving?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

18 **cut off, honk or yell at other drivers who drive too slowly or cut you off?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

19 **drive to reduce tension?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

20 **do other things while driving, like use cell phone, eat or drink, put on makeup, read things, or smoke cigarettes?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

21 **take your eyes off the road to adjust the CD player or pick something up from the floor?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

22 **take your eyes off the road to talk to passengers?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

23 **race other cars or drivers?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

24 **not check the rearview mirror when passing another car or merging onto the highway?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

25 **drive 10-20 mph over limit?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

26 **drive more than 20 mph over limit?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

27 **not yield to pedestrians?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

28 **drive without wearing a safety belt?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

29 **turn without signaling?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

30 **drive with badly worn tires?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

31 **pass where visibility was obscured?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

32 **not make a full stop at stop sign?**

Please choose **only one** of the following:

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Often

Submit your survey.
Thank you for completing this survey.

APPENDIX D

Barkley's ADHD Quick Screen Questionnaire

Name_____ **Date**_____

Instructions

Please circle the number next to each item that best describes your behavior **DURING THE PAST 6 MONTHS**.

Items:	Never or Rarely	Sometimes	Often	Very Often
1. Easily distracted	0	1	2	3
2. Have difficulty organizing tasks and activities	0	1	2	3
3. Lose things necessary for tasks or activities	0	1	2	3
4. Have difficulty awaiting my turn	0	1	2	3
5. Feel restless	0	1	2	3
6. Have difficulty engaging in leisure activities or doing fun things quietly	0	1	2	3

For Office Use:

Add up the scores for each item. Enter Total Score Here _____

APPENDIX E

Sensation Seeking Scale Questionnaire

[Replicated exactly as originally shown in Zuckerman, 1994.]

Sensation Seeking Scale—form V (SSS-V)

Interest and preference test

Directions: Each of the items below contains two choices, A and B. Please indicate which of the choices most describes your likes or the way you feel. In some cases you may find items in which both choices describe your likes or feelings. Please choose the one which better describes your likes or feelings. In some cases you may find items in which you do not like either choice. In these cases mark the choice you dislike least. Do not leave any items blank. It is important you respond to all items with only one choice, A or B. We are interested only in your likes or feelings, not in how others feel about these things or how one is supposed to feel. There are no right or wrong answers as in other kinds of tests. Be frank and give your honest appraisal of yourself.

1. A. I like "wild" uninhibited parties.
   B. I prefer quiet parties with good conversation.

2. A. There are some movies I enjoy seeing a second or even third time.
   B. I can't stand watching a movie that I've seen before.

3. A. I often wish I could be a mountain climber.
   B. I can't understand people who risk their necks climbing mountains.

4. A. I dislike all body odors.
   B. I like some of the earthy body smells.

5. A. I get bored seeing the same old faces.
   B. I like the comfortable familiarity of everyday friends.

6. A. I like to explore a strange city or section of town by myself, even if it means getting lost.
   B. I prefer a guide when I am in a place I don't know well.

7. A. I dislike people who do or say things just to shock or upset others.
   B. When you can predict almost everything a person will do and say he or she must be a bore.

8. A. I usually don't enjoy a movie or play where I can predict what will happen in advance.
   B. I don't mind watching a movie or play where I can predict what will happen in advance.

9. A. I have tried marijuana or would like to.
   B. I would never smoke marijuana.

10. A. I would not like to try any drug which might produce strange and dangerous effects on me.
    B. I would like to try some of the drugs that produce hallucinations.

11. A. A sensible person avoids activities that are dangerous.
    B. I sometimes like to do things that are a little frightening.

12. A. I dislike "swingers" (people who are uninhibited and free about sex).
    B. I enjoy the company of real "swingers."

13. A. I find that stimulants make me uncomfortable.
    B. I often like to get high (drinking liquor or smoking marijuana).

14. A. I like to try new foods that I have never tasted before.
    B. I order the dishes with which I am familiar so as to avoid disappointment and unpleasantness.

15. A. I enjoy looking at home movies, videos, or travel slides.
    B. Looking at someone's home movies, videos, or travel slides bores me tremendously.

16. A. I would like to take up the sport of water skiing.
    B. I would not like to take up water skiing.

17. A. I would like to try surfboard riding.
    B. I would not like to try surfboard riding.

18. A. I would like to take off on a trip with no preplanned or definite routes, or timetable.
    B. When I go on a trip I like to plan my route and timetable fairly carefully.

19. A. I prefer the "down to earth" kinds of people as friends.
    B. I would like to make friends in some of the "far-out" groups like artists or "punks."

20. A. I would not like to learn to fly an airplane.
    B. I would like to learn to fly an airplane.

21. A. I prefer the surface of the water to the depths.
    B. I would like to go scuba diving.

22. A. I would like to meet some persons who are homosexual (men or women).
    B. I stay away from anyone I suspect of being "gay" or "lesbian."

23. A. I would like to try parachute jumping.
    B. I would never want to try jumping out of a plane, with or without a parachute.

24. A. I prefer friends who are excitingly unpredictable.
    B. I prefer friends who are reliable and predictable.

25. A. I am not interested in experience for its own sake.
    B. I like to have new and exciting experiences and sensations even if they are a little frightening, unconventional, or illegal.

26. A. The essence of good art is in its clarity, symmetry of form, and harmony of colors.
    B. I often find beauty in the "clashing" colors and irregular forms of modern paintings.

27. A. I enjoy spending time in the familiar surroundings of home.
    B. I get very restless if I have to stay around home for any length of time.

28. A. I like to dive off the high board.
    B. I don't like the feeling I get standing on the high board (or I don't go near it at all).

29. A. I like to date persons who are physically exciting.
    B. I like to date persons who share my values.

30. A. Heavy drinking usually ruins a party because some people get loud and boisterous.
    B. Keeping the drinks full is the key to a good party.

31. A. The worst social sin is to be rude.
    B. The worst social sin is to be a bore.

32. A. A person should have considerable sexual experience before marriage.
    B. It's better if two married persons begin their sexual experience with each other.

33. A. Even if I had the money, I would not care to associate with flighty rich persons in the "jet set."
    B. I could conceive of myself seeking pleasures around the world with the "jet set."

34. A. I like people who are sharp and witty even if they do sometimes insult others.
    B. I dislike people who have their fun at the expense of hurting the feelings of others.

35. A. There is altogether too much portrayal of sex in movies.
    B. I enjoy watching many of the "sexy" scenes in movies.

36. A. I feel best after taking a couple of drinks.
    B. Something is wrong with people who need liquor to feel good.

37. A. People should dress according to some standard of taste, neatness, and style.
    B. People should dress in individual ways even if the effects are sometimes strange.

38. A. Sailing long distances in small sailing crafts is foolhardy.
    B. I would like to sail a long distance in a small but seaworthy sailing craft.

39. A. I have no patience with dull or boring persons.
    B. I find something interesting in almost every person I talk to.

40. A. Skiing down a high mountain slope is a good way to end up on crutches.
    B. I think I would enjoy the sensations of skiing very fast down a high mountain slope.

END OF TEST

APPENDIX F

Driving Knowledge Questionnaire

Q#	State	Question	Answer	Question Category
1		***Night driving is dangerous because:*** A. Some traffic signs are less visible at night. B. More vehicles are on the road at night. C. The distance we can see ahead is reduced. D. Street lights tend to blur our vision.		
2		***You are coming to an intersection with a yellow flashing light. You should:*** A. Stop and wait for the light to change. B. Make a U-turn; the intersection is closed. C. Slow down and drive carefully through the intersection. D. Prepare to stop; the light is about to turn red.		
3		***A steady downward green arrow over a traffic lane means you:*** A. May use the lane. B. Are not permitted to use the lane. C. Must change to a different lane. D. May use the lane for left turns only.		
4		***The maximum speed limit on a rural Interstate Highway is:*** A. 55 miles per hour. B. 60 miles per hour. C. 65 miles per hour. D. 75 miles per hour		
5		***When you see or hear an emergency vehicle coming, you should:*** A. Stop immediately and let the vehicle pass. B. Drive as far toward the right side of the road as it is safe and stop. C. Proceed slowly and permit the vehicle to pass. D. Keep moving slowly, staying to the right side of the road.		
6		**Dim your lights when you are within 200 feet of:** A. A vehicle you are approaching from behind. B. An official vehicle. C. An oncoming vehicle. D. An intersection.		
7		 ***This sign means:*** A. One-way traffic B. Intersection ahead. C. Merging traffic from the right. D. Highway curves ahead.		

(continued on next page)

Q#	State	Question	Answer	Question Category
8		 ***This sign is used to warn drivers about:*** A. Upcoming intersections. B. Changes in traffic lanes. C. Road curves ahead. D. Road construction.		
9		***If you are stopped by a police officer, your should:*** A. Get your paperwork ready before the officer reaches your car. B. Unbuckle your seat belt and lower your window. C. Get out of your car and walk toward the patrol car. D. Stay in your vehicle with your hands on the steering wheel, and wait for the officer to approach you.		
10		***You have the right-of-way when you are:*** A. Entering a traffic circle B. Backing out of a driveway C. Leaving a parking space D. Already in a traffic circle		
11		***You should always park further than ___ feet away from a fire hydrant:*** A. 5 B. 10 C. 15 D. 20		
12		***The basic color for various traffic control devices used in construction and maintenance work areas is:*** A. Red B. Orange C. Yellow D. Blue		
13		***A broken yellow line beside a solid yellow line indicates:*** A. Passing is permitted on the side of the solid yellow line B. Passing is not permitted in either direction C. Passing is permitted on the side of the broken yellow line D. Nothing related to passing.		
14		***What is the proper way to enter an expressway from the entrance ramp?*** A. Slow on your way down the entrance ramp until it is clear to proceed. B. Go down the ramp and cross over to the traffic lane as soon as possible. C. Use the acceleration lane to blend into the traffic. D. Go down to the bottom of the ramp and stop until it is safe to enter the expressway.		
15		***When changing lanes, you can check your blind spot by:*** A. Turning your head and looking over your shoulder B. Using the inside rearview mirror. C. Using the outside rearview mirror. D. Using both inside and outside rearview mirrors.		
16		***On long trips you can prevent drowsiness by:*** A. Turning on your car radio. B. Slowing down so you can react better. C. Stopping at regular intervals for a rest. D. Moving your eyes from side to side as you drive.		
17		***City driving is more dangerous than expressway driving because of the:*** A. Lower speed limits. B. Narrower driving lanes. C. Cross traffic and pedestrians. D. Worse road conditions in bad weather.		
18		***You are approaching an intersection with a traffic signal and the light changes from green to yellow. You should:*** A. Consider it the same as a caution sign and continue through the intersection. B. Stop immediately. C. Stop before entering the intersection unless you are too close to stop safely. D. Speed up to get through the intersection before the red light comes on.		

(continued on next page)

Q#	State	Question	Answer	Question Category
19		***You have allowed the wheels of your vehicle to run off the right edge of the pavement. You should:*** A. Release the gas pedal and turn the front wheels slightly to the left to edge the car back on the pavement. B. Hold the steering wheel firmly; release the gas pedal; and gently apply the brakes. Return to the pavement when the vehicle has slowed enough to allow roll steer back onto the highway safely. C. Speed up enough to regain control of the vehicle. D. Apply the brakes and turn the front wheels sharply to the left.		
20		**Bicycles are** A. considered vehicles and have the same rights-of-way as motor vehicles. B. required to stay on sidewalks. C. considered vehicles but do not have the same rights-of-way as motor vehicles. D. required to stay on bicycle paths.		

APPENDIX G

Medical Conditions and Medications Survey and Medical Conditions and Medications Exit Survey

Medical Conditions & Medications

There are 38 questions in this survey

General Information

1

Note: 4 ft = 48 inches; 5 ft = 60 inches; 6 ft = 72 inches

Please write your answer(s) here:

Height (inches):	
Weight (lbs):	
Neck Size (inches):	

If you do not know your neck size enter "0"

Instructions

2 Instructions: Below is a list of medical conditions, diseases, and medications that may affect driving. For each condition, check Yes or No.

Only choose Yes for recent conditions as follows:

- **If you were treated for the condition within the past year (e.g., a doctor's office visit, hospitalization, or surgery), OR**
- **If you are currently on medication for the condition OR**
- **If you are using an aid related to the condition (e.g., corrective lenses, a hearing aid, or a cane) OR**
- **Currently active health condition.**

Vision Conditions

3 Check all that apply:

Please choose **all** that apply:

- ☐ Objects far away are blurry when not wearing corrective lenses (e.g., nearsighted).
- ☐ Objects close up are blurry when not wearing corrective lenses (e.g., farsighted).
- ☐ Astigmatism
- ☐ Reading glasses needed
- ☐ Glaucoma
- ☐ Color blindness
- ☐ Blind in one eye
- ☐ Poor night vision
- ☐ Detached retina
- ☐ Tunnel (no peripheral) vision
- ☐ Lasik or similar surgery

4 Other vision conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

5 Please select one of the following to describe your use of vision correction aids:

Please choose **only one** of the following:

- ○ I do not use glasses or contact lenses
- ○ I use glasses for reading only
- ○ I use glasses for driving and similar activities only
- ○ I wear glasses most of the time
- ○ I wear contact lenses

6 If you wear corrective lenses while driving, they are:

Please choose **only one** of the following:

- ○ Standard
- ○ Bifocal
- ○ Trifocal
- ○ Progressive lenses

Hearing Conditions

7 Check all that apply:

Please choose **all** that apply:

- ☐ Difficulty hearing, but no hearing aid
- ☐ Hearing aid
- ☐ Deafness

8 Other hearing conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Heart Conditions

9 Check all that apply:

Please choose **all** that apply:

- ☐ Angina
- ☐ Angioplasty
- ☐ Heart attack
- ☐ Bypass surgery
- ☐ Pacemaker
- ☐ Congestive heart failure
- ☐ Hypertension (high blood pressure)
- ☐ Hypotension (low blood pressure)

10 Other heart conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Stroke and Similar Brain Conditions

11 Check all that apply:

Please choose **all** that apply:

- [ ] Stroke
- [ ] TIA (mini-stroke)
- [ ] Brain aneurysm
- [ ] Brain hemorrhage
- [ ] Brain surgery
- [ ] Traumatic brain injury

12 Other brain conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Vascular (Blood Vessel) Conditions

13 Check all that apply:

Please choose **all** that apply:

- ☐ Peripheral aneurysm (in legs, arms, hands, or feet)
- ☐ Aortic aneurysms
- ☐ Deep-vein thrombosis (blood clot)

14 Other vascular conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Nervous System and Sleep Conditions

15 Check all that apply:

Please choose **all** that apply:

- [ ] Epilepsy
- [ ] Narcolepsy
- [ ] Sleep apnea
- [ ] Insomnia
- [ ] Restless Leg Syndrome
- [ ] Shift Work Disorder
- [ ] Periodic Limb Movement Disorder
- [ ] Parkinson's Disease
- [ ] Multiple Sclerosis
- [ ] Migraines
- [ ] Dizziness
- [ ] Brain tumors
- [ ] Peripheral Neuropathy (numbness and tingling in hands, feet, arms, and legs)

16 Other nervous system conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Respiratory Conditions

17 Check all that apply:

Please choose **all** that apply:

- ☐ Asthma
- ☐ Chronic Obstructive Pulmonary Disease (COPD)

18 Other respiratory conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Diabetes and Other Metabolic Conditions

19 Check all that apply:

Please choose **all** that apply:

- ☐ Type 1: Insulin dependent
- ☐ Type 2: Non-insulin dependent
- ☐ Type 2: Insulin dependent
- ☐ Hyperthyroidism
- ☐ Hypothyroidism

20 Other metabolic conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Kidney Conditions

21 Chronic kidney failure

Please choose **only one** of the following:

- ○ Yes
- ○ No

22 Other kidney conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Musculoskeletal (Muscle and Bone) Conditions

23 Limited flexibility (e.g., difficulty checking blind spots)

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

24 Severe Arthritis

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

25 Artificial limbs

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

26 Paralysis

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

27 Muscle and movement disorders

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

28 Other musculoskeletal conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

29 Which of the following do you use on a regular basis?

Please choose **all** that apply:

- ☐ Crutches
- ☐ Cane
- ☐ Walker
- ☐ Wheelchair
- ☐ Other

Cancer

30 Cancer

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Psychiatric Conditions

31 Check all that apply:

Please choose **all** that apply:

- ☐ Anxiety or panic attacks
- ☐ Depression
- ☐ ADD / ADHD / Tourette's Syndrome
- ☐ Personality disorders
- ☐ Psychotic disorders
- ☐ Bipolar disorder

32 Other psychiatric conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Current Medications

Many medications can affect driving. Please indicate which medications you are currently taking (generic or brand name, dosage, and frequency) in the space below, one line per medication.

Please include all over the counter medications as well as vitamins and supplements.

For your convenience, a list of the top 300 medications can be found at the following website http://www.rxlist.com/script/main/art.asp?articlekey=79510

Examples:

- Ibuprofen, 400 mg, twice per day
- Levothyroxine Sodium (Synthroid), 0.15 mg, once per day

33 List your presently Prescribed Medications

Please write your answer here:

Multiple Medical Conditions and Medications

34 I have been informed by a doctor in the past year that my multiple *medical conditions* may affect my ability to drive.

Please choose **only one** of the following:

- ○ Yes
- ○ No

35 I have been informed by a doctor in the past year that my multiple *medications* may affect my ability to drive.

Please choose **only one** of the following:

- ○ Yes
- ○ No

36 I have been informed by a doctor in the past year that my age-related *medical conditions* may affect my ability to drive.

Please choose **only one** of the following:

- ○ Yes
- ○ No

37 I have had to give up driving for a period of time at some point in the past due to health issues (examples: injury, epilepsy, pregnancy, cancer, narcolepsy).

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Other Medical Issues or Concerns

38 Are there any other medical issues or concerns not reflected above that may affect your driving?

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Submit Your Survey.
Thank you for completing this survey.

Medical Conditions & Medications - EXIT Survey

There are 40 questions in this survey

General Information

1 Age:

Please write your answer here:

2 Gender:

Please choose **only one** of the following:

- ○ Female
- ○ Male

3

Note: 4 ft = 48 inches; 5 ft = 60 inches; 6 ft = 72 inches

Please write your answer(s) here:

Height (inches):	
Weight (lbs):	
Neck Size (inches):	

If you do not know your neck size enter "0"

Instructions

4 Instructions: Below is a list of medical conditions, diseases, and medications that may affect driving. For each condition, check Yes or No.

Only choose Yes for recent conditions as follows:

- **If you were treated for the condition within the past year (e.g., a doctor's office visit, hospitalization, or surgery), OR**
- **If you are currently on medication for the condition OR**
- **If you are using an aid related to the condition (e.g., corrective lenses, a hearing aid, or a cane) OR**
- **Currently active health condition.**

Vision Conditions

5 Check all that apply:

Please choose all that apply:

- [ ] Objects far away are blurry when not wearing corrective lenses (e.g., nearsighted).
- [ ] Objects close up are blurry when not wearing correective lenses (e.g., farsighted).
- [ ] Astigmatism
- [ ] Reading glasses needed
- [ ] Glaucoma
- [ ] Color blindness
- [ ] Blind in one eye
- [ ] Poor night vision
- [ ] Detached retina
- [ ] Tunnel (no peripheral) vision
- [ ] Lasik or similar surgery

6 Other vision conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

7 Please select one of the following to describe your use of vision correction aids:

Please choose **only one** of the following:

- ○ I do not use glasses or contact lenses
- ○ I use glasses for reading only
- ○ I use glasses for driving and similar activities only
- ○ I wear glasses most of the time
- ○ I wear contact lenses

8 If you wear corrective lenses while driving, they are:

Please choose **only one** of the following:

- ○ Standard
- ○ Bifocal
- ○ Trifocal
- ○ Progressive lenses

Hearing Conditions

9 Check all that apply:

Please choose **all** that apply:

- ☐ Difficulty hearing, but no hearing aid
- ☐ Hearing aid
- ☐ Deafness

10 Other hearing conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Heart Conditions

11 Check all that apply:

Please choose **all** that apply:

- [ ] Angina
- [ ] Angioplasty
- [ ] Heart attack
- [ ] Bypass surgery
- [ ] Pacemaker
- [ ] Congestive heart failure
- [ ] Hypertension (high blood pressure)
- [ ] Hypotension (low blood pressure)

12 Other heart conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Stroke and Similar Brain Conditions

13 Check all that apply:

Please choose **all** that apply:

- [ ] Stroke
- [ ] TIA (mini-stroke)
- [ ] Brain aneurysm
- [ ] Brain hemorrhage
- [ ] Brain surgery
- [ ] Traumatic brain injury

14 Other brain conditions

Please choose **only one** of the following:

- ( ) Yes
- ( ) No

Make a comment on your choice here:

Vascular (Blood Vessel) Conditions

15 Check all that apply:

Please choose **all** that apply:

- [ ] Peripheral aneurysm (in legs, arms, hands, or feet)
- [ ] Aortic aneurysms
- [ ] Deep-vein thrombosis (blood clot)

16 Other vascular conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Nervous System and Sleep Conditions

17 Check all that apply:

Please choose **all** that apply:

- [ ] Epilepsy
- [ ] Narcolepsy
- [ ] Sleep apnea
- [ ] Insomnia
- [ ] Restless Leg Syndrome
- [ ] Shift Work Disorder
- [ ] Periodic Limb Movement Disorder
- [ ] Parkinson's Disease
- [ ] Multiple Sclerosis
- [ ] Migraines
- [ ] Dizziness
- [ ] Brain tumors
- [ ] Peripheral Neuropathy (numbness and tingling in hands, feet, arms, and legs)

18 Other nervous system conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Respiratory Conditions

19 Check all that apply:

Please choose **all** that apply:

- [ ] Asthma
- [ ] Chronic Obstructive Pulmonary Disease (COPD)

20 Other respiratory conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Diabetes and Other Metabolic Conditions

21 Check all that apply:

Please choose **all** that apply:

- [ ] Type 1: Insulin dependent
- [ ] Type 2: Non-insulin dependent
- [ ] Type 2: Insulin dependent
- [ ] Hyperthyroidism
- [ ] Hypothyroidism

22 Other metabolic conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Kidney Conditions

23 Chronic kidney failure

Please choose **only one** of the following:

- ○ Yes
- ○ No

24 Other kidney conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Musculoskeletal (Muscle and Bone) Conditions

25 Limited flexibility (e.g., difficulty checking blind spots)

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

26 Severe Arthritis

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

27 Artificial limbs

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

28 Paralysis

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

29 Muscle and movement disorders

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

30 Other musculoskeletal conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

31 Which of the following do you use on a regular basis?

Please choose **all** that apply:

- ☐ Crutches
- ☐ Cane
- ☐ Walker
- ☐ Wheelchair
- ☐ Other

Cancer

32 Cancer

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Psychiatric Conditions

33

Check all that apply:

Please choose **all** that apply:

- [ ] Anxiety or panic attacks
- [ ] Depression
- [ ] ADD / ADHD / Tourette's Syndrome
- [ ] Personality disorders
- [ ] Psychotic disorders
- [ ] Bipolar disorder

34 Other psychiatric conditions

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Current Medications

Many medications can affect driving. Please indicate which medications you are currently taking (generic or brand name, dosage, and frequency) in the space below, one line per medication.

Please include all over the counter medications as well as vitamins and supplements.

For your convenience, a list of the top 300 medications can be found at the following website http://www.rxlist.com/script/main/art.asp?articlekey=79510

Examples:

- Ibuprofen, 400 mg, twice per day
- Levothyroxine Sodium (Synthroid), 0.15 mg, once per day

35 List your presently Prescribed Medications

Please write your answer here:

Multiple Medical Conditions and Medications

36 I have been informed by a doctor in the past year that my multiple *medical conditions* may affect my ability to drive.

Please choose **only one** of the following:

- ○ Yes
- ○ No

37 I have been informed by a doctor in the past year that my multiple *medications* may affect my ability to drive.

Please choose **only one** of the following:

- ○ Yes
- ○ No

38 I have been informed by a doctor in the past year that my age-related *medical conditions* may affect my ability to drive.

Please choose **only one** of the following:

- ○ Yes
- ○ No

39 I have had to give up driving for a period of time at some point in the past due to health issues (examples: injury, epilepsy, pregnancy, cancer, narcolepsy).

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Other Medical Issues or Concerns

40 Are there any other medical issues or concerns not reflected above that may affect your driving?

Please choose **only one** of the following:

- ○ Yes
- ○ No

Make a comment on your choice here:

Submit Your Survey.
Thank you for completing this survey.

APPENDIX H

Modified Manchester Driver Behavior Questionnaire

	Never	Hardly Ever	Occasionally	Quite Often	Frequently	Nearly All The Time
Attempt to drive away from traffic lights in the wrong gear	0	1	2	3	4	5
Become impatient with a slow driver in the fast lane and pass on the right	0	1	2	3	4	5
Drive especially close to a car in front as a signal to the driver to go faster or get out of the way	0	1	2	3	4	5
Attempt to pass someone that you hadn't noticed to be making a left turn	0	1	2	3	4	5
Forget where you left your car in a parking lot	0	1	2	3	4	5
Turn on one thing, such as your headlights, when you mean to switch on something else, such as the windshield wipers	0	1	2	3	4	5
Realize that you have no clear recollection of the road along which you have just been traveling	0	1	2	3	4	5
Cross an intersection knowing that the traffic lights have already changed from yellow to red	0	1	2	3	4	5
Fail to notice that pedestrians are crossing when turning onto a side street from a main road	0	1	2	3	4	5
Angered by another driver's behavior, you catch up to them with the intention of giving him/her "a piece of your mind."	0	1	2	3	4	5

	Never	Hardly Ever	Occasionally	Quite Often	Frequently	Nearly All The Time
Misread the signs and turn the wrong direction on a one-way street	0	1	2	3	4	5
Disregard the speed limits late at night or early in the morning	0	1	2	3	4	5
When turning right, nearly hit a bicyclist who is riding along side of you	0	1	2	3	4	5
Attempting to turn onto a main road, you pay such close attention to traffic on the road you are entering that you nearly hit the car in front of you that is also waiting to turn.	0	1	2	3	4	5
Drive even though you realize you might be over the legal blood alcohol limit	0	1	2	3	4	5
Have an aversion to a particular class of road user, and indicate your hostility by whatever means you can	0	1	2	3	4	5
Underestimate the speed of an oncoming vehicle when attempting to pass a vehicle in your own lane	0	1	2	3	4	5
Hit something when backing up that you had not previously seen	0	1	2	3	4	5
Intending to drive to destination A, you 'wake up' to find yourself on a road to destination B, perhaps because destination B is a more common destination.	0	1	2	3	4	5
Get into the wrong lane approaching an intersection	0	1	2	3	4	5
Miss "Yield" signs, and narrowly avoid colliding with traffic having the right of way	0	1	2	3	4	5
Fail to check your rearview mirror before pulling out, changing lanes, etc.	0	1	2	3	4	5
Get involved in unofficial 'races' with other drivers	0	1	2	3	4	5
Brake to quickly on a slippery road or steer the wrong way into a skid	0	1	2	3	4	5

APPENDIX I

Crash Interview

Driver Interview

There are 209 questions in this survey

group 1

1 Driver's description of the crash events and related factors:

Please write your answer here:

2 If applicable and consented, occupant's description of incident events and related factors:

Please write your answer here:

3 How many days have elapsed between the date of the crash and initiating this post-crash interview?

Please choose **only one** of the following:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11
- ○ 12
- ○ 13
- ○ 14
- ○ 15 or more

4 City where the incident occurred:

Please write your answer here:

5 State where the incident occurred:

Please choose **only one** of the following:

- ○ AL - Alabama
- ○ AK - Alaska
- ○ AZ - Arizona
- ○ AR - Arkansas
- ○ CA - California
- ○ CO - Colorado
- ○ CT - Connecticut
- ○ DE - Delaware

- ○ DC - District of Columbia
- ○ FL - Florida
- ○ GA - Georgia
- ○ HI - Hawaii
- ○ ID - Idaho
- ○ IL - Illinois
- ○ IN - Indiana
- ○ IA - Iowa
- ○ KS - Kansas
- ○ KY - Kentucky
- ○ LA - Louisiana
- ○ ME - Maine
- ○ MD - Maryland
- ○ MA - Massachusetts
- ○ MI - Michigan
- ○ MN - Minnesota
- ○ MS - Mississippi
- ○ MO - Missouri
- ○ MT - Montana
- ○ NE - Nebraska
- ○ NV - Nevada
- ○ NH - New Hampshire
- ○ NJ - New Jersey
- ○ NM - New Mexico
- ○ NY - New York
- ○ NC - North Carolina
- ○ ND - North Dakota
- ○ OH - Ohio
- ○ OK - Oklahoma
- ○ OR - Oregon
- ○ PA - Pennsylvania
- ○ RI - Rhode Island
- ○ SC - South Carolina
- ○ SD - South Dakota
- ○ TN - Tennessee
- ○ TX - Texas

- ○ UT - Utah
- ○ VT - Vermont
- ○ VA - Virginia
- ○ WA - Washington
- ○ WV - West Virginia
- ○ WI - Wisconsin
- ○ WY - Wyoming

6 Date of incident:

Please enter a date:

7 Time of incident:

Please write your answer here:

Enter in 12 hour format using hour and minutes with either a.m. or p.m.

8 Please fill in the following information, to the best of the participant's knowledge, for each occupant.

9 What was the Driver's seat belt usage?

Please choose **only one** of the following:

- ○ Belted
- ○ Car Seat
- ○ Unbelted
- ○ Unknown

10 What is the Driver's age?

Please write your answer here:

11 What is the Driver's weight?

Please write your answer here:

12 What is the Driver's height?

Please write your answer here:

enter height as: 5' 10" or 5ft 10in or 5-10

13 What is the Driver's gender?

Please choose **only one** of the following:

- ○ Female
- ○ Male

14 How many passengers were in the vehicle (do not count the driver)?

Please choose **only one** of the following:

- ○ None
- ○ 1 passenger
- ○ 2 passengers
- ○ 3 passengers
- ○ 4 passengers
- ○ 5 passengers
- ○ 6 passengers
- ○ 7 passengers

15 Where was Passenger 1 sitting?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '1 passenger' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Front Right Outboard
- ○ Front Center
- ○ 2nd Row Right Outboard
- ○ 2nd Row Center
- ○ 2nd Row Left Outboard
- ○ 3rd Row Right Outboard
- ○ 3rd Row Center
- ○ 3rd Row Left Outboard

16 What was Passenger 1's seat belt usage?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '1 passenger' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Belted
- ○ Car Seat
- ○ Unbelted
- ○ Unknown

17 What is Passenger 1's age?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '1 passenger' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

18 What is Passenger 1's weight?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '1 passenger' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

19 What is Passenger 1's height?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '1 passenger' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ 20"
- ○ 21"
- ○ 22"
- ○ 23"
- ○ 24"
- ○ 25"
- ○ 26"
- ○ 27"
- ○ 28"
- ○ 29"
- ○ 30"
- ○ 31"
- ○ 32"
- ○ 33"
- ○ 34"
- ○ 35"
- ○ 3' = 36"
- ○ 3' 1"
- ○ 3' 2"
- ○ 3' 3"
- ○ 3' 4"
- ○ 3' 5"
- ○ 3' 6"
- ○ 3' 7"

- ○ 3' 8"
- ○ 3' 9"
- ○ 3' 10"
- ○ 3' 11"
- ○ 4'
- ○ 4' 1"
- ○ 4' 2"
- ○ 4' 3"
- ○ 4' 4"
- ○ 4' 5"
- ○ 4' 6"
- ○ 4' 7"
- ○ 4' 8"
- ○ 4' 9"
- ○ 4' 10"
- ○ 4' 11"
- ○ 5'
- ○ 5' 1"
- ○ 5' 2"
- ○ 5' 3"
- ○ 5' 4"
- ○ 5' 5"
- ○ 5' 6"
- ○ 5' 7"
- ○ 5' 8"
- ○ 5' 9"
- ○ 5' 10"
- ○ 5' 11"
- ○ 6'
- ○ 6' 1"
- ○ 6' 2"
- ○ 6' 3"
- ○ 6' 4"
- ○ 6' 5"
- ○ 6' 6"
- ○ 6' 7"

- ○ 6' 8"
- ○ 6' 9"
- ○ 6' 10"
- ○ 6' 11"
- ○ 7'
- ○ 7' 1"
- ○ 7' 2"
- ○ 7' 3"
- ○ 7' 4"
- ○ 7' 5"
- ○ 7' 6"
- ○ 7' 7"
- ○ 7' 8"
- ○ 7' 9"
- ○ 7' 10"

20 What is Passenger 1's gender?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '1 passenger' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Female
- ○ Male

21 Where was Passenger 2 sitting?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '2 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Front Right Outboard
- ○ Front Center
- ○ 2nd Row Right Outboard
- ○ 2nd Row Center
- ○ 2nd Row Left Outboard
- ○ 3rd Row Right Outboard
- ○ 3rd Row Center
- ○ 3rd Row Left Outboard

22 What was Passenger 2's seat belt usage?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '2 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Belted
- ○ Car Seat
- ○ Unbelted
- ○ Unknown

23 What is Passenger 2's age?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '2 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

24 What is Passenger 2's weight?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '2 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

25 What is Passenger 2's height?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '2 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ 20"
- ○ 21"
- ○ 22"
- ○ 23"
- ○ 24"
- ○ 25"
- ○ 26"
- ○ 27"
- ○ 28"
- ○ 29"
- ○ 30"
- ○ 31"
- ○ 32"
- ○ 33"
- ○ 34"
- ○ 35"
- ○ 3' = 36"
- ○ 3' 1"
- ○ 3' 2"
- ○ 3' 3"
- ○ 3' 4"
- ○ 3' 5"
- ○ 3' 6"
- ○ 3' 7"

- ○ 3' 8"
- ○ 3' 9"
- ○ 3' 10"
- ○ 3' 11"
- ○ 4'
- ○ 4' 1"
- ○ 4' 2"
- ○ 4' 3"
- ○ 4' 4"
- ○ 4' 5"
- ○ 4' 6"
- ○ 4' 7"
- ○ 4' 8"
- ○ 4' 9"
- ○ 4' 10"
- ○ 4' 11"
- ○ 5'
- ○ 5' 1"
- ○ 5' 2"
- ○ 5' 3"
- ○ 5' 4"
- ○ 5' 5"
- ○ 5' 6"
- ○ 5' 7"
- ○ 5' 8"
- ○ 5' 9"
- ○ 5' 10"
- ○ 5' 11"
- ○ 6'
- ○ 6' 1"
- ○ 6' 2"
- ○ 6' 3"
- ○ 6' 4"
- ○ 6' 5"
- ○ 6' 6"
- ○ 6' 7"

- ○ 6' 8"
- ○ 6' 9"
- ○ 6' 10"
- ○ 6' 11"
- ○ 7'
- ○ 7' 1"
- ○ 7' 2"
- ○ 7' 3"
- ○ 7' 4"
- ○ 7' 5"
- ○ 7' 6"
- ○ 7' 7"
- ○ 7' 8"
- ○ 7' 9"
- ○ 7' 10"

26 What is Passenger 2's gender?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '2 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Female
- ○ Male

27 Where was Passenger 3 sitting?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '3 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Front Right Outboard
- ○ Front Center
- ○ 2nd Row Right Outboard
- ○ 2nd Row Center
- ○ 2nd Row Left Outboard
- ○ 3rd Row Right Outboard
- ○ 3rd Row Center
- ○ 3rd Row Left Outboard

28 What was Passenger 3's seat belt usage?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '3 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Belted
- ○ Car Seat
- ○ Unbelted
- ○ Unknown

29 What is Passenger 3's age?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '3 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

30 What is Passenger 3's weight?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '3 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

31 What is Passenger 3's height?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '3 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ 20"
- ○ 21"
- ○ 22"
- ○ 23"
- ○ 24"
- ○ 25"
- ○ 26"
- ○ 27"
- ○ 28"
- ○ 29"
- ○ 30"
- ○ 31"
- ○ 32"
- ○ 33"
- ○ 34"
- ○ 35"
- ○ 3' = 36"
- ○ 3' 1"
- ○ 3' 2"
- ○ 3' 3"
- ○ 3' 4"
- ○ 3' 5"
- ○ 3' 6"
- ○ 3' 7"

- ○ 3' 8"
- ○ 3' 9"
- ○ 3' 10"
- ○ 3' 11"
- ○ 4'
- ○ 4' 1"
- ○ 4' 2"
- ○ 4' 3"
- ○ 4' 4"
- ○ 4' 5"
- ○ 4' 6"
- ○ 4' 7"
- ○ 4' 8"
- ○ 4' 9"
- ○ 4' 10"
- ○ 4' 11"
- ○ 5'
- ○ 5' 1"
- ○ 5' 2"
- ○ 5' 3"
- ○ 5' 4"
- ○ 5' 5"
- ○ 5' 6"
- ○ 5' 7"
- ○ 5' 8"
- ○ 5' 9"
- ○ 5' 10"
- ○ 5' 11"
- ○ 6'
- ○ 6' 1"
- ○ 6' 2"
- ○ 6' 3"
- ○ 6' 4"
- ○ 6' 5"
- ○ 6' 6"
- ○ 6' 7"

- ○ 6' 8"
- ○ 6' 9"
- ○ 6' 10"
- ○ 6' 11"
- ○ 7'
- ○ 7' 1"
- ○ 7' 2"
- ○ 7' 3"
- ○ 7' 4"
- ○ 7' 5"
- ○ 7' 6"
- ○ 7' 7"
- ○ 7' 8"
- ○ 7' 9"
- ○ 7' 10"

32 What is Passenger 3's gender?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '3 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Female
- ○ Male

33 Where was Passenger 4 sitting?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '4 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Front Right Outboard
- ○ Front Center
- ○ 2nd Row Right Outboard
- ○ 2nd Row Center
- ○ 2nd Row Left Outboard
- ○ 3rd Row Right Outboard
- ○ 3rd Row Center
- ○ 3rd Row Left Outboard

34 What was Passenger 4's seat belt usage?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '4 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Belted
- ○ Car Seat
- ○ Unbelted
- ○ Unknown

35 What is Passenger 4's age?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '4 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

36 What is Passenger 4's weight?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '4 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

37 What is Passenger 4's height?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '4 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ 20"
- ○ 21"
- ○ 22"
- ○ 23"
- ○ 24"
- ○ 25"
- ○ 26"
- ○ 27"
- ○ 28"
- ○ 29"
- ○ 30"
- ○ 31"
- ○ 32"
- ○ 33"
- ○ 34"
- ○ 35"
- ○ 3' = 36"
- ○ 3' 1"
- ○ 3' 2"
- ○ 3' 3"
- ○ 3' 4"
- ○ 3' 5"
- ○ 3' 6"
- ○ 3' 7"

- ○ 3' 8"
- ○ 3' 9"
- ○ 3' 10"
- ○ 3' 11"
- ○ 4'
- ○ 4' 1"
- ○ 4' 2"
- ○ 4' 3"
- ○ 4' 4"
- ○ 4' 5"
- ○ 4' 6"
- ○ 4' 7"
- ○ 4' 8"
- ○ 4' 9"
- ○ 4' 10"
- ○ 4' 11"
- ○ 5'
- ○ 5' 1"
- ○ 5' 2"
- ○ 5' 3"
- ○ 5' 4"
- ○ 5' 5"
- ○ 5' 6"
- ○ 5' 7"
- ○ 5' 8"
- ○ 5' 9"
- ○ 5' 10"
- ○ 5' 11"
- ○ 6'
- ○ 6' 1"
- ○ 6' 2"
- ○ 6' 3"
- ○ 6' 4"
- ○ 6' 5"
- ○ 6' 6"
- ○ 6' 7"

- ○ 6' 8"
- ○ 6' 9"
- ○ 6' 10"
- ○ 6' 11"
- ○ 7'
- ○ 7' 1"
- ○ 7' 2"
- ○ 7' 3"
- ○ 7' 4"
- ○ 7' 5"
- ○ 7' 6"
- ○ 7' 7"
- ○ 7' 8"
- ○ 7' 9"
- ○ 7' 10"

38 What is Passenger 4's gender?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '4 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Female
- ○ Male

39 Where was Passenger 5 sitting?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '5 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Front Right Outboard
- ○ Front Center
- ○ 2nd Row Right Outboard
- ○ 2nd Row Center
- ○ 2nd Row Left Outboard
- ○ 3rd Row Right Outboard
- ○ 3rd Row Center
- ○ 3rd Row Left Outboard

40 What was Passenger 5's seat belt usage?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '5 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Belted
- ○ Car Seat
- ○ Unbelted
- ○ Unknown

41 What is Passenger 5's age?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '5 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

42 What is Passenger 5's weight?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '5 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

43 What is Passenger 5's height?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '5 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ 20"
- ○ 21"
- ○ 22"
- ○ 23"
- ○ 24"
- ○ 25"
- ○ 26"
- ○ 27"
- ○ 28"
- ○ 29"
- ○ 30"
- ○ 31"
- ○ 32"
- ○ 33"
- ○ 34"
- ○ 35"
- ○ 3' = 36"
- ○ 3' 1"
- ○ 3' 2"
- ○ 3' 3"
- ○ 3' 4"
- ○ 3' 5"
- ○ 3' 6"
- ○ 3' 7"

- ○ 3' 8"
- ○ 3' 9"
- ○ 3' 10"
- ○ 3' 11"
- ○ 4'
- ○ 4' 1"
- ○ 4' 2"
- ○ 4' 3"
- ○ 4' 4"
- ○ 4' 5"
- ○ 4' 6"
- ○ 4' 7"
- ○ 4' 8"
- ○ 4' 9"
- ○ 4' 10"
- ○ 4' 11"
- ○ 5'
- ○ 5' 1"
- ○ 5' 2"
- ○ 5' 3"
- ○ 5' 4"
- ○ 5' 5"
- ○ 5' 6"
- ○ 5' 7"
- ○ 5' 8"
- ○ 5' 9"
- ○ 5' 10"
- ○ 5' 11"
- ○ 6'
- ○ 6' 1"
- ○ 6' 2"
- ○ 6' 3"
- ○ 6' 4"
- ○ 6' 5"
- ○ 6' 6"
- ○ 6' 7"

- ○ 6' 8"
- ○ 6' 9"
- ○ 6' 10"
- ○ 6' 11"
- ○ 7'
- ○ 7' 1"
- ○ 7' 2"
- ○ 7' 3"
- ○ 7' 4"
- ○ 7' 5"
- ○ 7' 6"
- ○ 7' 7"
- ○ 7' 8"
- ○ 7' 9"
- ○ 7' 10"

44 What is Passenger 5's gender?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '5 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Female
- ○ Male

45 Where was Passenger 6 sitting?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '6 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Front Right Outboard
- ○ Front Center
- ○ 2nd Row Right Outboard
- ○ 2nd Row Center
- ○ 2nd Row Left Outboard
- ○ 3rd Row Right Outboard
- ○ 3rd Row Center
- ○ 3rd Row Left Outboard

46 What was Passenger 6's seat belt usage?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '6 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Belted
- ○ Car Seat
- ○ Unbelted
- ○ Unknown

47 What is Passenger 6's age?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '6 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

48 What is Passenger 6's weight?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '6 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

49 What is Passenger 6's height?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '6 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ 20"
- ○ 21"
- ○ 22"
- ○ 23"
- ○ 24"
- ○ 25"
- ○ 26"
- ○ 27"
- ○ 28"
- ○ 29"
- ○ 30"
- ○ 31"
- ○ 32"
- ○ 33"
- ○ 34"
- ○ 35"
- ○ 3' = 36"
- ○ 3' 1"
- ○ 3' 2"
- ○ 3' 3"
- ○ 3' 4"
- ○ 3' 5"
- ○ 3' 6"
- ○ 3' 7"

- ○ 3' 8"
- ○ 3' 9"
- ○ 3' 10"
- ○ 3' 11"
- ○ 4'
- ○ 4' 1"
- ○ 4' 2"
- ○ 4' 3"
- ○ 4' 4"
- ○ 4' 5"
- ○ 4' 6"
- ○ 4' 7"
- ○ 4' 8"
- ○ 4' 9"
- ○ 4' 10"
- ○ 4' 11"
- ○ 5'
- ○ 5' 1"
- ○ 5' 2"
- ○ 5' 3"
- ○ 5' 4"
- ○ 5' 5"
- ○ 5' 6"
- ○ 5' 7"
- ○ 5' 8"
- ○ 5' 9"
- ○ 5' 10"
- ○ 5' 11"
- ○ 6'
- ○ 6' 1"
- ○ 6' 2"
- ○ 6' 3"
- ○ 6' 4"
- ○ 6' 5"
- ○ 6' 6"
- ○ 6' 7"

- ○ 6' 8"
- ○ 6' 9"
- ○ 6' 10"
- ○ 6' 11"
- ○ 7'
- ○ 7' 1"
- ○ 7' 2"
- ○ 7' 3"
- ○ 7' 4"
- ○ 7' 5"
- ○ 7' 6"
- ○ 7' 7"
- ○ 7' 8"
- ○ 7' 9"
- ○ 7' 10"

50 What is Passenger 6's gender?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '6 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Female
- ○ Male

51 Where was Passenger 7 sitting?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '7 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Front Right Outboard
- ○ Front Center
- ○ 2nd Row Right Outboard
- ○ 2nd Row Center
- ○ 2nd Row Left Outboard
- ○ 3rd Row Right Outboard
- ○ 3rd Row Center
- ○ 3rd Row Left Outboard

52 What was Passenger 7's seat belt usage?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '7 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Belted
- ○ Car Seat
- ○ Unbelted
- ○ Unknown

53 What is Passenger 7's age?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '7 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

54 What is Passenger 7's weight?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '7 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

55 What is Passenger 7's height?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '7 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ 20"
- ○ 21"
- ○ 22"
- ○ 23"
- ○ 24"
- ○ 25"
- ○ 26"
- ○ 27"
- ○ 28"
- ○ 29"
- ○ 30"
- ○ 31"
- ○ 32"
- ○ 33"
- ○ 34"
- ○ 35"
- ○ 3' = 36"
- ○ 3' 1"
- ○ 3' 2"
- ○ 3' 3"
- ○ 3' 4"
- ○ 3' 5"
- ○ 3' 6"
- ○ 3' 7"

- ○ 3' 8"
- ○ 3' 9"
- ○ 3' 10"
- ○ 3' 11"
- ○ 4'
- ○ 4' 1"
- ○ 4' 2"
- ○ 4' 3"
- ○ 4' 4"
- ○ 4' 5"
- ○ 4' 6"
- ○ 4' 7"
- ○ 4' 8"
- ○ 4' 9"
- ○ 4' 10"
- ○ 4' 11"
- ○ 5'
- ○ 5' 1"
- ○ 5' 2"
- ○ 5' 3"
- ○ 5' 4"
- ○ 5' 5"
- ○ 5' 6"
- ○ 5' 7"
- ○ 5' 8"
- ○ 5' 9"
- ○ 5' 10"
- ○ 5' 11"
- ○ 6'
- ○ 6' 1"
- ○ 6' 2"
- ○ 6' 3"
- ○ 6' 4"
- ○ 6' 5"
- ○ 6' 6"
- ○ 6' 7"

- ○ 6' 8"
- ○ 6' 9"
- ○ 6' 10"
- ○ 6' 11"
- ○ 7'
- ○ 7' 1"
- ○ 7' 2"
- ○ 7' 3"
- ○ 7' 4"
- ○ 7' 5"
- ○ 7' 6"
- ○ 7' 7"
- ○ 7' 8"
- ○ 7' 9"
- ○ 7' 10"

56 What is Passenger 7's gender?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '7 passengers' at question '14 [8]' (How many passengers were in the vehicle (do not count the driver)?)

Please choose **only one** of the following:

- ○ Female
- ○ Male

57 In which lane were you traveling?

Please choose **only one** of the following:

- ○ Lane one (right curb lane)
- ○ Lane two
- ○ Lane three
- ○ Lane four
- ○ Not applicable
- ○ Unknown
- ○ Other, specify: _____

58 What was your travel speed?

Please choose **only one** of the following:

- ○ Stopped
- ○ 1-10 mph
- ○ 11-20 mph
- ○ 21-30 mph
- ○ 31-40 mph
- ○ 41-50 mph
- ○ 51-60 mph
- ○ 61-70 mph
- ○ > 70 mph
- ○ No driver present
- ○ Unknown

59 Before impact, what were you intending to do?

Please choose **all** that apply:

- ☐ Go straight
- ☐ Slow down
- ☐ Accelerate
- ☐ Stop
- ☐ Change lanes to right
- ☐ Change lanes to left
- ☐ Turn left
- ☐ Turn right
- ☐ Merge
- ☐ Negotiate curve
- ☐ Backup
- ☐ U-turn
- ☐ Stopped, no movement intended
- ☐ Unknown
- ☐ Other, specify::

63 Regulatory Signs

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '61 [48]' (Were there any traffic signs or signals at the crash scene? If so, which was most relevant to your vehicle's position?)

Please choose **only one** of the following:

- ○ Stop sign
- ○ Yield sign
- ○ Unknown type of regulatory sign
- ○ Other regulatory sign (specify) _____

64 School zone signs

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '61 [48]' (Were there any traffic signs or signals at the crash scene? If so, which was most relevant to your vehicle's position?)

Please choose **only one** of the following:

- ○ School zone speed limit
- ○ School advance or crossing sign
- ○ Other school related sign (specify) _____

65 Warning signs

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '61 [48]' (Were there any traffic signs or signals at the crash scene? If so, which was most relevant to your vehicle's position?)

Please choose **only one** of the following:

- ○ Warning sign
- ○ Other _____

66 Misc not at RR crossing

Please choose **only one** of the following:

- ○ Officer, crossing guard, flagman, etc
- ○ Other _____

60 Did you have your turn signal on?

Please choose **only one** of the following:

- ○ No
- ○ Yes
- ○ Not Applicable
- ○ Unknown

61 Were there any traffic signs or signals at the crash scene? If so, which was most relevant to your vehicle's position?

Please choose **only one** of the following:

- ○ Yes
- ○ No

62 Traffic Signals

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '61 [48]' (Were there any traffic signs or signals at the crash scene? If so, which was most relevant to your vehicle's position?)

Please choose **only one** of the following:

- ○ No control devices
- ○ Control signal (on colors) w/ pedestrian signal
- ○ Control signal (on colors) w/o pedestrian signal
- ○ Control signal (on colors) unknown pedestrian signal
- ○ Flashing control signal
- ○ Flashing beacon
- ○ Flashing highway signal, unknown or other
- ○ Lane use control signal
- ○ Highway signal, type unknown
- ○ Other

67 RR Grade crossing - active

Please choose **only one** of the following:

- ○ Gates (active)
- ○ Flashing lights (active)
- ○ Traffic control signal (active)
- ○ Wigwags (active)
- ○ Bells (active)
- ○ Active device, type unknown
- ○ Other train activated device (specify) [ ]

68 RR Grade crossing - passive

Please choose **only one** of the following:

- ○ Cross-bucks (passive)
- ○ Stop sign (passive)
- ○ Special warning device (passive)
- ○ Passive device, type unknown
- ○ Other passive railroad crossing device (specify) [ ]

69 RR Grade crossing - misc dev

Please choose **only one** of the following:

- ○ Grade crossing controlled, type unknown
- ○ Other [ ]

70 Other control device

Please choose **only one** of the following:

- ○ Not applicable
- ○ Unknown
- ○ Other, specify: [ ]

71 (If applicable) Was the traffic sign/signal functioning properly?

Please choose **only one** of the following:

- ○ No traffic signs or signals
- ○ Traffic sign/signal functioning properly
- ○ Not applicable
- ○ Unknown
- ○ Traffic sign/signal not functioning (specify) [ ]

72 What was the weather like at the time of the crash? Were there any adverse atmospheric conditions?

Please choose **only one** of the following:

- ○ Clear - no adverse conditions
- ○ Cloudy
- ○ Snow
- ○ Fog, smog, smoke
- ○ Rain
- ○ Sleet, hail (Freezing drizzle or rain)
- ○ Blowing snow
- ○ Severe crosswinds
- ○ Unknown
- ○ Other (specify) [ ]

73 Was there any control loss due to weather or mechanical problems?

Please choose **only one** of the following:

- ○ No control loss due to weather or mechanical problems
- ○ Yes, control loss due to weather
- ○ Yes, control loss due to mechanical problems
- ○ Yes, control loss due to both
- ○ Not applicable
- ○ Unknown
- ○ Other [ ]

74 What was the movement of your vehicle just before you realized a crash was imminent?

Please choose **only one** of the following:

- ○ Going straight
- ○ Decelerating in traffic lane
- ○ Accelerating in traffic lane
- ○ Straight in traffic lane
- ○ Stopped in traffic lane
- ○ Passing or overtaking another vehicle
- ○ Disabled or parked in traffic lane
- ○ Leaving a parking position
- ○ Entering a parking position
- ○ Turning right
- ○ Turning left
- ○ Making a U-turn
- ○ Backing up (other than for parking position)
- ○ Negotiating a curve
- ○ Changing lanes
- ○ Merging
- ○ Successful avoidance maneuver to a previous critical event
- ○ Unknown
- ○ Other (specify) [ ]

75 How many lateral movements occurred immediately before impact?

Please choose **only one** of the following:

- ○ None
- ○ 1 lateral movement
- ○ 2 lateral movements
- ○ 3 lateral movements
- ○ 4 lateral movements
- ○ 5 lateral movements
- ○ 6 lateral movements
- ○ 7 lateral movements
- ○ 8 lateral movements
- ○ 9 lateral movements
- ○ 10 lateral movements

76 What was the first lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '1 lateral movement' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ No pre-first harmful event maneuver sequence
- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) _____

77 What was the second lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '2 lateral movements' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) _____

78 What was the third lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '3 lateral movements' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) [ ]

79 What was the fourth lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '4 lateral movements' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) _____

80 What was the fifth lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '5 lateral movements' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) [ ]

81 What was the sixth lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '6 lateral movements' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) _____

82 What was the seventh lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '7 lateral movements' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) _____

83 What was the eighth lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '8 lateral movements' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) _____

84 What was the ninth lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to '9 lateral movements' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) _____

85 What was the tenth lateral movement of your vehicle immediately before impact?

Only answer this question if the following conditions are met:
° Answer was '10 lateral movements' at question '75 [61]' (How many lateral movements occurred immediately before impact?)

Please choose **only one** of the following:

- ○ Lane departure - left side
- ○ Lane departure - right side
- ○ Lane return - left side
- ○ Lane return - right side
- ○ Road departure - left side
- ○ Road departure - right side
- ○ Road return - left side
- ○ Road return - right side
- ○ Non-contact power unit jacknife
- ○ Non-contact trailer swing
- ○ Unknown
- ○ Other (specify) _____

86 What avoidance actions did you take, if any?

Please choose **only one** of the following:

- ○ None
- ○ Full ABS application
- ○ Braking without lock-up
- ○ Braking with lock-up
- ○ Braking (lock-up unknown)
- ○ Releasing brakes
- ○ Steering left
- ○ Steering right
- ○ Accelerating
- ○ Unknown
- ○ Not applicable
- ○ Other (specify) _____

87 (If applicable) Did you use foot brakes? Hand brakes?

Please choose **only one** of the following:

- ○ No brake activation
- ○ Hand activated brakes
- ○ Foot activated brakes
- ○ Inertia brakes
- ○ Unknown
- ○ Other [ ]

88 Did any of the vehicle's avoidance features activate?

Please choose **only one** of the following:

- ○ No
- ○ Unknown
- ○ Not applicable
- ○ Yes (specify) [ ]

89 Where was your vehicle just prior to the first impact?

Please choose **only one** of the following:

- ○ Stayed in original travel lane
- ○ Stayed on roadway but left original travel lane
- ○ Stayed on roadway but not known if left original travel lane
- ○ Departed roadway
- ○ Remained off roadway
- ○ Returned to roadway
- ○ Entered roadway
- ○ Unknown
- ○ Other [ ]

90 Where was your vehicle at the time of the first impact?

Please choose **only one** of the following:

- ○ Original travel lane
- ○ Different travel lane
- ○ In intersection
- ○ Off roadway to right
- ○ Off roadway to left
- ○ Unknown
- ○ Not applicable
- ○ Other (specify) [ ]

91 Did your vehicle roll over?

Please choose **only one** of the following:

- ○ Yes
- ○ No

92 If so which way?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '91 [187]' (Did your vehicle roll over?)

Please choose **only one** of the following:

- ○ No rollover
- ○ Longitudinal
- ○ End over end
- ○ Unknown
- ○ Other [ ]

93 Number of lateral quarter turns

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '91 [187]' (Did your vehicle roll over?)

Please choose **only one** of the following:

- ○ Unknown
- ○ No rollover
- ○ End over end [ ]

94 (If applicable) What caused your vehicle to roll over? Did you contact something?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '91 [187]' (Did your vehicle roll over?)

Please choose **only one** of the following:

- ○ Vehicle
- ○ Noncollision
- ○ Collision with fixed object
- ○ Collision with non-fixed object
- ○ Unknown event or fixed object
- ○ No rollover
- ○ Other event (specify) [ ]

95 Were you transporting cargo?

Please choose **only one** of the following:

- ○ Yes
- ○ No

96 Did you experience a cargo shift?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '95 [71]' (Were you transporting cargo?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

97 When did the cargo shift occur?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '96 [75]' (Did you experience a cargo shift?)

Please choose **only one** of the following:

- ○ Prior to impact
- ○ During impact
- ○ Following impact
- ○ Unknown
- ○ Other [ ]

98 Where in your vehicle was the cargo located?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '96 [75]' (Did you experience a cargo shift?)

Please choose **only one** of the following:

- ○ No cargo
- ○ No cargo shift
- ○ Cargo in trailing unit
- ○ Cargo in pickup bed
- ○ Cargo in cargo unit of truck
- ○ Cargo inside vehicle
- ○ Cargo on top of vehicle
- ○ Cargo in trunk
- ○ Cargo on back of vehicle
- ○ Unknown
- ○ Other (specify) [ ]

99 (If applicable) Why do you think the cargo shifted?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '96 [75]' (Did you experience a cargo shift?)

Please choose **only one** of the following:

- ○ No cargo
- ○ No cargo shift
- ○ Improper loading - solid
- ○ Inadequate securement - solid
- ○ Less than full load - liquids (slosh)
- ○ Baffle failure - liquids (specify)
- ○ Compartment partition failure - liquids (specify)
- ○ Tank failure - liquids (specify)
- ○ Other (specify solids or liquids and source)
- ○ Unknown
- ○ Other

100 Did your vehicle jackknife?

Please choose **only one** of the following:

- ○ Yes
- ○ No

101 When did the jackknife occur?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '100 [79]' (Did your vehicle jackknife?)

Please choose **only one** of the following:

- ○ No jackknife
- ○ Prior to first impact
- ○ Following first impact
- ○ During impact
- ○ Unknown
- ○ Other

102 Did your vehicle catch fire?

Please choose **only one** of the following:

- ○ Yes
- ○ No

103 (If applicable) Did the fire ignite before or after impact?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '102 [81]' (Did your vehicle catch fire?)

Please choose **only one** of the following:

- ○ Pre-impact
- ○ Post-impact
- ○ Fire presence - unknown time of ignition
- ○ No fire
- ○ Unknown
- ○ Other

104 If fire present before impact, specify time before crash in minutes.

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '102 [81]' (Did your vehicle catch fire?)

Please write your answer here:

105 What were you doing immediately before the start of the collision course?

Please choose **all** that apply:

- ☐ Non-driving activities
- ☐ Driving sleepy or asleep
- ☐ Looking at other vehicles
- ☐ Looking at intended turn destination
- ☐ Looking at exterior location
- ☐ External focus
- ☐ Other external focus
- ☐ Looking at moving object in vehicle
- ☐ Looking at other occupant
- ☐ Talking to a passenger
- ☐ Dialing phone
- ☐ Talking on phone
- ☐ Talking on CB radio
- ☐ Listening to radio/cd/tape/portable playback device
- ☐ Adjusting radio/cassette/CD player
- ☐ Adjusting climate controls
- ☐ Adjusting a device/controls integral to the vehicle
- ☐ Reading map/directions/newspaper etc
- ☐ Reading/adjusting navigation system
- ☐ Watching DVD/television
- ☐ Eating or drinking
- ☐ Applying make-up
- ☐ Smoking
- ☐ Retrieving fallen object
- ☐ Focused on other internal object
- ☐ Text messaging
- ☐ Unknown
- ☐ Other: _____

106 Were you conversing with anyone?

Please choose **only one** of the following:

- ○ Not conversing
- ○ Conversing with passenger
- ○ Talking on phone
- ○ Talking on CB radio
- ○ Unknown
- ○ Other (specify) _____

107 (If applicable) What is the relationship between you and the person you were talking to?

Please choose **only one** of the following:

- ○ Business
- ○ Social (friend)
- ○ Boy/girlfriend
- ○ Husband/wife
- ○ Parent/child
- ○ Other relative
- ○ No relationship/stranger
- ○ Unknown
- ○ Not applicable
- ○ Other (specify) _____

108 (If applicable) What was the nature of your discussion?

Please choose **only one** of the following:

- ○ Business
- ○ Social
- ○ Family matter
- ○ Argument
- ○ Disciplinary
- ○ Unknown
- ○ Not applicable
- ○ Other (specify) [ ]

109 Were you using a cell phone before the crash?

Please choose **only one** of the following:

- ○ Yes
- ○ No

110 If not, was a cell phone present?

Only answer this question if the following conditions are met:
° Answer was 'No' at question '109 [88]' (Were you using a cell phone before the crash?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

111 (If applicable) What type of cell phone were you using?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '109 [88]' (Were you using a cell phone before the crash?)

Please choose **only one** of the following:

- ○ Handheld
- ○ Hands free, installed cradle, OEM or aftermarket
- ○ Hands free, integrated phone system such as Onstar, etc.
- ○ Unknown
- ○ Not applicable
- ○ Hands free, other (specify) _____

112 Where were you looking immediately before the crash?

Please choose **only one** of the following:

- ○ Looking straight ahead
- ○ Looking right
- ○ Looking left
- ○ Looking rearward
- ○ Looking inside the car
- ○ Unknown
- ○ Other (specify) _____

113 (If applicable) If exterior source was located to your rear, how did you track it?

Please choose **only one** of the following:

- ○ Turned head
- ○ Used rearview mirror
- ○ Used side mirror
- ○ Unknown
- ○ Not applicable
- ○ Other (specify) _____

114 What were you doing after the start of the collision course?

Please choose **only one** of the following:

- ○ No non-driving activities
- ○ Driving sleepy or asleep
- ○ Looking at other vehicles
- ○ Looking at intended turn destination
- ○ Looking at exterior location
- ○ External focus, not specific
- ○ Other external focus
- ○ Looking at moving object in vehicle
- ○ Looking at other occupant
- ○ Talking to passenger
- ○ Dialing phone
- ○ Talking on phone
- ○ Talking on CB radio
- ○ Listening to radio/CD/tape/portable playback device
- ○ Adjusting radio/cassette/CD player
- ○ Adjusting climate controls
- ○ Using device/controls integral to the vehicle
- ○ Reading map/directions/newspaper etc
- ○ Reading/adjusting navigation system
- ○ Watching DVD/television
- ○ Eating or drinking
- ○ Applying make-up
- ○ Smoking
- ○ Retrieving fallen object
- ○ Focused on other internal object
- ○ Text messaging
- ○ Unknown
- ○ Other [ ]

115 Where were you looking after the start of the crash sequence?

Please choose **only one** of the following:

- ○ Looking straight ahead
- ○ Looking right
- ○ Looking left
- ○ Looking rearward
- ○ Looking inside the vehicle
- ○ Unknown
- ○ Other (specify) [ ]

116 Where were your hands and arms immediately before impact?

Please choose **only one** of the following:

- ○ Both hands on steering wheel, steering
- ○ Both hands on steering wheel, bracing
- ○ One hand on steering wheel, other hand resting in lap
- ○ One hand on steering wheel, other hand adjusting a control
- ○ One hand on steering wheel, other hand dialing a mobile/cell phone
- ○ One hand on steering wheel, other hand holding a mobile/cell phone
- ○ One hand on steering wheel, other hand out window
- ○ No hands on wheel
- ○ Unknown
- ○ Other (specify) [ ]

117 When did you first see the other vehicle?

Please choose **only one** of the following:

- ○ Never saw the other vehicle prior to impact
- ○ Unknown
- ○ Not applicable
- ○ Saw the other vehicle before impact (specify) [ ]

118 (If applicable) Where was the other vehicle coming from, in relation to yours?

Please choose **only one** of the following:

- ○ 180 degrees opposed (oncoming)
- ○ From left front
- ○ From left
- ○ From left rear
- ○ From right front
- ○ From right
- ○ From right rear
- ○ From behind
- ○ Unknown
- ○ Not applicable
- ○ Other (specify) [ ]

119 (If applicable) How close were you to the vehicle in front of you (in feet)?

Please choose **only one** of the following:

- ○ Not applicable
- ○ Unknown
- ○ Enter # of feet [ ]

120 (If applicable) What was your speed in relation to the other vehicle? Faster, slower, the same?

Please choose **only one** of the following:

- ○ Overtaking other vehicle
- ○ Being overtaken by other vehicle
- ○ Both vehicles traveling at constant and relatively equal speed
- ○ Unknown
- ○ Not applicable
- ○ Other (specify) [ ]

121 (If applicable) Was your sight line to the other vehicle clear? If not, what was blocking it?

Please choose **only one** of the following:

- ○ Yes, clear
- ○ No, view obstructed by road curvature
- ○ No, view obstructed by roadway grade
- ○ No, view obstructed by roadside appurenance (vehicle, building, shrubbery)
- ○ Other vehicle in blind spot of mirror
- ○ Unknown
- ○ Not applicable
- ○ No, other obstruction (specify) [ ]

122 (If applicable) Was your view of the other vehicle obscured?

Please choose **only one** of the following:

- ○ No, not obscured
- ○ Yes, obscured by sun glare
- ○ Yes, obscured by headlight glare
- ○ Yes, obscured by darkness (nighttime)
- ○ Yes, nighttime and color of other vehicle
- ○ Unknown
- ○ Not applicable
- ○ Yes, obscured by other type of glare or condition (specify) [ ]

123 (If applicable) How long were you stopped before you entered the intersection (or were struck)?

Please choose **only one** of the following:

- ○ Traveling at constant velocity (did not stop)
- ○ Decelerating (did not stop)
- ○ Rolling stop prior to proceeding
- ○ Stopped < 1 second prior to proceeding
- ○ Stopped 1-2 seconds prior to proceeding
- ○ Stopped 3-4 seconds prior to proceeding
- ○ Stopped 5-10 seconds prior to proceeding
- ○ Stopped more than 10 seconds prior to proceeding
- ○ Stopped, never proceeded
- ○ Unknown
- ○ Not applicable
- ○ Other

124 Where were you coming from?

Please choose **only one** of the following:

- ○ Unknown
- ○ Coming from (specify)

125 What time did this trip start?

Please choose **only one** of the following:

- ○ Unknown start time
- ○ Enter time (12 hr format)

126 Where were you going?

Please choose **only one** of the following:

- ○ Unknown
- ○ Destination: [ ]

127 What was the purpose of this trip?

Please choose **only one** of the following:

- ○ Commuting
- ○ Work related
- ○ Errand
- ○ Leisure
- ○ Unknown
- ○ Other (specify) [ ]

128 Did you have to be somewhere at a certain time?

Please choose **only one** of the following:

- ○ Yes
- ○ No

129 How many miles had you driven when the crash occurred?

Please choose **only one** of the following:

- ○ Unknown distance
- ○ Enter miles: [ ]

130 Were you in a hurry?

Please choose **only one** of the following:

- ○ Yes
- ○ No

131 If so, why were you in a hurry?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '130 [111]' (Were you in a hurry?)

Please choose **only one** of the following:

- ○ Not in a hurry
- ○ Late for start of work shift/start of school classes
- ○ Late for business appointment
- ○ Due to work related delivery schedule
- ○ Late for social appointment
- ○ Normal driving pattern
- ○ Unknown
- ○ Other

132 Were there concerns in your employment, family, or personal relationships?

Please choose **only one** of the following:

- ○ No
- ○ Employment
- ○ Family
- ○ Personal relationships
- ○ Unknown
- ○ Other

133 (If applicable) Were you thinking about any of your concerns immediately before the crash sequence?

Please choose **all** that apply:

- ☐ Not thinking about concerns
- ☐ Personal problem
- ☐ Family problem
- ☐ Financial problem
- ☐ Preceeding argument
- ☐ Future events (e.g. vacation, wedding, etc)
- ☐ Inattentive, thought focus unknown
- ☐ Unknown
- ☐ Not applicable
- ☐ Other: ____

134 Did you have any arguments within 6 hours prior to the incident?

Please choose **only one** of the following:

- ○ Yes
- ○ No

135 Did you have any arguments within 12 hours prior to the incident?

Please choose **only one** of the following:

- ○ Yes
- ○ No

136 (If applicable) Did you experience work related stress?

Please choose **only one** of the following:

- ○ No employer relation factors
- ○ Required to work extended work shifts
- ○ Required to work rotating shift schedule
- ○ Required to fill in for other workers
- ○ Learning new position
- ○ Tight/unrealistic production/delivery schedule
- ○ Adversarial work relationship (in management)
- ○ Adversarial work relationship (fellow workers)
- ○ Unknown
- ○ Not applicable
- ○ Other [ ]

137 How is your general health?

Please choose **only one** of the following:

- ○ Good
- ○ Fair
- ○ Poor
- ○ Unknown

138 Were you ill at the time of the crash?

Please choose **only one** of the following:

- ○ No
- ○ Heart attack
- ○ Seizure (related to diagnosed epilepsy)
- ○ Seizure (other source)
- ○ Blackout (diabetes related)
- ○ Blackout (other source)
- ○ Severe cold/flu symptoms
- ○ Unknown
- ○ Other [ ]

139 Do you have any pre-existing health conditions?

Please choose **only one** of the following:

- ○ No
- ○ Unknown
- ○ Yes (specify) [ ]

140 (If applicable) Did the above conditions affect your driving?

Please choose **only one** of the following:

- ○ No
- ○ Unknown
- ○ Not applicable
- ○ Yes (specify) [ ]

141 Any medications or drugs taken in the last 24 hours?

Please choose **only one** of the following:

- ○ Yes
- ○ No

142 (If applicable) Which medications or drugs were taken?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '141 [122]' (Any medications or drugs taken in the last 24 hours?)

Please write your answer here:

143 Do you need to wear corrective lenses?

Please choose **only one** of the following:

- ○ Yes
- ○ No

144 If so, for what condition?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '143 [124]' (Do you need to wear corrective lenses?)

Please choose **only one** of the following:

- ○ Hyperopic far-sighted
- ○ Myopic near-sighted
- ○ Astigmatism
- ○ Unknown condition
- ○ Unknown
- ○ Yes, other (specify)

145 (If applicable) Were you wearing your glasses/lenses at the time of the crash?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '143 [124]' (Do you need to wear corrective lenses?)

Please choose **only one** of the following:

- ○ Yes
- ○ No
- ○ Unknown
- ○ Not applicable
- ○ Other

146 Were you wearing sunglasses at the time of the crash?

Please choose **only one** of the following:

- ○ Yes
- ○ No

147 Were they prescription?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '146 [127]' (Were you wearing sunglasses at the time of the crash?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

148 Do you have a hearing aid?

Please choose **only one** of the following:

- ○ Yes
- ○ No

149 (If applicable) Were you wearing your hearing aid at the time of the crash?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '148 [129]' (Do you have a hearing aid?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

150 Have you ever been diagnosed with sleep apnea?

Please choose **only one** of the following:

- ○ Yes
- ○ No

151 If so, are you receiving treatment?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '150 [131]' (Have you ever been diagnosed with sleep apnea?)

Please choose **only one** of the following:

- ○ No current treatment
- ○ CPAP treatment
- ○ Unknown
- ○ Other treatment

152 Did you perform any household chores or other activities in the last 7 days that involved strenuous labor?

Please choose **only one** of the following:

- ○ Yes
- ○ No

153 If so, please specify.

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '152 [133]' (Did you perform any household chores or other activities in the last 7 days that involved strenuous labor?)

Please write your answer here:

154 Did you participate in any recreational activities during the last 7 days that involved strenuous exercise?

Please choose **only one** of the following:

- ○ Yes
- ○ No

155 If so, please specify.

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '154 [135]' (Did you participate in any recreational activities during the last 7 days that involved strenuous exercise?)

Please write your answer here:

156 In the last 24 hours, how many hours of sleep did you get?

Please write your answer here:

157 Where did you last sleep?

Please choose **only one** of the following:

- ○ Residence
- ○ Hotel/motel
- ○ Vehicle (vehicle moving)
- ○ Vehicle (stationary)
- ○ Unknown
- ○ Other

158 What day did your last sleep begin?

Please enter a date:

159 What time did your last sleep period start? (Hour, minute, and AM or PM)

Please write your answer here:

160 What date did your last sleep end?

Please enter a date:

161 What time did your last sleep period end? (Enter hour, minute, and AM or PM)

Please write your answer here:

162 How do you normally feel when you wake up?

Please choose **only one** of the following:

- ○ Rested
- ○ Fatigued
- ○ Drowsy
- ○ Irritated/upset
- ○ Unknown
- ○ Other (specify) _____

163 How long do you normally sleep each night/day? (Enter number of hours)

Please write your answer here:

_____

164 During the last 7 days, did your sleep or work schedule rotate or shift?

Please choose **only one** of the following:

- ○ Yes
- ○ No

165 (If applicable) In the last 7 days, what was your shortest day worked?

Please choose **only one** of the following:

- ○ Not applicable
- ○ Unknown
- ○ Enter hours _____

166 (If applicable) In the last 7 days, what was your longest period worked?

Please choose **only one** of the following:

- ○ Not applicable
- ○ Unknown
- ○ Enter hours [ ]

167 (If applicable) In the last 7 days, what is the total number of hours worked?

Please choose **only one** of the following:

- ○ Not applicable
- ○ Unknown
- ○ Enter hours [ ]

168 (If applicable) In the last 7 days, what was your average number of hours worked per day?

Please choose **only one** of the following:

- ○ Not applicable
- ○ Unknown
- ○ Enter hours [ ]

169 (If applicable) How many days have you worked since your last day off?

Please write your answer here:

[ ]

170 How did you feel when you started driving this leg of this trip?

Please choose **only one** of the following:

- ○ Rested
- ○ Fatigued
- ○ Drowsy
- ○ Irritated/upset
- ○ Unknown
- ○ Other

171 How often do you drive on this roadway?

Please choose **only one** of the following:

- ○ Daily
- ○ Weekly
- ○ Several times a month
- ○ Monthly
- ○ Rarely
- ○ First time on road
- ○ Unknown
- ○ Other

172 How many total years have you been driving (any type of vehicle)? (Enter experience in years and months)

Please write your answer here:

173 Did you ever take any form of Driver Education?

Please choose **only one** of the following:

- ○ Yes
- ○ No

174 If so, from where?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '173 [154]' (Did you ever take any form of Driver Education?)

Please choose **only one** of the following:

- ○ None
- ○ Driving school
- ○ Company
- ○ Military
- ○ Community college, etc
- ○ Professinal/specialized driving course
- ○ High School
- ○ Classroom instruction only - No behind the wheel training
- ○ Received training - source unknown
- ○ Unknown
- ○ Other

175 How many years of experience do you have driving this class of vehicle (car, van, truck, SUV)?
(Enter experience in years and months)

Please write your answer here:

176 Did you have any specific/professional driver education for this class of vehicle?

Please choose **only one** of the following:

- ○ Yes
- ○ No

177 If so, specify.

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '176 [157]' (Did you have any specific/professional driver education for this class of vehicle?)

Please choose **only one** of the following:

- ○ No training
- ○ Informal training
- ○ Basic Driver education
- ○ Defensive driving training
- ○ Professional driver training
- ○ Received training - type unknown
- ○ Unknown
- ○ Other

178 (If applicable.) How long has it been since you finished your highest level of Driver Education - for this class of vehicle?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '176 [157]' (Did you have any specific/professional driver education for this class of vehicle?)

Please choose **only one** of the following:

- ○ More than 5 years ago
- ○ 3-5 years ago
- ○ 1-2 years ago
- ○ 7-12 months ago
- ○ Within the last 6 months
- ○ Not applicable
- ○ Unknown

179 How many times have you driven this vehicle in the last three months?

Please choose **only one** of the following:

- ○ More than 10 times in the past three months
- ○ 6-10 times in the last three months
- ○ 2-5 times in the last three months
- ○ Less than 2 times in the last three months
- ○ First time driving this vehicle
- ○ Unknown

180 How comfortable were you with your vehicle?

Please choose **only one** of the following:

- ○ Very comfortable
- ○ Comfortable
- ○ Neutral
- ○ Uncomfortable
- ○ Very uncomfortable
- ○ Not applicable
- ○ Unknown

181 (If applicable) How comfortable were you with the handling of your vehicle due to the cargo load?

Please choose **only one** of the following:

- ○ Very comfortable
- ○ Comfortable
- ○ Neutral
- ○ Uncomfortable
- ○ Very uncomfortable
- ○ Not applicable
- ○ Unknown

182 (If applicable) How comfortable were you with handling of your vehicle due to the passenger load?

Please choose **only one** of the following:

- ○ Very comfortable
- ○ Comfortable
- ○ Neutral
- ○ Uncomfortable
- ○ Very uncomfortable
- ○ Not applicable
- ○ Unknown

183 On a scale of 1 to 5, rate the condition of your vehicle's equipment. (1-Good, 2-Fair, 3-Moderate, 4-Poor, 5-Nonfunctional, 9-Unknown)

Please choose all that apply and provide a comment:

☐ Headlights	
☐ Steering	
☐ Brakes	
☐ Suspension	
☐ Tires	
☐ Transmission	
☐ Engine	
☐ Wiring	

184 What was the condition of the windshield?

Please choose **only one** of the following:

- ○ Clean and clear
- ○ Surface contamination (ice, snow, dirt, bug smears, etc)
- ○ Cracked, discolored or other integral visual interference
- ○ Unknown

185 Were the wipers on at the time of the crash?

Please choose **only one** of the following:

- ○ Yes
- ○ No

186 If so, steady or interval?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '185 [166]' (Were the wipers on at the time of the crash?)

Please choose **only one** of the following:

- ○ Interval
- ○ Steady
- ○ Using washer function
- ○ No wiper(s) present
- ○ Unknown

187 Were your headlights on at the time of the crash?

Please choose **only one** of the following:

- ○ Yes
- ○ No

188 In what State is your driver's license issued?

Please choose all that apply and provide a comment:

☐ Enter state	
☐ Foreign country (specify)	
☐ Not licensed	
☐ Unknown	

189 Is your license current and valid?

Please choose **only one** of the following:

- ○ Current and valid
- ○ Suspended
- ○ Revoked
- ○ License permit
- ○ Not licensed
- ○ Unknown
- ○ Other - not valid (specify) _____

190 Are there any restrictions on your license?

Please choose **only one** of the following:

- ○ No restrictions
- ○ Restrictions complied with
- ○ Restrictions not complied with
- ○ Restrictions, compliance unknown
- ○ Not licensed
- ○ Unknown

191 Any endorsements on your license?

Please choose **only one** of the following:

- ○ No endorsements
- ○ Endorsements complied with
- ○ Endorsements not complied with
- ○ Endorsements, compliance unknown
- ○ Not licensed
- ○ Unknown

192 Which race do you consider yourself a member of?

Please choose **only one** of the following:

- ○ White
- ○ Black or African American
- ○ Asian
- ○ Native Hawaiian or Other Pacific Islander
- ○ American Indian or Alaska Native
- ○ Unknown
- ○ Other

193 What is your ethnic background?

Please choose **only one** of the following:

- ○ Hispanic or Latino
- ○ Not Hispanic or Latino
- ○ Unknown

194 Did Emergency Medical Services (EMS) arrive at the scene of the crash?

Please choose **only one** of the following:

- ○ Yes
- ○ No

195 If so, did they provide services to anyone involved in the crash?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '194 [188]' (Did Emergency Medical Services (EMS) arrive at the scene of the crash?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

196 Who called EMS?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '194 [188]' (Did Emergency Medical Services (EMS) arrive at the scene of the crash?)

Please write your answer here:

197 Was EMS automatically called via a vehicle response system in your vehicle?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '194 [188]' (Did Emergency Medical Services (EMS) arrive at the scene of the crash?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

198 How long after the crash occurred did EMS personnel arrive?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '194 [188]' (Did Emergency Medical Services (EMS) arrive at the scene of the crash?)

Please write your answer here:

199 Which EMS services arrived at the crash site?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '194 [188]' (Did Emergency Medical Services (EMS) arrive at the scene of the crash?)

Please choose **all** that apply:

- ☐ Police
- ☐ Fire department
- ☐ Ambulance
- ☐ Other

200 Did you sustain any injuries as a direct result of the crash?

Please choose **only one** of the following:

- ○ Yes
- ○ No

201 Did you seek or receive medical attention?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '200 [194]' (Did you sustain any injuries as a direct result of the crash?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

202 How would you rate the severity of your injuries?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '200 [194]' (Did you sustain any injuries as a direct result of the crash?)

Please choose **only one** of the following:

- ○ bumps and bruises
- ○ Lacerations
- ○ Broken bones/internal injuries
- ○ Severe or potentially life-threatening injuries

203 Please list the injuries you sustained as a direct result of the crash.

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '200 [194]' (Did you sustain any injuries as a direct result of the crash?)

Please write your answer here:

204 Were you admitted or treated as an out-patient?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '200 [194]' (Did you sustain any injuries as a direct result of the crash?)

Please choose **only one** of the following:

- ○ Admitted
- ○ Out-patient

205 How were you transported to the hospital?

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '200 [194]' (Did you sustain any injuries as a direct result of the crash?)

Please choose **only one** of the following:

- ○ Self
- ○ Ambulance
- ○ Other EMS
- ○ Other non-EMS (e.g., family/friend/etc.)

206 How many days of work or school (or similar) did you miss as a result of the crash?

Please write your answer here:

207 Interview completion date

Please enter a date:

208 Final interview result

Please choose **only one** of the following:

- ○ Completed at scene
- ○ Complete - started at scene/completed later
- ○ Completed - not at scene
- ○ Partial interview - started at scene
- ○ Partial interview - started later

209 Please select the type of crash that occurred:

Please choose **only one** of the following:

- ○ Vehicle Failure
- ○ Control Loss With Prior Vehicle Action
- ○ Control Loss Without Prior Vehicle Action
- ○ Running Red Light
- ○ Running Stop Sign
- ○ Road Edge Departure With Prior Vehicle Maneuver
- ○ Road Edge Departure Without Prior Vehicle Maneuver
- ○ Road Edge Departure While Backing Up
- ○ Animal Crash With Prior Vehicle Maneuver
- ○ Animal Crash Without Prior Vehicle Maneuver
- ○ Pedestrian Crash With Prior Vehicle Maneuver
- ○ Pedestrian Crash Without Prior Vehicle Maneuver
- ○ Pedalcyclist Crash With Prior Vehicle Maneuver
- ○ Pedalcyclist Crash Without Prior Vehicle Maneuver

- ○ Backing Up Into Another Vehicle
- ○ Vehicle(s) Turning - Same Direction
- ○ Vehicle(s) Parking - Same Direction
- ○ Vehicle(s) Changing Lanes - Same Direction
- ○ Vehicle(s) Drifting - Same Direction
- ○ Vehicle(s) Making a Maneuver - Opposite Direction
- ○ Vehicle(s) Not Making a Maneuver - Opposite Direction
- ○ Following Vehicle Making a Maneuver
- ○ Lead Vehicle Accelerating
- ○ Lead Vehicle Moving at Lower Constant Speed
- ○ Lead Vehicle Decelerating
- ○ Lead Vehicle Stopped
- ○ Left Turn Across Path From Opposite Directions at Signalized Junctions
- ○ Vehicle Turning Right at Signalized Junctions
- ○ Left Turn Across Path From Opposite Directions at Non-Signalized Junctions
- ○ Straight Crossing Paths at Non-Signalized Junctions
- ○ Vehicle(s) Turning at Non-Signalized Junctions
- ○ Evasive Action With Prior Vehicle Maneuver
- ○ Evasive Action Without Prior Vehicle Maneuver
- ○ Non-Collision Incident
- ○ Object Crash With Prior Vehicle Maneuver
- ○ Object Crash Without Prior Vehicle Maneuver
- ○ Other

Submit Your Survey.
Thank you for completing this survey.

APPENDIX J

Primary Driver Consent Form

PARTICIPANT CONSENT FORM FOR PRIMARY DRIVER, VARIABLE ENROLLMENT PERIOD (4–7 MONTHS)

IN-VEHICLE DRIVING BEHAVIOR AND CRASH RISK STUDY

("*The SHRP 2 Naturalistic Driving Study*")

SPONSORS: **National Academies of Science, Transportation Research Board, SHRP 2 Program**

The United States Department of Transportation

INVESTIGATORS: Tom Dingus, Jon Hankey, Jon Antin, Suzie Lee, and Lisa Eichelberger:
Virginia Tech Transportation Institute

John Pierowicz, Alan Blatt, and Marie Flanigan:
Calspan University of Buffalo Research Center (CUBRC)

Ann Brach and Ken Campbell: National Academies,
Transportation Research Board, SHRP 2 Program

WHAT IS THE PURPOSE OF THIS RESEARCH?

The Naturalistic Driving Study is a large research effort directed at improving Highway Safety in the United States where more than 30,000 people are killed and 2 million are injured every year in highway-related accidents. The study will help researchers gain a deeper understanding of the interaction between the driver, vehicle and roadway and lead to safer roadways, vehicles, and driver training programs. The SHRP 2 Naturalistic Driving Study will look at how people normally drive by installing cameras and sensors in people's own vehicles. The study is being conducted at six locations across the United States with up to 3,300 participants. Length of enrollment varies from four months to two years. Your enrollment is scheduled to last _____ months.

WHAT SHOULD I KNOW BEFORE DECIDING TO PARTICIPATE?

1. You are providing permission for us to collect data (including video) whenever the study vehicle is used or whenever you happen to drive another vehicle that is part of the study (for example, a vehicle owned by a friend who also happens to be in the study). If there are drivers of the study vehicle who have not signed consent forms, we will delete their data from every trip in which they drove the vehicle. If you do not own or lease the study vehicle, you will have to obtain the owner's written permission to use the vehicle before you enroll in the study.
2. There will be video of your face and portions of your body and the roadway. Audio will not be recorded unless you press a red incident button. The video, audio, and other data that personally identifies you, or could be used to personally identify you, will be held under a high level of security at one or more data repositories. Your data will be identified with

a code rather than your name. Finally, only qualified researchers will be authorized to have access to data that personally identifies you, or can be used to personally identify you, and the level to which they have access will be based on their level of authorization.
3. No identifying information will be collected on passengers.
4. For the duration of the project you or the owner of the vehicle used in the study will be responsible for your insurance coverage. If you are in a crash, please contact emergency services as you normally would. We will then ask for more information, as detailed below.
5. You may withdraw from the study at any time. If you do withdraw from the study before your scheduled end date, or if the vehicle's owner decides to withdraw the vehicle, you must agree to allow us to retrieve the data collection system from the vehicle as soon as is feasible.

WHAT DO I HAVE TO DO IF I CHOOSE TO PARTICIPATE?

The study involves a _____ month data collection effort in which a data collection system containing sensors and cameras will be installed in the study vehicle to record a variety of driving measures. As a participant, you will complete the following activities:

1. Have the vehicle equipped (see the section below: "What will I have to do to get the vehicle equipped for the study?").
2. Drive as you normally would.
3. Provide us with contact information for all other adult drivers (over the age of 18) who drive the vehicle at least once a week. We would like to contact them to get permission to use data collected any time they happen to be driving the vehicle. We will also ask them to fill out two brief questionnaires and provide a reference picture to allow us to identify when they are driving.
4. If requested, make an appointment to allow us to maintain the equipment or collect the driving data from the vehicle. Only one appointment is anticipated during your enrollment period. Appointments will typically take 15 minutes but could take up to one hour. They will be scheduled to take place at a location that is convenient for you such as your home, work, school, or at a local shopping mall. You will not need to do anything at an appointment apart from providing access to the trunk or interior of the vehicle; a trained technician will handle everything else.
5. While you are in the study, we ask that you not drive the vehicle into any areas where cameras are not allowed, including any international border crossings, military bases, or similar facilities.
6. Advise other drivers of the video and audio equipment installed in the vehicle and ask them not to drive into areas where cameras are not allowed. Let these other drivers know that data will be collected when they drive the vehicle but will only be retained and analyzed if they sign a consent form. If they do not sign a consent form, then the data will be deleted for every trip in which they drove the vehicle.

WHAT WILL I HAVE TO DO TO GET THE VEHICLE EQUIPPED FOR THE STUDY?

1. If you do not own or lease the study vehicle, you must first obtain the written permission of the vehicle owner. This can be provided on the day you enroll in the study by one of two methods: 1) the owner attends and signs the form in person, or 2) via a telephone call in which a third person at the study site will witness and sign the owner's permission form on behalf of the owner. We cannot accept pre-signed owner permission forms in which we have not had personal or telephone contact with the vehicle owner.
2. Bring the vehicle to CUBRC at the scheduled day and time to have the data collection system installed. The technicians will strive to complete each vehicle in less than four (4) hours, but it may take longer in rare cases. The system will require a connection to the vehicle power and the vehicle network box. These connections will provide additional data as well as power for the system; by agreeing to participate, you are providing us permission to get information from the vehicle network as well as to install new sensors. Before we begin installation, we will show you where we will place the system and also show you pictures of what the completed installation will look like. The vehicle will be returned to its original state when your participation is concluded.
3. While the system is being installed on the vehicle, you will be provided a comfortable area in which to complete the consent process and testing at CUBRC, which should take about 2–3 hours. Specifically, you will be asked to:
   a. Provide us with proof of a valid U.S. driver's license, proof of vehicle insurance, and proof of ownership (vehicle registration showing the name of the owner or lessee of the vehicle so that we may confirm that we have correctly obtained the permission of the vehicle's owner).

   b. Review and sign this informed consent form.
   c. Undergo about 20 minutes of non-invasive vision tests, performed on a computer monitor and a machine that you will look into but that will not touch or blow air into your eyes.
   d. Take about 30 minutes of computer tests that will assess your memory, decision making, and attention skills, none of which require previous computer skill or knowledge.
   e. Take a 2 minute memory and attention test using pencil and paper and the following two tests of your body movements and strength.
      i. You will be asked to walk as fast as you can without falling or tripping to a point 10 feet away, and then to return to the starting point. This should take about one minute.
      ii. You will be asked to sit down and squeeze a device that measures grip strength. This should also take about two minutes.
   f. Fill out nine (9) questionnaires on a computer (some may be completed online from home later, if you prefer). The questionnaires vary in length and take between 5 and 15 minutes each to complete. They contain questions about: your health history and health status; driving behavior, history and knowledge. You will be asked to fill out one or more final questionnaires after completing your participation in the study.
   g. Take home and give copies of an Informed Consent form and questionnaires to any other adult drivers who drive the vehicle at least once a week.
4. Allow our technicians to drive the vehicle as needed during the installation and testing process.
5. When the vehicle is ready, we will show you the data collection system and provide you with information about who to contact if you have any vehicle problems that could be related to your data collection system, or if you notice any maintenance issues with the system (for example, a camera or device that comes loose).
6. We will take some reference pictures of you in the vehicle so that software can be used to identify you as the driver.

WHAT DO I DO AFTER THE VEHICLE IS EQUIPPED FOR THE STUDY?

1. After you return home, you will be asked to complete any questionnaires you did not have time to complete during installation of the data collection system into the vehicle. Once you have completed all of the online questionnaires, you will receive your first payment of $100 via check or direct deposit.
2. Drive as you normally would for the duration of your enrollment.
3. If you are in a crash while in the study, we ask that you do five things (in the following order):
   a. Seek emergency help the way that you normally would.
   b. If possible, press an incident button that is located near the rear view mirror to describe the incident. The system will then record your brief description. You will know the button is working if the red light comes on when you press it.
   c. Call us at (716) 204-5138 or (716) 204-5177 to notify us as soon as it is safe to do so.
   d. Allow a member of the research team to interview you about the crash if we decide that your crash should be investigated in more detail. This interview would ideally take place soon after the crash, but only when you are comfortable and able to do so.
   e. Allow us to have access to the police accident report, if any, which results from the crash.
4. We anticipate making an appointment with you to collect the driving data from the vehicle or to maintain the equipment. An appointment will typically take about 15 minutes, but could take up to one hour depending on what needs to be done. It will be scheduled to take place at a location that is convenient for you such as your home, work, school, or at a local shopping mall. You will not need to be in the vehicle when the data are collected, but you will need to provide us with access to the trunk or interior of the vehicle. As mentioned above, we also will collect data from the vehicle after a crash, either at a place of your choosing or where the vehicle was towed.
5. Let us know if you notice any unusual warning light activity, for example, warning lights that go on or off.
6. While you are in the study, do not drive the vehicle into any areas where cameras are not allowed, including any international border crossings.
7. If we notice a new person driving the vehicle, we may contact you to find out if you have already asked them about participating in the study.

WHAT HAPPENS WHEN THE STUDY IS OVER?

1. After _____ months, you will be asked to return to CUBRC so that we may remove the system from the vehicle. While the vehicle is being worked on, we will ask you to fill out some final questionnaires. This process is expected to take about two hours. After this session is complete, you will receive your final payment via check or direct deposit.

2. When you leave the study, we may ask you whether we can keep your contact information to contact you for participation in future follow-on studies. This will be optional, and if you do not agree, we will delete your contact information one year after data collection is complete at CUBRC.
3. Once we have all the data, we will begin data analysis and reporting. It is likely that you will see references to the results of the study in the news or elsewhere. However, these reports will not identify participants by name, nor will personally identifying video be shown.

WHAT ARE THE RISKS OF PARTICIPATING IN THIS STUDY?

The operation or drivability of the vehicle should not be affected by the instrumentation, and thus carries a similar risk as when you operate the vehicle normally. However, if you violate state or local driving laws (such as driving under the influence, exceeding posted speed limits, or driving while distracted), the instrumentation could record evidence of these violations. This has the potential to pose greater than minimal risk of legal harm. A variety of strategies and procedures have been developed to reduce the potential for legal or economic harms. These strategies include encrypting the data obtained by sensors and cameras, using a code number to identify you with the code key maintained in a secure location, and obtaining a Certificate of Confidentiality. More details on these strategies are provided below.

All data collection equipment is mounted such that, to the greatest extent possible, it does not pose a hazard or problem for you when you drive. None of the data collection equipment should get in the way of your normal field of view. In the vast majority of cases, placing the data collection system in the vehicle will not affect the operating or handling characteristics of the vehicle. In some rare cases, the electromagnetic signals generated by the data collection system may cause interference with the vehicle's radio, keyless entry key fob, or other electronic components or sensors, such as the tire pressure monitoring system. If this happens in your vehicle, CUBRC will use engineering countermeasures to attempt to minimize the interference to an unnoticeable level. If you experience persistent tire pressure monitoring system problems, you will be asked to leave the study, while for other problems, you will be given the option to continue participation with the problem unresolved or to leave the study. If you like, CUBRC personnel can provide information on our latest experience (a rough likelihood) of this problem occurring with your vehicle's particular make, model, year, and equipment package.

You are not being asked to change the way you drive or where you drive, except for your visits to CUBRC at the beginning and end of the study.

There are non-driving risks resulting from participation. Five cameras will be placed in the vehicle. If you drive into an area where cameras are not allowed, including international border crossings, certain military and intelligence locations, and certain manufacturing plants, there is a risk that you may be detained or arrested or that the vehicle may be impounded. For this reason, by signing this Informed Consent and thereby agreeing to participate in the study, you also are agreeing not to drive into any such areas while you are in this study. We have provided a letter for the glove box which can be used to explain the vehicle's role in the study while still maintaining your privacy and keeping confidential your role in the study.

Throughout the study, we will take all possible steps to protect your privacy and keep confidential your role in the study and the confidentiality of your personally identifying information. To help us protect your privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your removal from the study and reporting of the behavior to the appropriate authorities. In the event of a crash, it may not be possible to prevent the equipment and the data from falling into the hands of the police or an insurance company; if this happens, however, the data are still encrypted and inaccessible and unreadable to these individuals.

However, you too, are responsible for taking steps to protect your privacy. Do not post or disclose your participation on any public forum including websites, Facebook, newspapers, radio and television. Protect your role in the study the same way that you protect other personal and private information. If you do not keep confidential your role in the study, there is a risk that some of the data collected during the study, including your personally identifying information, may be used against you in a court case or other legal proceeding.

The risk to you of completing the pre-collection questionnaires and tests while the data collection equipment is being installed in the vehicle is no more than when you are doing activities in your daily life like filling in forms, walking, squeezing your hand, and working at a computer. The assessment component involves filling in forms, standard vision tests, and standard computer-based tests. It is believed that there are no more than minimal risks involved with such activities. In addition, you will be asked to squeeze a grip strength tester and to rapidly walk 10 feet back and forth as fast as you can without running or falling. The risk with using the grip strength tester is brief hand soreness. The main risk with the Rapid Pace Walk is falling if you try to go too fast. Because the assessment process may take 2 or 3 hours, you may get tired, but you can also take breaks as needed.

If you are not the owner, co-owner, or lessee of the vehicle, there is a risk that the owner may decide to withdraw the vehicle from the study earlier than your planned term of enrollment. If this occurs, you will only be compensated for the portion of time you were enrolled in the study.

WHAT ARE THE BENEFITS OF PARTICIPATING IN THIS STUDY?

While there are no direct benefits to you from this research, you may find this study interesting. No promise or guarantee of benefits is being made to encourage your participation. Participation will help to improve the body of knowledge regarding driving behavior and safety. Participation may also help us design safer vehicles and roadways in future years.

HOW WILL MY DATA BE KEPT CONFIDENTIAL AND SECURE AND WHO WILL HAVE ACCESS TO MY DATA?

Any data collected during this study that personally identifies you or that could be used to personally identify you will be treated with confidentiality. As soon as you begin participating in this study, your name and other identifying information will be separated from the raw data collected while you drive the vehicle and replaced with a number. That is, your raw data will not be attached to your name, but rather to a number (for example, Driver 0011). The raw data collected while you drive the vehicle will be encrypted (made unreadable) from the moment it is collected until it is transferred to one or more secure central storage locations. Your name also will be separated from any data about you, either provided by you in response to questionnaires or gathered by researchers during the study, including crash investigation data, and will be replaced by the same driver number (for example, Driver 0011).

Several types of information and data about you and the study vehicle will be collected during the study:

Contact information includes your name, address, email address, phone numbers, and similar information used to contact you when needed. It will be stored securely in electronic form during the course of the study and destroyed after the study is complete (unless you grant permission for us to keep your contact information when the study is over). This information will not be linked to or mingled with your study data, and will not be used in any research or analysis.

Auxiliary study information includes your Social Security Number, license plate number, bank account information (for those using direct deposit) and similar information. This information is used to verify your identity and to make payments for your participation. This information will be stored at the site in electronic form (securely encrypted) destroyed after the study is complete. This information will not be linked to or mingled with your study data, and will not be used in any research or analysis.

Driver data includes your answers to questionnaires, vision test results, and the results of the brief physical tests described above. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driving data, vehicle data, and additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

Vehicle data includes the vehicle make and model, its condition, and how it is equipped. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driver data, driving data, and additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

Driving data includes the data we collect from the vehicle while you are driving, including video data and sensor data. This information will contain video of your face and GPS coordinates of your trips, both of which could be used to personally identify you. These data will be encrypted (stored in an unreadable format) from the moment of their creation until they are downloaded from the vehicle, transferred to a secure data storage facility, and verified. From this point on they will be decrypted (made readable) on as as-needed basis for each analysis. These data will be used for analysis, both on their own and in combination with the driver data, the vehicle data, and the additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

Additional crash data includes items we may collect after a crash, including answers to an interview with one of our researchers and the police accident report resulting from the crash. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driver data, vehicle data, and driving data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

It is possible that an authorized Institutional Review Board (IRB) may view this study's collected data for auditing purposes. An IRB is responsible for the oversight of the protection of human subjects involved in research.

It is also possible that the study sponsors or investigators may view this study's driver data and driving data for quality control or administrative purposes; in this case, the study sponsors or investigators will be required to maintain the security and confidentiality of any data that personally identifies study participants or that could be used to personally identify study participants.

While driving the vehicle, a camera will videotape your face with some added space around the head to handle any head movements. An example is shown below. Also, video cameras will capture views of the forward view, the rear view, an external view to the right, as well as a dashboard/lap-belt view. A camera will also periodically take a permanently blurred snapshot of the vehicle interior which will allow researchers to count the number of passengers and make rough estimates of age, gender, and seatbelt use. Passenger identification will not be possible from these blurred snapshots. All video will be captured and stored in digital format (no tape copies will exist).

There will also be an ambient atmospheric analyzer that is capable of detecting the presence of alcohol in the passenger compartment under certain conditions. It may not be able to distinguish whether the alcohol was imbibed or applied (as in hand sanitizer), and it will be unable to determine whether it is emanating from the driver or a passenger. However, this sensor will flag the data for possible indications of impaired driving.

If a safety-related incident or crash occurs, you are asked to press a button on the unit mounted near the rearview mirror. You will know this button is working if a red light appears when you press it. This will allow researchers to find the incident in the database after the data have been collected. Also, pressing the button starts a microphone for 30 seconds. During these 30-seconds, you can tell us what happened. No audio will be captured except when you press this incident button. Please note that pressing this button does NOT make a phone call, unlike OnStar™. It simply records your voice in an audio file that remains in the vehicle until the data is collected.

During the data collection phase of this study, all data collected from the vehicle will be encrypted (made unreadable) from the time of its creation and then stored in a specific password-protected project folder on a secure server; the driving data will only be decrypted (made readable) once it has been stored in this folder. At the conclusion of the collection phase of this study, the driver data, driving data, and additional crash data will be permanently housed at one or more highly secure data storage facilities. One set of data will be permanently housed at Virginia Tech under the supervision of the Virginia Tech Transportation Institute, the organization overseeing the data collection for the entire study. It is possible that, after data collection is complete,

one copy of study data will be transferred to the U.S. Department of Transportation (or other secure facilities as determined by the Transportation Research Board) for permanent storage and oversight.

Only authorized project personnel and authorized employees of the research sponsors will have access to study data that personally identifies you or that could be used to personally identify you. As explained below, other qualified research partners may be given limited access to your driver data, vehicle data, driving data, and additional crash data, solely for authorized research purposes and with the consent of an IRB. This limited access will be under the terms of a data sharing agreement or contract that, at a minimum, provides you with the same level of confidentiality and protection provided by this Consent Form. However, even these qualified researchers will not be permitted to copy raw study data that identifies you, or that could be used to identify you, or to remove it from the secure facilities in which it is stored without your consent.

Project personnel, the project sponsors and qualified, authorized research partners may show specific clips of video at research conferences. The project sponsors also may show specific clips of video to the media, driver's education teachers and students, and others involved in efforts to improve highway and road safety. The face portion of the video will be blurred, blacked out, or replaced with an animation for these purposes. Your name and other personally identifying information will never be associated with the showing of these video clips. Identifying location information will not be shown in association with these video clips.

It is expected that the data we capture throughout the course of the entire study, including that from all the approximately 3,300 primary participants, will be a valuable source of data on how drivers respond to certain situations and how the roadway and vehicle might be enhanced to improve driver safety. Researchers who study traffic congestion and traffic patterns may also find the data useful. Therefore, it is expected that there will be follow-on data analyses using all or part of the data for up to 30 years into the future. These follow-on analyses will be conducted by qualified researchers with IRB approval, as required by law, who may or may not be part of the original project team. In consenting to this study, you are consenting to future research uses of the information and videos we gather from you, consistent with the protections described above and elsewhere in this document.

If you are involved in a crash while participating in this study, the data collection equipment in the vehicle will likely capture the events leading up to the event. You are under NO LEGAL OBLIGATION to voluntarily mention the data collection equipment or your participation in this study at the time of a crash or traffic offense. We have provided a letter which you should keep in the glove box for these cases. The letter describes the vehicle's role in the study without identifying you as a participant in the study.

Because the vehicle camera system is storing continuous video, it may capture some incriminating evidence if an at-fault collision should occur. To help us protect your privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, neither the researchers nor study sponsors can be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. Identifying information for the purposes of this study includes your contact information, your auxiliary study information, your driving data (including video of your face and GPS coordinates which may identify your home, work, or school locations), or any information in your driver data, vehicle data, or additional crash data that could be used to personally identify you. While your confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by you or others, you may be prevented by a court from raising certain claims or defenses unless you agree to waive the confidentiality protection. The researchers and study sponsors will use the Certificate to resist any demands for information that would identify you, except as explained below.

The Certificate cannot be used to resist a demand for information from personnel of the United States Government that is used for auditing or evaluation of federally funded projects or for information that must be disclosed in order to meet the requirements of the federal Food and Drug Administration (FDA).

This Certificate of Confidentiality does not mean that the Federal government endorses this study. You should understand that a Certificate of Confidentiality does not prevent you or a member of your family from voluntarily releasing information about yourself or your involvement in this research. If an insurer, employer, or other person obtains your written consent to receive research information, then the researchers may not use the Certificate to withhold that information. If you are not the vehicle owner, you should know that the vehicle owner will not have access to your data.

The Certificate of Confidentiality also does not prevent the researchers from disclosing voluntarily matters such as child abuse, or subject's threatened or actual harm to self or others. This could also include behaviors such as habitually driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. If this type of behavior is observed, we reserve the right to remove you from the study and inform the appropriate authorities of what we have observed. In most cases, we will notify you first of the behaviors we have observed prior to removing you from the study or informing others of our observations. If you are removed from the study, your compensation will be prorated based on the time you have already spent as a participant in the study.

The protections of the Certificate of Confidentiality described herein may not apply to passengers or drivers of the vehicle who have not consented to being in this study. For this reason, Informed Consent will be sought from all other adults who drive the vehicle, and these individuals will be protected by the Certificate of Confidentiality to the same degree as you are.

To summarize, your level of confidentiality in this study is as follows:

1. There will be video of your face and portions of your body. There will be audio recorded, but only for 30 seconds if you press the red incident button. The study also will collect health and driving data about you. The video, audio, and other data that personally identifies you, or could be used to personally identify you, will be held under a high level of security at one or more data storage facilities. Your data will be identified with a code rather than your name.
2. All data collected from other drivers who have not signed a consent form will be deleted. No identifying information will be collected on passengers.
3. For the purposes of this project, only authorized project personnel, authorized employees of the project sponsors, and qualified research partners will have access to study data containing personally identifying information, or that could be used to personally identify you. The data, including face video which has been blurred, blacked out, or replaced by animation, may be shown at research conferences and by the research sponsors for the highway and road safety purposes identified above. Under no circumstances will your name and other personally identifying information be associated with the video clips.
4. The personally identifying data collected in this study may be analyzed in the future for other research purposes by this project team or by other qualified researchers in a secure environment. Such efforts will require those researchers to sign a data sharing agreement which will continue to protect your confidentiality, and will also require additional IRB approval. The confidentiality protection provided to you by these data sharing agreements will be as great as or greater than the level provided and described in this document. Research partners will not be permitted to copy raw data that identifies you, or that could be used to identify you, or to remove it from the secure facility in which it is stored except with your consent.
5. A Certificate of Confidentiality has been obtained from the National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your removal from the study and reporting of the behavior to the appropriate authorities. While your confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by you or others, you may be prevented by a court from raising certain claims or defenses unless you agree to waive the confidentiality protection.

WILL I RECEIVE PAYMENT FOR PARTICIPATING IN THIS STUDY?

Total payment for your participation in this research will be as follows, depending on the length of enrollment. You are scheduled to be enrolled for _____ months. You are required to provide a valid social security number in order to receive your first payment.

1. After you have been enrolled in the study (the vehicle has been prepared for our study and you have completed the enrollment process, including the online questionnaires), you will receive $100 via check or direct deposit.
2. After your enrollment is complete, and after you return to CUBRC to have the system removed from the vehicle and complete a few final questionnaires, you will receive any final payment due via check or direct deposit. The amount of this final payment will depend on your length of enrollment, as follows:
   a. Four months: $100 (study total of $200).
   b. Five months: $110 (study total of $210).
   c. Six months: $152 (study total of $252).
   d. Seven months: $194 (study total of $294).

If you discontinue your participation before the four month minimum enrollment, by your own choice, because the vehicle owner decides to withdraw their vehicle, or because you are asked to leave by someone on the study team, you will not receive any additional payment beyond your initial $100.

If you are asked to leave due to persistent tire pressure monitoring system problems, you will be paid $42 for each month or partial month of participation.

In addition, you will also be entered into a drawing for $1,000 paid in the same way as your other compensation. One $1,000 prize will be awarded every six months for every 150 drivers currently enrolled at your site, and you are guaranteed entry into the next scheduled drawing (next drawing date: _____, _____) even if your scheduled enrollment is less than six months.

WHAT ABOUT INSURANCE?

Please note that since you are driving your own vehicle or another vehicle with the owner's permission, neither study personnel nor their respective organizations are responsible for the expenses that are caused by a crash you may experience. In the event of a crash, you are **not** responsible for any damage to the data collection system that is installed into the vehicle.

Participants in a study are considered volunteers, regardless of whether they receive payment for their participation. Under New York state law, workers compensation does not apply to volunteers; therefore, the participants are responsible for their own medical insurance for bodily injury. Appropriate health insurance is strongly recommended to cover these types of expenses.

If you get hurt in a crash, whether in or out of an automobile, the medical treatment available to you would be that provided to any person by emergency medical services in the vicinity where the accident occurs. The participant agrees that this agreement shall be construed in accordance with the laws of the Commonwealth of Virginia, notwithstanding any conflicts of law provisions. Further, any and all claims and/or actions against Virginia Tech or the Commonwealth of Virginia shall be brought in a court of the Commonwealth of Virginia.

AM I FREE TO WITHDRAW FROM THIS STUDY AT ANY TIME?

As a participant in this research, you are free to withdraw at any time without penalty. If you choose to withdraw, you will receive partial payment as described in the Payment for Participation section of this form. You **are free to choose not to answer any questions** or respond to any tests that you choose without penalty. If you withdraw or are dismissed from the study, or if the vehicle owner withdraws the vehicle from the study, we will retain data collected before the withdrawal/dismissal, but delete any data collected in the interval between when we become aware of the withdrawal/dismissal and before we are able to remove the data collection equipment. If you choose to end your participation in the study earlier than originally planned, we will need to schedule a time to remove the data collection system from the vehicle. You will not receive any final payment due until we have removed the instrumentation from the vehicle.

HAS THIS RESEARCH BEEN APPROVED?

Before this experiment begins, the research must be approved by the Institutional Review Board for research involving human subjects at Virginia Tech. The research has also been approved by the IRB for the National Academies of Science. You should know that this approval has been obtained and is valid through the date listed at the bottom of this form.

HOW DO I PROVIDE MY CONSENT?

I _____ (participant) have read and understand this consent form and conditions of participation. I understand what is being asked of me. My questions have been answered. I freely agree to participate and have not been coerced into participation. I understand that participation is voluntary and that I may withdraw at any time without penalty.

I certify either that I am the owner, co-owner, or lessee of the vehicle that will be used in the study and that I am permitting the instruments and sensors to be installed in the vehicle, or that I have obtained written permission from the vehicle owner to do so. If I lease my vehicle, I certify that I have carefully reviewed my lease agreement to be sure that the installation of the instruments and sensors is allowed under the terms of my lease. I certify that I hold a valid United States driver's license, and that the vehicle that will be used in the study has at least the minimum amount of liability insurance required by the state in which it is registered.

_____	_____	_____
Participant (Print Name)	Signature	Date
_____	_____	_____
Experimenter (Print Name)	Signature	Date

==========

Should I have any questions about this research or its conduct, I may contact:

Alan Blatt	CUBRC Site Principal Investigator	(716) ***-****-*****@cubrc.org
Jon Antin	Project Manager	(540) ***-****-*****@vtti.vt.edu
David Moore	Chair, Virginia Tech Institutional Review Board for the Protection of Human Subjects Office of Research Compliance 2000 Kraft Drive, Suite 2000 (0497) Blacksburg, VA 24060	(540) ***-****-*****@vt.edu

The Participant Must Be Provided With a Copy of This Consent Form.

APPENDIX K

Secondary Driver Consent Form

PARTICIPANT CONSENT FORM FOR SECONDARY DRIVER, VARIABLE ENROLLMENT PERIOD (4–7 MONTHS)

IN-VEHICLE DRIVING BEHAVIOR AND CRASH RISK STUDY

(*"The SHRP 2 Naturalistic Driving Study"*)

SPONSORS: **National Academies of Science, Transportation Research Board, SHRP 2 Program**

The United States Department of Transportation

INVESTIGATORS: Tom Dingus, Jon Hankey, Jon Antin, Suzie Lee, and Lisa Eichelberger:
Virginia Tech Transportation Institute

John Pierowicz, Alan Blatt, and Marie Flanigan:
Calspan University of Buffalo Research Center (CUBRC)

Ann Brach and Ken Campbell: National Academies,
Transportation Research Board, SHRP 2 Program

WHAT IS THE PURPOSE OF THIS RESEARCH?

The Naturalistic Driving Study is a large research effort directed at improving Highway Safety in the United States where more than 30,000 people are killed and 2 million are injured every year in highway-related accidents. The study will help researchers gain a deeper understanding of the interaction between the driver, vehicle and roadway and lead to safer roadways, vehicles, and driver training programs. The SHRP 2 Naturalistic Driving Study will look at how people normally drive by installing cameras and sensors in people's own vehicles. The study is being conducted at six locations across the United States with up to 3,300 participants. Length of enrollment varies from four months to two years. Your enrollment is scheduled to last _____ months.

WHAT DO I HAVE TO DO IF I CHOOSE TO PARTICIPATE?

The owner, co-owner, or lessee of a vehicle you sometimes drive has allowed us to install a data collection system in their vehicle as part of a study. Data will be collected whenever the vehicle is driven, and some of this data may identify you as the driver. Data that could identify you includes face video and location information (such as your home, work, and school locations). We are inviting you to participate in the study as well and to allow us to use your identifying information for research purposes. There are three options with regard to participation:

1. You may choose to participate fully by reading and signing this consent form and following the steps listed below.
2. You may decline to participate fully but continue to drive the vehicle. If you choose this option, data will be collected whenever you drive the vehicle, but the data will be deleted once it is determined that you were the driver and that you did not sign a consent form.

3. You may decline to participate and choose not to drive the vehicle while it is in the study. In this case, no data would be collected.

The study involves a _____ month data collection effort in which a data collection system containing sensors and video cameras will be installed in the vehicle(s) you regularly drive to record a variety of driving measures. As a fully enrolled secondary participant, you would complete the following activities:

1. Complete the enrollment process, which should take no more than 20 minutes, and return the forms to CUBRC. These forms include:
   a. This informed consent form
   b. A brief questionnaire about you and your driving history
   c. A questionnaire about your driving behaviors
2. Provide us with a digital picture of your face so that we may automatically identify you as a secondary driver. We will provide instructions on how to do this when we talk to you on the phone about your participation.
3. Drive as you normally would.
4. Let us or the primary participant know if you notice any unusual warning light activity, for example, warning lights that go on or off.
5. While you are in the study, we ask that you not drive the vehicle into any areas where cameras are not allowed, including any international border crossings, military bases, or similar facilities.
6. If you are in a crash while in the study, we ask that you do five things (in the following order):
   a. Seek emergency help the way that you normally would.
   b. If possible, press an incident button that is located near the rear view mirror to describe the incident. The system will then record your brief description. You will know the button is working if the red light comes on when you press it.
   c. Call us at (716) 204-5138 or (716) 204-5177 to notify us as soon as it is safe to do so.
   d. Allow a member of the research team to interview you about the crash if we decide that your crash should be investigated in more detail. This interview would ideally take place soon after the crash, but only when you are comfortable and able to do so.
   e. Allow us to have access to the police accident report, if any, which results from the crash.

WHAT ARE THE RISKS OF PARTICIPATING IN THIS STUDY?

The operation or drivability of the vehicle should not be affected by the instrumentation, and thus carries a similar risk as when you operate the vehicle normally. However, if you violate state or local driving laws (such as driving under the influence, exceeding posted speed limits, or driving while distracted), the instrumentation could record evidence of these violations. This has the potential to pose greater than minimal risk of legal harm. A variety of strategies and procedures have been developed to reduce the potential for legal or economic harms. These strategies include encrypting the data obtained by sensors and cameras, using a code number to identify you with the code key maintained in a secure location, and obtaining a Certificate of Confidentiality. More details on these strategies are provided below.

All data collection equipment is mounted such that, to the greatest extent possible, it should not pose a hazard or problem for you when you drive. None of the data collection equipment should get in the way of your normal field of view. You are not being asked to change the way you drive or where you drive.

In the vast majority of cases, placing the data collection system in the vehicle will not affect the operating or handling characteristics of the vehicle. In some rare cases, the electromagnetic signals generated by the data collection system may cause interference with the vehicle's radio, keyless entry key fob, or other electronic components or sensors, such as the tire pressure monitoring system. If this happens in the study vehicle, CUBRC will use engineering countermeasures to attempt to minimize the interference to an unnoticeable level. If the study vehicle experiences persistent tire pressure monitoring system problems, the primary participant will be asked to leave the study, while for other problems, the primary participant will be given the option to continue participation with the problem unresolved or to leave the study.

Five cameras are placed in the vehicle. If you drive into an area where cameras are not allowed, including international border crossings, certain military and intelligence locations, and certain manufacturing plants, there is a risk that you may be detained or arrested or that the vehicle may be impounded. For this reason, by signing this Informed Consent and thereby agreeing to participate in the study, you also are agreeing not to drive into any such areas while you are in this study. We have

provided a letter for the glove box which can be used to explain the vehicle's role in the study while still maintaining your privacy and keeping confidential your role in the study.

Throughout the study, we will take all possible steps to protect your privacy and keep confidential your role in the study and the confidentiality of your personally identifying information. To help us protect your privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your removal from the study and reporting of the behavior to the appropriate authorities. In the event of a crash, it may not be possible to prevent the equipment and the data from falling into the hands of the police or an insurance company; if this happens, however, the data are still encrypted and inaccessible and unreadable to these individuals.

However, you too, are responsible for taking steps to protect your privacy. Do not post or disclose your participation on any public forum including websites, Facebook, newspapers, radio and television. Protect your role in the study the same way that you protect other personal and private information. If you do not keep confidential your role in the study, there is a risk that some of the data collected during the study, including your personally identifying information, may be used against you in a court case or other legal proceeding.

The risk to you of completing the questionnaires is no more than when you are doing activities in your daily life like filling in forms, and working at a computer.

WHAT ARE THE BENEFITS OF PARTICIPATING IN THIS STUDY?

While there are no direct benefits to you from this research, you may find this study interesting. No promise or guarantee of benefits is being made to encourage your participation. Participation will help to improve the body of knowledge regarding driving behavior and safety. Participation may also help us design safer vehicles and roadways in future years.

HOW WILL MY DATA BE KEPT CONFIDENTIAL AND SECURE AND WHO WILL HAVE ACCESS TO MY DATA?

Any data collected during this study that personally identifies you or that could be used to personally identify you will be treated with confidentiality. As soon as you begin participating in this study, your name and other identifying information will be separated from the raw data collected while you drive the vehicle and replaced with a number. That is, your raw data will not be attached to your name, but rather to a number (for example, Driver 0011). The raw data collected while you drive the vehicle will be encrypted (made unreadable) from the moment it is collected until it is transferred to one or more secure central storage locations. Your name also will be separated from any data about you, either provided by you in response to questionnaires or gathered by researchers during the study, including crash investigation data, and will be replaced by the same driver number (for example, Driver 0011).

Several types of information and data about you and the vehicle will be collected during the study:

1. **Contact information** includes your name, address, email address, phone numbers, and similar information used to contact you when needed. It will be stored securely in electronic form during the course of the study and destroyed after the study is complete (unless you grant permission for us to keep your contact information when the study is over). This information will not be linked to or mingled with your study data, and will not be used in any research or analysis.
2. **Driver data** includes your answers to questionnaires. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driving data, vehicle data, and additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).
3. **Driving data** includes the data we collect from the vehicle while you are driving, including video data and sensor data. This information will contain video of your face and GPS coordinates of your trips, both of which could be used to personally identify you. These data will be encrypted (stored in an unreadable format) from the moment of their creation until they are downloaded from the vehicle, transferred to a secure data storage facility, and verified. From this point on they will be decrypted (made readable) on as as-needed basis for each analysis. These data will be used for analysis, both on their own and in combination with the driver data, the vehicle data, and the additional crash data. We will also treat the digital picture

you send us as driving data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

4. **Additional crash data** includes items we may collect after a crash, including answers to an interview with one of our researchers and the police accident report resulting from the crash. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driver data, vehicle data, and driving data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

It is possible that an authorized Institutional Review Board (IRB) may view this study's collected data for auditing purposes. An IRB is responsible for the oversight of the protection of human subjects involved in research.

It is also possible that the study sponsors or investigators may view this study's driver data and driving data for quality control or administrative purposes; in this case, the study sponsors or investigators will be required to maintain the security and confidentiality of any data that personally identifies study participants or that could be used to personally identify study participants.

While driving the vehicle, a camera will videotape your face with some added space around the head to handle any head movements. An example is shown below. Also, video cameras will capture views of the forward view, the rear view, an external view to the right, as well as a dashboard/lap-belt view. A camera will also periodically take a permanently blurred snapshot of the vehicle interior which will allow researchers to count the number of passengers and make rough estimates of age, gender, and seatbelt use. Passenger identification will not be possible from these blurred snapshots. All video will be captured and stored in digital format (no tape copies will exist).

There will also be an ambient atmospheric analyzer that is capable of detecting the presence of alcohol in the passenger compartment under certain conditions. It may not be able to distinguish whether the alcohol was imbibed or applied (as in hand sanitizer), and it will be unable to determine whether it is emanating from the driver or a passenger. However, this sensor will flag the data for possible indications of impaired driving.

If a safety-related incident or crash occurs, you are asked to press a button on the unit mounted near the rearview mirror. You will know this button is working if a red light appears when you press it. This will allow researchers to find the incident in the database after the data have been collected. Also, pressing the button starts a microphone for 30 seconds. During these 30-seconds, you can tell us what happened. No audio will be captured except when you press this incident button. Please note that pressing this button does NOT make a phone call, unlike OnStar™. It simply records your voice in an audio file that remains in the vehicle until the data is collected.

During the data collection phase of this study, all data collected from the vehicle will be encrypted (made unreadable) from the time of its creation and then stored in a specific password-protected project folder on a secure server; the driving data will only be decrypted (made readable) once it has been stored in this folder. At the conclusion of the collection phase of this study, the driver data, driving data, and additional crash data will be permanently housed at one or more highly secure data storage facilities. One set of data will be permanently housed at Virginia Tech under the supervision of the Virginia Tech Transportation

Institute, the organization overseeing the data collection for the entire study. It is possible that, after data collection is complete, one copy of study data will be transferred to the U.S. Department of Transportation (or other secure facilities as determined by the Transportation Research Board) for permanent storage and oversight.

Only authorized project personnel and authorized employees of the research sponsors will have access to study data that personally identifies you or that could be used to personally identify you. As explained below, other qualified research partners may be given limited access to your driver data, vehicle data, driving data, and additional crash data, solely for authorized research purposes and with the consent of an IRB. This limited access will be under the terms of a data sharing agreement or contract that, at a minimum, provides you with the same level of confidentiality and protection provided by this Consent Form. However, even these qualified researchers will not be permitted to copy raw study data that identifies you, or that could be used to identify you, or to remove it from the secure facilities in which it is stored without your consent.

Project personnel, the project sponsors and qualified, authorized research partners may show specific clips of video at research conferences. The project sponsors also may show specific clips of video to the media, driver's education teachers and students, and others involved in efforts to improve highway and road safety. The face portion of the video will be blurred, blacked out, or replaced with an animation for these purposes. Your name and other personally identifying information will never be associated with the showing of these video clips. Identifying location information will not be shown in association with these video clips.

It is expected that the data we capture throughout the course of the entire study, including that from the secondary participants, will be a valuable source of data on how drivers respond to certain situations and how the roadway and vehicle might be enhanced to improve driver safety. Researchers who study traffic congestion and traffic patterns may also find the data useful.

Therefore, it is expected that there will be follow-on data analyses using all or part of the data for up to 30 years into the future. These follow-on analyses will be conducted by qualified researchers with IRB approval, as required by law, who may or may not be part of the original project team. In consenting to this study, you are consenting to future research uses of the information and videos we gather from you, consistent with the protections described above and elsewhere in this document.

If you are involved in a crash while participating in this study, the data collection equipment in the vehicle will likely capture the events leading up to the event. You are under NO LEGAL OBLIGATION to voluntarily mention the data collection equipment or your participation in this study at the time of a crash or traffic offense. We have placed a letter in the glove box for these cases. The letter describes the vehicle's role in the study without identifying you as a participant in the study.

Because the vehicle camera system is storing continuous video, it may capture some incriminating evidence if an at-fault collision should occur. To help us protect your privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, neither the researchers nor study sponsors can be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. Identifying information for the purposes of this study includes your contact information, your auxiliary study information, the digital picture of your face, your driving data (including video of your face and GPS coordinates which may identify your home, work, or school locations), or any information in your driver data, vehicle data, or additional crash data that could be used to personally identify you. While your confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by you or others, you may be prevented by a court from raising certain claims or defenses unless you agree to waive the confidentiality protection. The researchers and study sponsors will use the Certificate to resist any demands for information that would identify you, except as explained below.

The Certificate cannot be used to resist a demand for information from personnel of the United States Government that is used for auditing or evaluation of federally funded projects or for information that must be disclosed in order to meet the requirements of the federal Food and Drug Administration (FDA).

This Certificate of Confidentiality does not mean that the Federal government endorses this study. You should understand that a Certificate of Confidentiality does not prevent you or a member of your family from voluntarily releasing information about yourself or your involvement in this research. If an insurer, employer, or other person obtains your written consent to receive research information, then the researchers may not use the Certificate to withhold that information.

The Certificate of Confidentiality also does not prevent the researchers from disclosing voluntarily matters such as child abuse, or subject's threatened or actual harm to self or others. This could also include behaviors such as habitually driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. If this type of behavior is observed, we reserve the right to remove you from the study and inform the appropriate authorities of what we have observed. In most cases, we will notify you first of the behaviors we have observed prior to removing you from the study or informing others of our observations. In the event of a crash, it may not be possible to prevent the equipment and the

data from falling into the hands of the police or an insurance company; if this happens, however, the data are still encrypted and inaccessible and unreadable to these individuals.

The protections of the Certificate of Confidentiality described herein may not apply to passengers or drivers of the vehicle who have not consented to being in this study.

To summarize, your level of confidentiality in this study is as follows:

1. There will be video of your face and portions of your body. There will be audio recorded, but only for 30 seconds if you press the red incident button. The study also will collect driving data about you. If you consent to participate in the study, the digital picture, video, audio, and other data that personally identifies you, or could be used to personally identify you, will be held under a high level of security at one or more data storage facilities. Your data will be identified with a code rather than your name. If you do not agree to participate, all of the data collected while you are driving will be deleted.
2. For the purposes of this project, only authorized project personnel, authorized employees of the project sponsors, and qualified research partners will have access to study data containing personally identifying information, or that could be used to personally identify you. The data, including face video which has been blurred, blacked out, or replaced by animation, may be shown at research conferences and by the research sponsors for the highway and road safety purposes identified above. Under no circumstances will your name and other personally identifying information be associated with the video clips.
3. The personally identifying data collected in this study may be analyzed in the future for other research purposes by this project team or by other qualified researchers in a secure environment. Such efforts will require those researchers to sign a data sharing agreement which will continue to protect your confidentiality, and will also require additional IRB approval. The confidentiality protection provided to you by these data sharing agreements will be as great as or greater than the level provided and described in this document. Research partners will not be permitted to copy raw data that identifies you, or that could be used to identify you, or to remove it from the secure facility in which it is stored except with your consent.
4. A Certificate of Confidentiality has been obtained from the National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your removal from the study and reporting of the behavior to the appropriate authorities. While your confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by you or others, you may be prevented by a court from raising certain claims or defenses unless you agree to waive the confidentiality protection.

WILL I RECEIVE PAYMENT FOR PARTICIPATING IN THIS STUDY?

Upon enrollment (completing this consent form, completing the questionnaires, and providing a digital picture of your face), you will receive $25 via check or direct deposit. You will need to provide a mailing address in order to receive this payment, and you may be asked to provide you Social Security Number.

WHAT ABOUT INSURANCE?

Please note that since you are not driving a vehicle owned by study personnel nor their respective organizations, neither study personnel nor their respective organizations are responsible for the expenses that are caused by a crash you may experience. In the event of a crash, you are **not** responsible for any damage to the data collection system that is installed into the vehicle.

Participants in a study are considered volunteers, regardless of whether they receive payment for their participation. Under New York state law, workers compensation does not apply to volunteers; therefore, the participants are responsible for their own medical insurance for bodily injury. Appropriate health insurance is strongly recommended to cover these types of expenses.

If you get hurt in a crash, whether in or out of an automobile, the medical treatment available to you would be that provided to any person by emergency medical services in the vicinity where the accident occurs.

The participant agrees that this agreement shall be construed in accordance with the laws of the Commonwealth of Virginia, notwithstanding any conflicts of law provisions. Further, any and all claims and/or actions against Virginia Tech or the Commonwealth of Virginia shall be brought in a court of the Commonwealth of Virginia.

AM I FREE TO WITHDRAW FROM THIS STUDY AT ANY TIME?

As a participant in this research, you are free to withdraw at any time without penalty. You **are free to choose not to answer any questions** or respond to any tests that you choose without penalty. If you decide to withdraw or are dismissed from the study, you need to notify one of the research team listed on the last page of this form so that any future data collected with you as a driver will be deleted. However, we will retain data collected before your withdrawal/dismissal.

HAS THIS RESEARCH BEEN APPROVED?

Before this experiment begins, the research must be approved by the Institutional Review Board for research involving human subjects at Virginia Tech. The research has also been approved by the IRB for the National Academies of Science. You should know that this approval has been obtained and is valid through the date listed at the bottom of this form.

HOW DO I PROVIDE MY CONSENT?

I _____ (participant) have read and understand this consent form and conditions of participation. I understand what is being asked of me. My questions have been answered. I freely agree to participate and have not been coerced into participation. I understand that participation is voluntary and that I may withdraw at any time without penalty.

I certify that I hold a valid United States driver's license.

I certify that I am 18 years old or older.

I also understand that if I choose not to participate, the data collected while I am driving will be deleted once it is determined that the driver of the vehicle for any trip did not sign a consent form. I also understand that if I choose not to participate, that my data may not be protected by the Certificate of Confidentiality, but again, the data will be deleted as soon as it is determined that the driver for that trip did not sign a consent form.

_____	_____	_____
Participant (Print Name)	Signature	Date
_____	_____	_____
Experimenter (Print Name)	Signature	Date

==========

Should I have any questions about this research or its conduct, I may contact:

Alan Blatt	CUBRC Site Principal Investigator	(716) ***-****-*****@cubrc.org
Jon Antin	Project Manager	(540) ***-****-*****@vtti.vt.edu
David Moore	Chair, Virginia Tech Institutional Review Board for the Protection of Human Subjects Office of Research Compliance 2000 Kraft Drive, Suite 2000 (0497) Blacksburg, VA 24060	(540) ***-****-*****@vt.edu

The Participant Must Be Provided With a Copy of This Consent Form.

APPENDIX L

Participant Information Sheet

The Naturalistic Driving Study is a large research effort directed at improving Highway Safety in the United States where more than 30,000 people are killed and 2 million are injured every year in highway-related accidents. The study will help researchers gain a deeper understanding of the interaction between the driver, vehicle and roadway and lead to safer roadways, vehicles, and driver training programs. The SHRP 2 Naturalistic Driving Study will look at how people normally drive by installing cameras and sensors in people's own vehicles. The study is being conducted at six locations across the United States with up to 3,300 participants. Participation will range from four months to two years. About 370 participants will be minors.

If you decide to participate in the study, we will install several pieces of data collection equipment in the vehicle you normally drive. The equipment will collect data continuously, from the time the vehicle is turned on until it is turned off. There will be video of your face, arms, and legs that will tell us what you do while you drive. There will also be video of the forward roadway and the roadway behind the vehicle. GPS will provide the location of the vehicle. Sensors will measure speed, braking, turn signal use and other vehicle and driver behaviors.

The risk while driving will be the same as the risk of driving when not in the study. Although there is only a low probability of occurrence, the biggest risk believed to be associated with participation in this study is the possibility that someone could obtain your data and use it in a way that harms you legally, financially, or emotionally. To prevent this, we have taken several steps to ensure your confidentiality and the confidentiality of your passengers and other people who drive your car.

- A Certificate of Confidentiality has been obtained from the National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings.
- The data will be encrypted (made unreadable) from the time it is collected until it is transferred to a high security data center. Once it is at the data center, care will be taken that the data are only used for legitimate research purposes.
- Data that can identify you, such as video of your face and the GPS locations of your home, work, or school, will be handled with extra care and will only be available to select researchers in a secure data center.
- The data of other drivers who have not signed a consent form will be deleted after data processing identifies them as unconsented drivers. No identifying information will be collected on passengers.

If you decide to participate, you will be asked to do the following things:

- Provide us with proof of a valid U.S. driver's license, vehicle insurance, and vehicle ownership (or written permission from the vehicle's owner).
- Undergo a consent process which includes reviewing and signing an informed consent form.
- Allow us to install the data collection equipment in the vehicle.
- Undergo tests of vision, memory, decision making, attention, body movement, and strength.
- Complete questionnaires about your health and your driving behavior, history, and knowledge.
- If you are in a crash, we may ask you later to participate in an interview about the crash and allow us to look at the police accident report.

There is compensation for participation in the study equivalent to $42 per month (with a minimum enrollment of 4 months).

APPENDIX M

Minor (Teen) Participant Information Sheet

The Naturalistic Driving Study is a large research effort directed at improving Highway Safety in the United States where more than 30,000 people are killed and 2 million are injured every year in highway-related accidents. The study will help researchers gain a deeper understanding of the interaction between the driver, vehicle and roadway and lead to safer roadways, vehicles, and driver training programs. The SHRP 2 Naturalistic Driving Study will look at how people normally drive by installing cameras and sensors in people's own vehicles. The study is being conducted at six locations across the United States with up to 3,300 participants. Participation will range from four months to two years. About 370 participants will be minors.

If you decide to participate in the study, we will install several pieces of data collection equipment in a vehicle owned or co-owned by you, a parent, or someone else who has given permission for the vehicle to be in the study. The equipment will collect data continuously, from the time the vehicle is turned on until it is turned off. There will be video of your face, arms, and legs that will tell us what you do while you drive. There will also be video of the forward roadway and the roadway behind the vehicle. GPS will provide the location of the vehicle. Sensors will measure speed, braking, turn signal use and other vehicle and driver behaviors.

The risk while driving will be the same as the risk of driving when not in the study. Although there is only a low probability of occurrence, the biggest risk believed to be associated with participation in this study is the possibility that someone could obtain your data and use it in a way that harms you legally, financially, or emotionally. To prevent this, we have taken several steps to ensure your confidentiality and the confidentiality of your passengers and other people who drive your car.

- A Certificate of Confidentiality has been obtained from the National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings.
- The data will be encrypted (made unreadable) from the time it is collected until it is transferred to a high security data center. Once it is at the data center, care will be taken that the data are only used for legitimate research purposes.
- Data that can identify you, such as video of your face and the GPS locations of your home, work, or school, will never be disclosed to the public. Such data will only be used by legitimate researchers in a secure data center, with the approval of an institutional review board charged with protection of research subjects, and under a data sharing agreement that protects the confidentiality of your data.
- The data of other drivers who have not signed a consent form will be deleted after data processing identifies them as unconsented drivers. No identifying information will be collected on passengers.

If you decide to participate, you will be asked to do the following things:

- Bring a parent with you when you enroll (you or the parent must own or co-own the vehicle used in the study, or you must provide written permission from the vehicle owner).
- Provide us with proof of a valid U.S. driver's license (you), vehicle insurance (you or your parent), and vehicle ownership (you, your parent, or someone else who has given permission for the vehicle to be in the study).
- Undergo a consent process which includes reviewing and signing an informed assent form. Your parent must review and sign an informed consent form allowing you

to participate (and allowing us to install the data collection equipment in their vehicle if they own the vehicle).
- Undergo tests of vision, memory, decision making, attention, body movement, and strength.
- Complete questionnaires about your health and your driving behavior, history, and knowledge.
- If you are in a crash, we may ask you later to participate in an interview about the crash and allow us to look at the police accident report.

There is compensation for participation in the study equivalent to $42 per month (with a minimum enrollment of 4 months).

APPENDIX N

Minor Assent Form

PARTICIPANT ASSENT FORM FOR MINORS—VARIABLE ENROLLMENT PERIOD (4–7 MONTHS)

IN-VEHICLE DRIVING BEHAVIOR AND CRASH RISK STUDY

("*The SHRP 2 Naturalistic Driving Study*")

SPONSORS: **National Academies of Science, Transportation Research Board, SHRP 2 Program**

The United States Department of Transportation

INVESTIGATORS: Tom Dingus, Jon Hankey, Jon Antin, Suzie Lee, and Lisa Eichelberger:
Virginia Tech Transportation Institute

John Pierowicz, Alan Blatt, and Marie Flanigan:
Calspan University of Buffalo Research Center (CUBRC)

Ann Brach and Ken Campbell: National Academies,
Transportation Research Board, SHRP 2 Program

WHAT IS THE PURPOSE OF THIS RESEARCH?

The Naturalistic Driving Study is a large research effort directed at improving Highway Safety in the United States where more than 30,000 people are killed and 2 million are injured every year in highway-related accidents. The study will help researchers gain a deeper understanding of the interaction between the driver, vehicle and roadway and lead to safer roadways, vehicles, and driver training programs. The SHRP 2 Naturalistic Driving Study will look at how people normally drive by installing cameras and sensors in people's own vehicles. The study is being conducted at six locations across the United States with up to 3,300 participants. Length of enrollment varies from four months to two years. Your enrollment is scheduled to last _____ months. About 370 participants will be minors.

WHAT SHOULD I KNOW BEFORE DECIDING TO PARTICIPATE?

1. Because you are a minor, a parent or legal guardian will need to be with you when you enroll in the study and they will have to sign a consent form allowing you to participate. If neither you nor the signing parent owns or leases the study vehicle, you will have to obtain the owner's written permission to use the vehicle before you enroll in the study.
2. You are providing permission for us to collect data (including video) whenever the study vehicle is used or whenever you happen to drive another vehicle that is part of the study (for example, a vehicle owned by a friend who also happens to be in the study). If there are drivers of the study vehicle who have not signed consent forms, we will delete their data from every trip in which they drove the vehicle.
3. There will be video of your face and portions of your body and the roadway. Audio will not be recorded unless you press a red incident button. The video, audio, and other data that personally identifies you, or could be used to personally identify you,

will be held under a high level of security at one or more data repositories. Your data will be identified with a code rather than your name. Finally, only qualified researchers will be authorized to have access to data that personally identifies you, or can be used to personally identify you, and the level to which they have access will be based on their level of authorization.
4. No identifying information will be collected on passengers.
5. For the duration of the project you or the owner of the vehicle used in the study will be responsible for your insurance coverage. If you are in a crash, please contact emergency services as you normally would. We will then ask for more information, as detailed below.
6. You may withdraw from the study at any time. If you do withdraw from the study before your scheduled end date, or if the vehicle's owner decides to withdraw the vehicle, you must agree to allow us to retrieve the data collection system from the vehicle as soon as is feasible.

WHAT DO I HAVE TO DO IF I CHOOSE TO PARTICIPATE?

The study involves a _____ month data collection effort in which a data collection system containing sensors and cameras will be installed in the vehicle to record a variety of driving measures. As a participant, you will complete the following activities:

1. Have the vehicle equipped (see the section below: "What will I have to do to get the vehicle equipped for the study?").
2. Drive as you normally would.
3. Provide us with contact information for all other adult drivers (over the age of 18) who drive the vehicle at least once a week. We would like to contact them to get permission to use data collected any time they happen to be driving the vehicle. We will also ask them to fill out two brief questionnaires and provide a reference picture to allow us to identify when they are driving.
4. If requested, make an appointment to allow us to maintain the equipment or collect the driving data from the vehicle. Only one appointment is anticipated during your enrollment period. Appointments will typically take 15 minutes but could take up to one hour. They will be scheduled to take place at a location that is convenient for you such as your home, work, school, or at a local shopping mall. You will not need to do anything at an appointment apart from providing access to the trunk or interior of the vehicle; a trained technician will handle everything else.
5. If you are enrolled in the study at the time of your 18th birthday, we will contact you to change from an informed assent form to an informed consent form.
6. While you are in the study, we ask that you not drive the vehicle into any areas where cameras are not allowed, including any international border crossings, military bases, or similar facilities.
7. Advise other drivers of the video and audio equipment installed in the vehicle and ask them not to drive into areas where cameras are not allowed. Let these other drivers know that data will be collected when they drive the vehicle but will only be retained and analyzed if they sign a consent form. If they do not sign a consent form, then the data will be deleted for every trip in which they drove the vehicle.

WHAT WILL I HAVE TO DO TO GET THE VEHICLE EQUIPPED FOR THE STUDY?

1. If you do not own or lease the study vehicle, you must first obtain the written permission of the vehicle owner. This can be provided on the day you enroll in the study by one of two methods: 1) the owner attends and signs the form in person, or 2) via a telephone call in which a third person at the study site will witness and sign the owner's permission form on behalf of the owner. We cannot accept pre-signed owner permission forms in which we have not had personal or telephone contact with the vehicle owner.
2. Bring the vehicle to CUBRC at the scheduled day and time to have the data collection system installed. The technicians will strive to complete each vehicle in less than four (4) hours, but it may take longer in rare cases. The system will require a connection to the vehicle power and the vehicle network box. These connections will provide additional data as well as power for the system; by agreeing to participate, you are providing us permission to get information from the vehicle network as well as to install new sensors. Before we begin installation, we will show you where we will place the system and also show you pictures of what the completed installation will look like. The vehicle will be returned to its original state when your participation is concluded.
3. While the system is being installed on the vehicle, you will be provided a comfortable area in which to complete the consent process and testing at CUBRC, which should take about 2–3 hours. Specifically, you will be asked to:
   a. Provide us with proof of a valid U.S. driver's license, proof of vehicle insurance, and proof of ownership (vehicle registration showing the name of the owner or lessee of the vehicle so that we may confirm that we have correctly obtained the permission of the vehicle's owner).

   b. Review and sign this informed assent form.
   c. Undergo about 20 minutes of non-invasive vision tests, performed on a computer monitor and a machine that you will look into but that will not touch or blow air into your eyes.
   d. Take about 30 minutes of computer tests that will assess your memory, decision making, and attention skills, none of which require previous computer skill or knowledge.
   e. Take a 2 minute memory and attention test using pencil and paper and the following two tests of your body movements and strength.
      i. You will be asked to walk as fast as you can without falling or tripping to a point 10 feet away, and then to return to the starting point. This should take about one minute.
      ii. You will be asked to sit down and squeeze a device that measures grip strength. This should also take about two minutes.
   f. Fill out nine (9) questionnaires on a computer (some may be completed online from home later, if you prefer). The questionnaires vary in length and take between 5 and 15 minutes each to complete. They contain questions about: your health history and health status; driving behavior, history and knowledge. You will be asked to fill out one or more final questionnaires after completing your participation in the study.
   g. Take home and give copies of an Informed Consent form and questionnaires to any other adult drivers who drive the vehicle at least once a week.
4. Allow our technicians to drive the vehicle as needed during the installation and testing process.
5. When the vehicle is ready, we will show you the data collection system and provide you with information about who to contact if you have any vehicle problems that could be related to your data collection system, or if you notice any maintenance issues with the system (for example, a camera or device that comes loose).
6. We will take some reference pictures of you in the vehicle so that software can be used to identify you as the driver.

WHAT DO I DO AFTER THE VEHICLE IS EQUIPPED FOR THE STUDY?

1. After you return home, you will be asked to complete any questionnaires you did not have time to complete during installation of the data collection system into the vehicle. Once you have completed all of the online questionnaires, you will receive your first payment of $100 via check or direct deposit.
2. Drive as you normally would for the duration of your enrollment.
3. If you are in a crash while in the study, we ask that you do five things (in the following order):
   a. Seek emergency help the way that you normally would.
   b. If possible, press an incident button that is located near the rear view mirror to describe the incident. The system will then record your brief description. You will know the button is working if the red light comes on when you press it.
   c. Call us at (716) 204-5138 or (716) 204-5177 to notify us as soon as it is safe to do so.
   d. Allow a member of the research team to interview you about the crash if we decide that your crash should be investigated in more detail. This interview would ideally take place soon after the crash, but only when you are comfortable and able to do so.
   e. Allow us to have access to the police accident report, if any, which results from the crash.
4. We anticipate making an appointment with you to collect the driving data from the vehicle or to maintain the equipment. An appointment will typically take about 15 minutes, but could take up to one hour depending on what needs to be done. It will be scheduled to take place at a location that is convenient for you such as your home, work, school, or at a local shopping mall. You will not need to be in the vehicle when the data are collected, but you will need to provide us with access to the trunk or interior of the vehicle. As mentioned above, we also will collect data from the vehicle after a crash, either at a place of your choosing or where the vehicle was towed.
5. If you are enrolled in the study at the time of your 18th birthday, we will contact you to change from an informed assent form to an informed consent form.
6. Let us know if you notice any unusual warning light activity, for example, warning lights that go on or off.
7. While you are in the study, do not drive the vehicle into any areas where cameras are not allowed, including any international border crossings.
8. If we notice a new person driving the vehicle, we may contact you to find out if you have already asked them about participating in the study.

WHAT HAPPENS WHEN THE STUDY IS OVER?

1. After _____ months, you will be asked to return to CUBRC so that we may remove the system from the vehicle. While the vehicle is being worked on, we will ask you to fill out some final questionnaires. This process is expected to take about two hours. After this session is complete, you will receive your final payment via check or direct deposit.
2. When you leave the study, we may ask you whether we can keep your contact information to contact you for participation in future follow-on studies. This will be optional, and if you do not agree, we will delete your contact information one year after data collection is complete at CUBRC.
3. Once we have all the data, we will begin data analysis and reporting. It is likely that you will see references to the results of the study in the news or elsewhere. However, these reports will not identify participants by name, nor will personally identifying video be shown.

WHAT ARE THE RISKS OF PARTICIPATING IN THIS STUDY?

The operation or drivability of the vehicle should not be affected by the instrumentation, and thus carries a similar risk as when you operate the vehicle normally. However, if you violate state or local driving laws (such as driving under the influence, exceeding posted speed limits, or driving while distracted), the instrumentation could record evidence of these violations. This has the potential to pose greater than minimal risk of legal harm. A variety of strategies and procedures have been developed to reduce the potential for legal or economic harms. These strategies include encrypting the data obtained by sensors and cameras, using a code number to identify you with the code key maintained in a secure location, and obtaining a Certificate of Confidentiality. More details on these strategies are provided below.

All data collection equipment is mounted such that, to the greatest extent possible, it does not pose a hazard or problem for you when you drive. None of the data collection equipment should get in the way of your normal field of view. You are not being asked to change the way you drive or where you drive, except for your visits to CUBRC at the beginning and end of the study.

In the vast majority of cases, placing the data collection system in the vehicle will not affect the operating or handling characteristics of the vehicle. In some rare cases, the electromagnetic signals generated by the data collection system may cause interference with the vehicle's radio, keyless entry key fob, or other electronic components or sensors, such as the tire pressure monitoring system. If this happens in your vehicle, CUBRC will use engineering countermeasures to attempt to minimize the interference to an unnoticeable level. If you experience persistent tire pressure monitoring system problems, you will be asked to leave the study, while for other problems, you will be given the option to continue participation with the problem unresolved or to leave the study. If you like, CUBRC personnel can provide information on our latest experience (a rough likelihood) of this problem occurring with your vehicle's particular make, model, year, and equipment package.

There are non-driving risks resulting from participation. Five cameras will be placed in the vehicle. If you drive into an area where cameras are not allowed, including international border crossings, certain military and intelligence locations, and certain manufacturing plants, there is a risk that you may be detained or arrested or that the vehicle may be impounded. For this reason, by signing this Informed Assent and thereby agreeing to participate in the study, you also are agreeing not to drive into any such areas while you are in this study. We have provided a letter for the glove box which can be used to explain the vehicle's role in the study while still maintaining your privacy and keeping confidential your role in the study.

Throughout the study, we will take all possible steps to protect your privacy and keep confidential your role in the study and the confidentiality of your personally identifying information. To help us protect your privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your removal from the study and reporting of the behavior to the appropriate authorities. In the event of a crash, it may not be possible to prevent the equipment and the data from falling into the hands of the police or an insurance company; if this happens, however, the data are still encrypted and inaccessible and unreadable to these individuals.

However, you too, are responsible for taking steps to protect your privacy. Do not post or disclose your participation on any public forum including websites, Facebook, newspapers, radio and television. Protect your role in the study the same way that you protect other personal and private information. If you do not keep confidential your role in the study, there is a risk that

some of the data collected during the study, including your personally identifying information, may be used against you in a court case or other legal proceeding.

The risk to you of completing the pre-collection questionnaires and tests while the data collection equipment is being installed in the vehicle is no more than when you are doing activities in your daily life like filling in forms, walking, squeezing your hand, and working at a computer. The assessment component involves filling in forms, standard vision tests, and standard computer-based tests. It is believed that there are no more than minimal risks involved with such activities. In addition, you will be asked to squeeze a grip strength tester and to rapidly walk 10 feet back and forth as fast as you can without running or falling. The risk with using the grip strength tester is brief hand soreness. The main risk with the Rapid Pace Walk is falling if you try to go too fast. Because the assessment process may take 2 or 3 hours, you may get tired, but you can also take breaks as needed.

If you are not the owner, co-owner, or lessee of the vehicle, there is a risk that the owner may decide to withdraw the vehicle from the study earlier than your planned term of enrollment. If this occurs, you will only be compensated for the portion of time you were enrolled in the study.

WHAT ARE THE BENEFITS OF PARTICIPATING IN THIS STUDY?

While there are no direct benefits to you from this research, you may find this study interesting. No promise or guarantee of benefits is being made to encourage your participation. Participation will help to improve the body of knowledge regarding driving behavior and safety. Participation may also help us design safer vehicles and roadways in future years.

HOW WILL MY DATA BE KEPT CONFIDENTIAL AND SECURE AND WHO WILL HAVE ACCESS TO MY DATA?

Any data collected during this study that personally identifies you or that could be used to personally identify you will be treated with confidentiality. As soon as you begin participating in this study, your name and other identifying information will be separated from the raw data collected while you drive the vehicle and replaced with a number. That is, your raw data will not be attached to your name, but rather to a number (for example, Driver 0011). The raw data collected while you drive the vehicle will be encrypted (made unreadable) from the moment it is collected until it is transferred to one or more secure central storage locations. Your name also will be separated from any data about you, either provided by you in response to questionnaires or gathered by researchers during the study, including crash investigation data, and will be replaced by the same driver number (for example, Driver 0011). YOUR PARENTS WILL NOT HAVE ACCESS TO YOUR DATA RESULTING FROM THIS STUDY. However, if we have reason to believe that you pose an imminent or ongoing danger to yourself or others, we may notify your parents of our findings.

Several types of information and data about you and the vehicle will be collected during the study:

1. **Contact information** includes your name, address, email address, phone numbers, and similar information used to contact you when needed. It will be stored securely in electronic form during the course of the study and destroyed after the study is complete (unless you grant permission for us to keep your contact information when the study is over). This information will not be linked to or mingled with your study data, and will not be used in any research or analysis.
2. **Auxiliary study information** includes your Social Security Number, license plate number, bank account information (for those using direct deposit) and similar information. This information is used to verify your identity and to make payments for your participation. This information will be stored at the site in electronic form (securely encrypted) and destroyed after the study is complete. This information will not be linked to or mingled with your study data, and will not be used in any research or analysis.
3. **Driver data** includes your answers to questionnaires, vision test results, and the results of the brief physical tests described above. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driving data, vehicle data, and additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).
4. **Vehicle data** includes the vehicle make and model, its condition, and how it is equipped. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driver data, driving data, and additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).
5. **Driving data** includes the data we collect from the vehicle while you are driving, including video data and sensor data. This information will contain video of your face and GPS coordinates of your trips, both of which could be used to personally

identify you. These data will be encrypted (stored in an unreadable format) from the moment of their creation until they are downloaded from the vehicle, transferred to a secure data storage facility, and verified. From this point on they will be decrypted (made readable) on as as-needed basis for each analysis. These data will be used for analysis, both on their own and in combination with the driver data, the vehicle data, and the additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

6. **Additional crash data** includes items we may collect after a crash, including answers to an interview with one of our researchers and the police accident report resulting from the crash. This data will not contain your name or any identifying information and will be used in analyses, both on its own and in combination with the driver data, vehicle data, and driving data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

It is possible that an authorized Institutional Review Board (IRB) may view this study's collected data for auditing purposes. An IRB is responsible for the oversight of the protection of human subjects involved in research.

It is also possible that the study sponsors or investigators may view this study's driver data and driving data for quality control or administrative purposes; in this case, the study sponsors or investigators will be required to maintain the security and confidentiality of any data that personally identifies study participants or that could be used to personally identify study participants.

While driving the vehicle, a camera will videotape your face with some added space around the head to handle any head movements. An example is shown below. Also, video cameras will capture views of the forward view, the rear view, an external view to the right, as well as a dashboard/lap-belt view. A camera will also periodically take a permanently blurred snapshot of the vehicle interior which will allow researchers to count the number of passengers and make rough estimates of age, gender, and seatbelt use. Passenger identification will not be possible from these blurred snapshots. All video will be captured and stored in digital format (no tape copies will exist).

There will also be an ambient atmospheric analyzer that is capable of detecting the presence of alcohol in the passenger compartment under certain conditions. It may not be able to distinguish whether the alcohol was imbibed or applied (as in hand sanitizer), and it will be unable to determine whether it is emanating from the driver or a passenger. However, this sensor will flag the data for possible indications of impaired driving.

If a safety-related incident or crash occurs, you are asked to press a button on the unit mounted near the rearview mirror. You will know this button is working if a red light appears when you press it. This will allow researchers to find the incident in the database after the data have been collected. Also, pressing the button starts a microphone for 30 seconds. During these 30-seconds, you can tell us what happened. No audio will be captured except when you press this incident button. Please note that pressing this button does NOT make a phone call, unlike OnStar™. It simply records your voice in an audio file that remains in the vehicle until the data is collected.

During the data collection phase of this study, all data collected from the vehicle will be encrypted (made unreadable) from the time of its creation and then stored in a specific password-protected project folder on a secure server; the driving data will only be decrypted (made readable) once it has been stored in this folder. At the conclusion of the collection phase of this study, the driver data, driving data, and additional crash data will be permanently housed at one or more highly secure data storage facilities. One set of data will be permanently housed at Virginia Tech under the supervision of the Virginia Tech Transportation Institute, the organization overseeing the data collection for the entire study. It is possible that, after data collection is complete, one copy of study data will be transferred to the U.S. Department of Transportation (or other secure facilities as determined by the Transportation Research Board) for permanent storage and oversight.

Only authorized project personnel and authorized employees of the research sponsors will have access to study data that personally identifies you or that could be used to personally identify you. As explained below, other qualified research partners may be given limited access to your driver data, vehicle data, driving data, and additional crash data, solely for authorized research purposes and with the consent of an IRB. This limited access will be under the terms of a data sharing agreement or contract that, at a minimum, provides you with the same level of confidentiality and protection provided by this Assent Form. However, even these qualified researchers will not be permitted to copy raw study data that identifies you, or that could be used to identify you, or to remove it from the secure facilities in which it is stored without your assent.

Project personnel, the project sponsors and qualified, authorized research partners may show specific clips of video at research conferences. The project sponsors also may show specific clips of video to the media, driver's education teachers and students, and others involved in efforts to improve highway and road safety. The face portion of the video will be blurred, blacked out, or replaced with an animation for these purposes. Your name and other personally identifying information will never be associated with the showing of these video clips. Identifying location information will not be shown in association with these video clips.

It is expected that the data we capture throughout the course of the entire study, including that from all the approximately 3,300 primary participants, will be a valuable source of data on how drivers respond to certain situations and how the roadway and vehicle might be enhanced to improve driver safety. Researchers who study traffic congestion and traffic patterns may also find the data useful. Therefore, it is expected that there will be follow-on data analyses using all or part of the data for up to 30 years into the future. These follow-on analyses will be conducted by qualified researchers with IRB approval, as required by law, who may or may not be part of the original project team. In assenting to this study, you are assenting to future research uses of the information and videos we gather from you, consistent with the protections described above and elsewhere in this document.

If you are involved in a crash while participating in this study, the data collection equipment in the study vehicle will likely capture the events leading up to the event. You are under NO LEGAL OBLIGATION to voluntarily mention the data collection equipment or your participation in this study at the time of a crash or traffic offense. We have provided a letter which you should keep in the glove box for these cases. The letter describes the vehicle's role in the study without identifying you as a participant in the study.

Because the vehicle camera system is storing continuous video, it may capture some incriminating evidence if an at-fault collision should occur. To help us protect your privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, neither the researchers nor study sponsors can be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. Identifying information for the purposes of this study includes your contact information, your auxiliary study information, your driving data (including video of your face and GPS coordinates which may identify your home, work, or school locations), or any information in your driver data, vehicle data, or additional crash data that could be used to personally identify you. While your confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by you or others, you may be prevented by a court from raising certain claims or defenses unless you agree to waive the confidentiality protection. The researchers and study sponsors will use the Certificate to resist any demands for information that would identify you, except as explained below.

The Certificate cannot be used to resist a demand for information from personnel of the United States Government that is used for auditing or evaluation of federally funded projects or for information that must be disclosed in order to meet the requirements of the federal Food and Drug Administration (FDA).

This Certificate of Confidentiality does not mean that the Federal government endorses this study. You should understand that a Certificate of Confidentiality does not prevent you or a member of your family from voluntarily releasing information about yourself or your involvement in this research. If an insurer, employer, or other person obtains your written assent to receive research information, then the researchers may not use the Certificate to withhold that information. If you are not the vehicle owner, you should know that the vehicle owner will not have access to your data.

The Certificate of Confidentiality also does not prevent the researchers from disclosing voluntarily matters such as child abuse, or subject's threatened or actual harm to self or others. This could also include behaviors such as habitually driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. If this type of behavior is observed, we reserve the right to remove you from the study and inform the appropriate authorities of what we have observed. In most cases, we will notify you first of the behaviors we have observed prior to removing you from the study or informing others of our observations. If you are removed from the study, your compensation will be prorated based on the time you have already spent as a participant in the study.

The protections of the Certificate of Confidentiality described herein may not apply to passengers or drivers of the vehicle who have not consented to being in this study. For this reason, Informed Consent will be sought from all other adults who drive the vehicle, and these individuals will be protected by the Certificate of Confidentiality to the same degree as you are.

To summarize, your level of confidentiality in this study is as follows:

1. There will be video of your face and portions of your body. There will be audio recorded, but only for 30 seconds if you press the red incident button. The study also will collect health and driving data about you. The video, audio, and other data that personally identifies you, or could be used to personally identify you, will be held under a high level of security at one or more data storage facilities. Your data will be identified with a code rather than your name.
2. All data collected from other drivers who have not signed a consent form, will be deleted. No identifying information will be collected on passengers.
3. For the purposes of this project, only authorized project personnel, authorized employees of the project sponsors, and qualified research partners will have access to study data containing personally identifying information, or that could be used to personally identify you. The data, including face video which has been blurred, blacked out, or replaced by animation, may be shown at research conferences and by the research sponsors for the highway and road safety purposes identified above. Under no circumstances will your name and other personally identifying information be associated with the video clips.
4. The personally identifying data collected in this study may be analyzed in the future for other research purposes by this project team or by other qualified researchers in a secure environment. Such efforts will require those researchers to sign a data sharing agreement which will continue to protect your confidentiality, and will also require additional IRB approval. The confidentiality protection provided to you by these data sharing agreements will be as great as or greater than the level provided and described in this document. Research partners will not be permitted to copy raw data that identifies you, or that could be used to identify you, or to remove it from the secure facility in which it is stored except with your assent.
5. A Certificate of Confidentiality has been obtained from the National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify you, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your removal from the study and reporting of the behavior to the appropriate authorities. While your confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by you or others, you may be prevented by a court from raising certain claims or defenses unless you agree to waive the confidentiality protection.

WILL I RECEIVE PAYMENT FOR PARTICIPATING IN THIS STUDY?

Total payment for your participation in this research will be as follows, depending on the length of enrollment. You are scheduled to be enrolled for _____ months. You are required to provide a valid social security number in order to receive your first payment.

1. After you have been enrolled in the study (the vehicle has been prepared for our study and you have completed the enrollment process, including the online questionnaires), you will receive $100 via check or direct deposit.
2. After your enrollment is complete, and after you return to CUBRC to have the system removed from the vehicle and complete a few final questionnaires, you will receive any final payment due via check or direct deposit. The amount of this final payment will depend on your length of enrollment, as follows:
   a. Four months: $100 (study total of $200).
   b. Five months: $110 (study total of $210).
   c. Six months: $152 (study total of $252).
   d. Seven months: $194 (study total of $294).

If you discontinue your participation before the four month minimum enrollment, by your own choice, because the vehicle owner decides to withdraw their vehicle, or because you are asked to leave by someone on the study team, you will not receive any additional payment beyond your initial $100.

If you are asked to leave due to persistent tire pressure monitoring system problems, you will be paid $42 for each month or partial month of participation.

In addition, you will also be entered into a drawing for $1,000 paid in the same way as your other compensation. One $1,000 prize will be awarded every six months for every 150 drivers currently enrolled at your site, and you are guaranteed entry into the next scheduled drawing (next drawing date: _____, _____) even if your scheduled enrollment is less than six months.

WHAT ABOUT INSURANCE?

Please note that since you are driving your own vehicle or another vehicle with the owner's permission, neither study personnel nor their respective organizations are responsible for the expenses that are caused by a crash you may experience. In the event of a crash, you are **not** responsible for any damage to the data collection system that is installed into the vehicle.

Participants in a study are considered volunteers, regardless of whether they receive payment for their participation. Under New York state law, workers compensation does not apply to volunteers; therefore, the participants are responsible for their own medical insurance for bodily injury. Appropriate health insurance is strongly recommended to cover these types of expenses.

If you get hurt in a crash, whether in or out of an automobile, the medical treatment available to you would be that provided to any person by emergency medical services in the vicinity where the accident occurs.

The participant and their parents, guardians, or other party with standing agree that this agreement shall be construed in accordance with the laws of the Commonwealth of Virginia, notwithstanding any conflicts of law provisions. Further, any and all claims and/or actions against Virginia Tech or the Commonwealth of Virginia shall be brought in a court of the Commonwealth of Virginia.

AM I FREE TO WITHDRAW FROM THIS STUDY AT ANY TIME?

As a participant in this research, you are free to withdraw at any time without penalty. If you choose to withdraw, you will receive partial payment as described in the Payment for Participation section of this form. You **are free to choose not to answer any questions** or respond to any tests that you choose without penalty. If you withdraw or are dismissed from the study, or if the vehicle owner withdraws the vehicle from the study, we will retain data collected before the withdrawal/dismissal, but delete any data collected in the interval between when we become aware of the withdrawal/dismissal and before we are able to remove the data collection equipment. If you choose to end your participation in the study earlier than originally planned, we will need to schedule a time to remove the data collection system from the vehicle. You will not receive any final payment due until we have removed the instrumentation from the vehicle.

HAS THIS RESEARCH BEEN APPROVED?

Before this experiment begins, the research must be approved by the Institutional Review Board for research involving human subjects at Virginia Tech. The research has also been approved by the IRB for the National Academies of Science. You should know that this approval has been obtained and is valid through the date listed at the bottom of this form.

HOW DO I PROVIDE MY ASSENT?

I _____ (participant) have read and understand this assent form and conditions of participation. I understand what is being asked of me. My questions have been answered. I freely agree to participate and have not been coerced into participation. I understand that participation is voluntary and that I may withdraw at any time without penalty.

I certify that the owner, co-owner, or lessee of the vehicle has granted permission for the instruments and sensors to be installed in the vehicle. I certify that I hold a valid United States driver's license, and that the vehicle that will be used in the study has at least the minimum amount of liability insurance required by the state in which it is registered.

_____	_____	_____
Participant (Print Name)	Signature	Date
_____	_____	_____
Experimenter (Print Name)	Signature	Date

==========

Should I have any questions about this research or its conduct, I may contact:

Alan Blatt	CUBRC Site Principal Investigator	(716) ***-****-*****@cubrc.org
Jon Antin	Project Manager	(540) ***-****-*****@vtti.vt.edu
David Moore	Chair, Virginia Tech Institutional Review Board for the Protection of Human Subjects Office of Research Compliance 2000 Kraft Drive, Suite 2000 (0497) Blacksburg, VA 24060	(540) ***-****-*****@vt.edu

The Participant Must Be Provided With a Copy of This Consent Form.

APPENDIX O

Parental Consent Form

PERMISSION FORM FOR PARENTS OF MINOR PARTICIPANTS—VARIABLE ENROLLMENT PERIOD (4–7 MONTHS)

IN-VEHICLE DRIVING BEHAVIOR AND CRASH RISK STUDY

("The SHRP 2 Naturalistic Driving Study")

SPONSORS: **National Academies of Science, Transportation Research Board, SHRP 2 Program**

The United States Department of Transportation

INVESTIGATORS: Tom Dingus, Jon Hankey, Jon Antin, Suzie Lee, and Lisa Eichelberger:
Virginia Tech Transportation Institute

John Pierowicz, Alan Blatt, and Marie Flanigan:
Calspan University of Buffalo Research Center (CUBRC)

Ann Brach and Ken Campbell: National Academies, Transportation Research Board, SHRP 2 Program

WHAT IS THE PURPOSE OF THIS RESEARCH?

The Naturalistic Driving Study is a large research effort directed at improving Highway Safety in the United States where more than 30,000 people are killed and 2 million are injured every year in highway-related accidents. The study will help researchers gain a deeper understanding of the interaction between the driver, vehicle and roadway and lead to safer roadways, vehicles, and driver training programs. The SHRP 2 Naturalistic Driving Study will look at how people normally drive by installing cameras and sensors in people's own vehicles. The study is being conducted at six locations across the United States with up to 3,300 participants. Length of enrollment varies from four months to two years. Your child's enrollment is scheduled to last _____ months. About 370 participants will be minors.

WHAT SHOULD I KNOW BEFORE DECIDING TO HAVE MY CHILD PARTICIPATE?

1. You are providing permission for us to collect data (including video) whenever your child's study vehicle is used or whenever your child happens to drive another vehicle that is part of the study (for example, a vehicle owned by a friend who also happens to be in the study). If there are drivers of your child's study vehicle who have not signed consent forms, we delete their data from every trip in which they drove the vehicle. If neither you nor your child owns or leases the study vehicle, you will have to obtain the owner's written permission to use the vehicle before your child enrolls in the study.
2. There will be video of your child's face and portions of your child's body and the roadway. Audio will not be recorded unless your child presses a red incident button. The video, audio, and other data that personally identifies your child, or could be used to personally identify your child, will be held under a high level of security at one or more data repositories.

Your child's data will be identified with a code rather than your child's name. Finally, only qualified researchers will be authorized to have access to data that personally identifies your child, or can be used to personally identify your child, and the level to which they have access will be based on their level of authorization.

3. No identifying information will be collected on passengers.
4. For the duration of the project you and/or your child or the owner of the vehicle used in the study will be responsible for insurance coverage. If your child is in a crash, we ask that he/she please contact emergency services as he/she normally would. We will then ask for more information, as detailed below.
5. Your child may withdraw from the study at any time. If your child does withdraw from the study before the scheduled end date, you and your child must agree to allow us to retrieve the data collection system from the vehicle as soon as is feasible.

WHAT WILL MY CHILD HAVE TO DO IF I CHOOSE TO ALLOW HIM/HER TO PARTICIPATE?

The study involves a _____ month data collection effort in which a data collection system containing sensors and cameras will be installed in the vehicle to record a variety of driving measures. As a participant, your child will complete the following activities:

1. Have the vehicle equipped (see the section below: "What will my child have to do to get the vehicle equipped for the study?").
2. Drive as he/she normally would.
3. We will ask your child to provide us with contact information for all other adult drivers (over the age of 18) who drive the vehicle at least once a week. We would like to contact him/her to get permission to use data collected any time he/she happens to be driving the vehicle. We will also ask him/her to fill out two brief questionnaires and provide a reference picture to allow us to identify when they are driving.
4. If requested, allow your child to make an appointment to allow us to maintain the equipment or collect the driving data from the vehicle. Only one appointment is anticipated during your child's enrollment period. Appointments will typically take 15 minutes but could take up to one hour. They will be scheduled to take place at a location that is convenient for your child such as your home, work, school, or at a local shopping mall. Your child will not need to do anything at an appointment apart from providing access to the trunk or interior of the vehicle; a trained technician will handle everything else.
5. If your child is enrolled in the study at the time of his/her 18th birthday, we will contact him/her to change from an informed assent form to an informed consent form.
6. While your child is in the study, we ask that he/she not drive the vehicle into any areas where cameras are not allowed, including any international border crossings, military bases, or similar facilities.
7. Advise other drivers of the video and audio equipment installed in the vehicle and ask them not to drive into areas where cameras are not allowed. Let these other drivers know that data will be collected when they drive the vehicle but will only be retained and analyzed if they sign a consent form. If they do not sign a consent form, then the data will be deleted for every trip in which they drove the vehicle.

WHAT WILL MY CHILD HAVE TO DO TO GET THE VEHICLE EQUIPPED FOR THE STUDY?

1. If you or your child do not own or lease the study vehicle, you must first obtain the written permission of the vehicle owner. This can be provided on the day your child enrolls in the study by one of two methods: 1) the owner attends and signs the form in person, or 2) via a telephone call in which a third person at the study site will witness and sign the owner's permission form on behalf of the owner. We cannot accept pre-signed owner permission forms in which we have not had personal or telephone contact with the vehicle owner.
2. Bring the vehicle to CUBRC at the scheduled day and time to have the data collection system installed. The technicians will strive to complete each vehicle in less than four (4) hours, but it may take longer in rare cases. The system will require a connection to the vehicle power and the vehicle network box. These connections will provide additional data as well as power for the system; by agreeing to have your child participate, you are providing us permission to get information from the vehicle network as well as to install new sensors. Before we begin installation, we will show your child where we will place the system and also show your child pictures of what the completed installation will look like. The vehicle will be returned to its original state when his/her participation is concluded.

3. While the system is being installed on the vehicle, he/she will be provided a comfortable area in which to complete the consent process and testing at CUBRC, which should take about 2–3 hours. Specifically, your child will be asked to:
   a. Provide us with proof of a valid U.S. driver's license, proof of vehicle insurance, and proof of ownership (vehicle registration showing the name of the owner or lessee of the vehicle so that we may confirm that we have correctly obtained the permission of the vehicle's owner).
   b. Review and sign an informed assent form with the same information provided in this consent form.
   c. Undergo about 20 minutes of non-invasive vision tests, performed on a computer monitor and a machine that your child will look into but that will not touch or blow air into his/her eyes.
   d. Take about 30 minutes of computer tests that will assess your child's memory, decision making, and attention skills, none of which require previous computer skill or knowledge.
   e. Take a 2 minute memory and attention test using pencil and paper and the following two tests of your child's body movements and strength.
      i. Your child will be asked to walk as fast as he/she can without falling or tripping to a point 10 feet away, and then to return to the starting point. This should take about one minute.
      ii. Your child will be asked to sit down and squeeze a device that measures grip strength. This should also take about two minutes.
   f. Fill out nine (9) questionnaires on a computer (some may be completed online from home later, if your child prefers). The questionnaires vary in length and take between 5 and 15 minutes each to complete. They contain questions about: your child's health history and health status; driving behavior, history and knowledge. Your child will be asked to fill out one or more final questionnaires after completing his/her participation in the study.
   g. Take home and give copies of an Informed Consent form and questionnaires to any adult drivers who drive the vehicle at least once a week.
4. Allow our technicians to drive the vehicle as needed during the installation and testing process.
5. When the vehicle is ready, we will show your child the data collection system and provide him/her with information about who to contact if he/she has any vehicle problems that could be related to the data collection system, or if he/she notices any maintenance issues with the system (for example, a camera or device that comes loose).
6. We will take some reference pictures of your child in the vehicle so that software can be used to identify him/her as the driver.

WHAT DOES MY CHILD DO AFTER THE VEHICLE IS EQUIPPED FOR THE STUDY?

1. After your child returns home, he/she will be asked to complete any questionnaires he/she did not have time to complete during installation of the data collection system into the vehicle. Once your child has completed all of the online questionnaires, he/she will receive his/her first payment of $100 via a mailed check.
2. Drive as he/she normally would for the duration of his/her enrollment.
3. If your child is in a crash while in the study, we ask that your child do five things (in the following order):
   a. Seek emergency help the way that he/she normally would.
   b. If possible, press an incident button that is located near the rear view mirror to describe the incident. The system will then record your child's brief description. He/she will know the button is working if the red light comes on when he/she presses it.
   c. Call us at (716) 204-5138 or (716) 204-5177 to notify us as soon as it is safe to do so.
   d. Allow a member of the research team to interview him/her about the crash if we decide that your child's crash should be investigated in more detail. This interview would ideally take place soon after the crash, but only when your child is comfortable and able to do so.
   e. Allow us to have access to the police accident report, if any, which results from the crash.
4. We anticipate making an appointment with your child to collect the driving data from the vehicle or to maintain the equipment. An appointment will typically take about 15 minutes, but could take up to one hour depending on what needs to be done. It will be scheduled to take place at a location that is convenient for your child such as his/her home, work, school, or at a local shopping mall. Your child will not need to be in the vehicle when the data are collected, but he/she will need to provide us with access to the trunk or interior of the vehicle. As mentioned above, we also will collect data from the vehicle after a crash, either at a place of your child's choosing or where the vehicle was towed.
5. If your child is enrolled in the study at the time of his/her 18th birthday, we will contact him/her to change from an informed assent form to an informed consent form.

6. Let us know if you or your child notices any unusual warning light activity, for example, warning lights that go on or off.
7. While your child is in the study, we ask that he/she not drive the vehicle into any areas where cameras are not allowed, including any international border crossings.
8. If we notice a new person driving the vehicle, we may contact your child to find out if your child has already asked them about participating in the study.

WHAT HAPPENS WHEN THE STUDY IS OVER?

1. After _____ months, your child will be asked to return to CUBRC so that we may remove the system from the vehicle. While the vehicle is being worked on, we will ask him/her to fill out some final questionnaires. This process is expected to take about two hours. After this session is complete, your child will receive his/her final payment via check or direct deposit.
2. If your child is 18 years or older when he/she leaves the study, we may ask him/her whether we can keep his/her contact information to contact him/her for participation in future follow-on studies. This will be optional, and if your child does not agree, we will delete his/her contact information one year after data collection is complete at CUBRC.
3. Once we have all the data, we will begin data analysis and reporting. It is likely that you and your child will see references to the results of the study in the news or elsewhere. However, these reports will not identify participants by name, nor will personally identifying video be shown.

WHAT ARE THE RISKS OF PARTICIPATING IN THIS STUDY?

The operation or drivability of the vehicle should not be affected by the instrumentation, and thus carries a similar risk as when your child operates the vehicle normally. However, if your child violates state or local driving laws (such as driving under the influence, exceeding posted speed limits, or driving while distracted), the instrumentation could record evidence of these violations. This has the potential to pose greater than minimal risk of legal harm. A variety of strategies and procedures have been developed to reduce the potential for legal or economic harms. These strategies include encrypting the data obtained by sensors and cameras, using a code number to identify your child with the code key maintained in a secure location, and obtaining a Certificate of Confidentiality. More details on these strategies are provided below.

All data collection equipment is mounted such that, to the greatest extent possible, it does not pose a hazard or problem for your child when he/she drives. None of the data collection equipment should get in the way of your child's normal field of view. Your child is not being asked to change the way he/she drives or where he/she drives, except for his/her visits to CUBRC at the beginning and end of the study.

In the vast majority of cases, placing the data collection system in the vehicle will not affect the operating or handling characteristics of the vehicle. In some rare cases, the electromagnetic signals generated by the data collection system may cause interference with the vehicle's radio, keyless entry key fob, or other electronic components or sensors, such as the tire pressure monitoring system. If this happens in your child's vehicle, CUBRC will use engineering countermeasures to attempt to minimize the interference to an unnoticeable level. If your child experiences persistent tire pressure monitoring system problems, your child will be asked to leave the study, while for other problems, your child will be given the option to continue participation with the problem unresolved or to leave the study. If your child likes, CUBRC personnel can provide information on our latest experience (a rough likelihood) of this problem occurring with your child's particular vehicle make, model, year, and equipment package.

There are non-driving risks resulting from participation. Five cameras will be placed in the vehicle. If he/she drives into an area where cameras are not allowed, including international border crossings, certain military and intelligence locations, and certain manufacturing plants, there is a risk that your child may be detained or arrested or that the vehicle may be impounded. For this reason, by signing the Informed Assent and thereby agreeing to participate in the study, your child is also agreeing not to drive into any such areas while he/she is in this study. We have provided a letter for the glove box which can be used to explain the vehicle's role in the study while still maintaining your child's privacy and keeping confidential his/her role in the study.

Throughout the study, we will take all possible steps to protect your child's privacy and keep confidential his/her role in the study and the confidentiality of his/her personally identifying information. To help us protect your child's privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify your child, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as

child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your child's removal from the study and reporting of the behavior to the appropriate authorities. In the event of a crash, it may not be possible to prevent the equipment and the data from falling into the hands of the police or an insurance company; if this happens, however, the data are still encrypted and inaccessible and unreadable to these individuals.

However, you and your child, too, are responsible for taking steps to protect your child's privacy. Do not post or disclose your child's participation on any public forum including websites, Facebook, newspapers, radio and television. Protect your child's role in the study the same way that you protect other personal and private information. If you do not keep confidential your child's role in the study, there is a risk that some of the data collected during the study, including your child's personally identifying information, may be used against him/her in a court case or other legal proceeding.

The risk to your child of completing the pre-collection questionnaires and tests while the data collection equipment is being installed in the vehicle is no more than when he/she is doing activities in his/her daily life like filling in forms, walking, squeezing his/her hand, and working at a computer. The assessment component involves filling in forms, standard vision tests, and standard computer-based tests. It is believed that there are no more than minimal risks involved with such activities. In addition, your child will be asked to squeeze a grip strength tester and to rapidly walk 10 feet back and forth as fast as he/she can without running or falling. The risk with using the grip strength tester is brief hand soreness. The main risk with the Rapid Pace Walk is falling if he/she tries to go too fast. Because the assessment process may take 2 or 3 hours, your child may get tired, but he/she can also take breaks as needed.

If you (or you child) are not the owner, co-owner, or lessee of the vehicle, there is a risk that the owner may decide to withdraw the vehicle from the study earlier than your child's planned term of enrollment. If this occurs, your child will only be compensated for the portion of time he/she was enrolled in the study.

WHAT ARE THE BENEFITS OF PARTICIPATING IN THIS STUDY?

While there are no direct benefits to your child from this research, he/she may find this study interesting. No promise or guarantee of benefits is being made to encourage your child's participation. Participation will help to improve the body of knowledge regarding driving behavior and safety. Participation may also help us design safer vehicles and roadways in future years.

HOW WILL MY CHILD'S DATA BE KEPT CONFIDENTIAL AND SECURE AND WHO WILL HAVE ACCESS TO MY CHILD'S DATA?

Any data collected during this study that personally identifies your child or that could be used to personally identify your child will be treated with confidentiality. As soon as your child begins participating in this study, his/her name and other identifying information will be separated from the raw data collected while your child drives the vehicle and replaced with a number. That is, your child's raw data will not be attached to his/her name, but rather to a number (for example, Driver 0011). The raw data collected while your child drives the vehicle will be encrypted (made unreadable) from the moment it is collected until it is transferred to one or more secure central storage locations. Your child's name also will be separated from any data about him/her, either provided by him/her in response to questionnaires or gathered by researchers during the study, including crash investigation data, and will be replaced by the same driver number (for example, Driver 0011). YOU WILL NOT HAVE ACCESS TO YOUR CHILD'S DATA RESULTING FROM THIS STUDY. However, if we have reason to believe that your child is an imminent or ongoing danger to themselves or others, we may notify you of our findings regarding your child.

Several types of information and data about your child and the study vehicle will be collected during the study:

1. **Contact information** includes your child's name, address, email address, phone numbers, and similar information used to contact your child when needed. It will be stored securely in electronic form during the course of the study and destroyed after the study is complete (unless your child grants permission for us to keep his/her contact information when the study is over). This information will not be linked to or mingled with your child's study data, and will not be used in any research or analysis.
2. **Auxiliary study information** includes your child's Social Security Number, license plate number, bank account information (for those using direct deposit) and similar information. This information is used to verify your child's identity and to make payments for his/her participation. This information will be stored at the site in electronic form (securely encrypted)

and destroyed after the study is complete. This information will not be linked to or mingled with your child's study data, and will not be used in any research or analysis.

3. **Driver data** includes your child's answers to questionnaires, vision test results, and the results of the brief physical tests described above. This data will not contain your child's name or any identifying information and will be used in analyses, both on its own and in combination with the driving data, vehicle data, and additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).
4. **Vehicle data** includes the vehicle make and model, its condition, and how it is equipped. This data will not contain your child's name or any identifying information and will be used in analyses, both on its own and in combination with the driver data, driving data, and additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).
5. **Driving data** includes the data we collect from the vehicle while he/she is driving, including video data and sensor data. This information will contain video of your child's face and GPS coordinates of his/her trips, both of which could be used to personally identify him/her. These data will be encrypted (stored in an unreadable format) from the moment of their creation until they are downloaded from the vehicle, transferred to a secure data storage facility, and verified. From this point on they will be decrypted (made readable) on as as-needed basis for each analysis. These data will be used for analysis, both on their own and in combination with the driver data, the vehicle data, and the additional crash data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).
6. **Additional crash data** includes items we may collect after a crash, including answers to an interview with one of our researchers and the police accident report resulting from the crash. This data will not contain your child's name or any identifying information and will be used in analyses, both on its own and in combination with the driver data, vehicle data, and driving data. This data will be stored securely in electronic form throughout the lifetime of the data (defined below).

It is possible that an authorized Institutional Review Board (IRB) may view this study's collected data for auditing purposes. An IRB is responsible for the oversight of the protection of human subjects involved in research.

It is also possible that the study sponsors or investigators may view this study's driver data and driving data for quality control or administrative purposes; in this case, the study sponsors or investigators will be required to maintain the security and confidentiality of any data that personally identifies study participants or that could be used to personally identify study participants.

While driving the vehicle, a camera will videotape your child's face with some added space around the head to handle any head movements. An example is shown below. Also, video cameras will capture views of the forward view, the rear view, an external view to the right, as well as a dashboard/lap-belt view. A camera will also periodically take a permanently blurred snapshot of the vehicle interior which will allow researchers to count the number of passengers and make rough estimates of age, gender, and seatbelt use. Passenger identification will not be possible from these blurred snapshots. All video will be captured and stored in digital format (no tape copies will exist).

There will also be an ambient atmospheric analyzer that is capable of detecting the presence of alcohol in the passenger compartment under certain conditions. It may not be able to distinguish whether the alcohol was imbibed or applied (as in hand sanitizer), and it will be unable to determine whether it is emanating from the driver or a passenger. However, this sensor will flag the data for possible indications of impaired driving.

If a safety-related incident or crash occurs, we will ask your child to press a button on the unit mounted near the rearview mirror. He/she will know this button is working if a red light appears when he/she presses it. This will allow researchers to find the incident in the database after the data have been collected. Also, pressing the button starts a microphone for 30 seconds. During these 30-seconds, your child can tell us what happened. No audio will be captured except when he/she presses this incident button. Please note that pressing this button does NOT make a phone call, unlike OnStar™. It simply records your child's voice in an audio file that remains in the vehicle until the data is collected.

During the data collection phase of this study, all data collected from the vehicle will be encrypted (made unreadable) from the time of its creation and then stored in a specific password-protected project folder on a secure server; the driving data will only be decrypted (made readable) once it has been stored in this folder. At the conclusion of the collection phase of this study, the driver data, driving data, and additional crash data will be permanently housed at one or more highly secure data storage facilities. One set of data will be permanently housed at Virginia Tech under the supervision of the Virginia Tech Transportation

Institute, the organization overseeing the data collection for the entire study. It is possible that, after data collection is complete, one copy of study data will be transferred to the U.S. Department of Transportation (or other secure facilities as determined by the Transportation Research Board) for permanent storage and oversight.

Only authorized project personnel and authorized employees of the research sponsors will have access to study data that personally identifies your child or that could be used to personally identify your child. As explained below, other qualified research partners may be given limited access to your child's driver data, vehicle data, driving data, and additional crash data, solely for authorized research purposes and with the consent of an IRB. This limited access will be under the terms of a data sharing agreement or contract that, at a minimum, provides your child with the same level of confidentiality and protection provided by this Consent Form. However, even these qualified researchers will not be permitted to copy raw study data that identifies your child, or that could be used to identify your child, or to remove it from the secure facilities in which it is stored without your consent and your child's assent (if your child is younger than 18) or without your child's consent (if your child is 18 years or older).

Project personnel, the project sponsors and qualified, authorized research partners may show specific clips of video at research conferences. The project sponsors also may show specific clips of video to the media, driver's education teachers and students, and others involved in efforts to improve highway and road safety. The face portion of the video will be blurred, blacked out, or replaced with an animation for these purposes. Your child's name and other personally identifying information will never be associated with the showing of these video clips. Identifying location information will not be shown in association with these video clips.

It is expected that the data we capture throughout the course of the entire study, including that from all the approximately 3,300 primary participants, will be a valuable source of data on how drivers respond to certain situations and how the roadway and vehicle might be enhanced to improve driver safety. Researchers who study traffic congestion and traffic patterns may also find the data useful. Therefore, it is expected that there will be follow-on data analyses using all or part of the data for up to 30 years into the future. These follow-on analyses will be conducted by qualified researchers with IRB approval, as required by law, who may or may not be part of the original project team. In consenting to this study, you are consenting and your child is assenting to future research uses of the information and videos we gather from him/her, consistent with the protections described above and elsewhere in this document.

If your child is involved in a crash while participating in this study, the data collection equipment in the study vehicle will likely capture the events leading up to the event. Your child is under NO LEGAL OBLIGATION to voluntarily mention the data collection equipment or his/her participation in this study at the time of a crash or traffic offense. We have provided a letter, which your child should keep in the glove box for these cases. The letter describes the vehicle's role in the study without identifying your child as a participant in the study.

Because the vehicle camera system is storing continuous video, it may capture some incriminating evidence if an at-fault collision should occur. To help us protect your child's privacy, we have obtained a Certificate of Confidentiality from the U.S. Department of Health and Human Services National Institutes of Health. With this Certificate, neither the researchers nor study sponsors can be forced to disclose information that may identify your child, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. Identifying information for the purposes of this study includes your child's contact information, your child's auxiliary study information, your child's driving data (including video

of his/her face and GPS coordinates which may identify his/her home, work, or school locations), or any information in your child's driver data, vehicle data, or additional crash data that could be used to personally identify him/her. While your child's confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by your child or others, your child may be prevented by a court from raising certain claims or defenses unless he/she agrees to waive the confidentiality protection. The researchers and study sponsors will use the Certificate to resist any demands for information that would identify your child, except as explained below.

The Certificate cannot be used to resist a demand for information from personnel of the United States Government that is used for auditing or evaluation of federally funded projects or for information that must be disclosed in order to meet the requirements of the federal Food and Drug Administration (FDA).

This Certificate of Confidentiality does not mean that the Federal government endorses this study. You and your child should understand that a Certificate of Confidentiality does not prevent your child or a member of your child's family from voluntarily releasing information about your child or his/her involvement in this research. If an insurer, employer, or other person obtains your written consent and your child's written assent to receive research information, then the researchers may not use the Certificate to withhold that information. If you (or your child) are not the vehicle owner, you should know that the vehicle owner will not have access to your child's data.

The Certificate of Confidentiality also does not prevent the researchers from disclosing voluntarily matters such as child abuse, or subject's threatened or actual harm to self or others. This could also include behaviors such as habitually driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. If this type of behavior is observed, we reserve the right to remove your child from the study and inform the appropriate authorities of what we have observed. In most cases, we will notify your child first of the behaviors we have observed prior to removing your child from the study or informing others of our observations. If your child is removed from the study, his/her compensation will be prorated based on the time he/she has already spent as a participant in the study.

The protections of the Certificate of Confidentiality described herein may not apply to passengers or drivers of the vehicle who have not consented to being in this study. For this reason, Informed Consent will be sought from all other adults who drive the vehicle, and these individuals will be protected by the Certificate of Confidentiality to the same degree as your child.

To summarize, your child's level of confidentiality in this study is as follows:

1. There will be video of your child's face and portions of your child's body. There will be audio recorded, but only for 30 seconds if your child presses the red incident button. The study also will collect health and driving data about your child. The video, audio, and other data that personally identifies your child, or could be used to personally identify your child, will be held under a high level of security at one or more data storage facilities. Your child's data will be identified with a code rather than his/her name.
2. All data collected from other drivers who have not signed a consent form will be deleted. No identifying information will be collected on passengers.
3. For the purposes of this project, only authorized project personnel, authorized employees of the project sponsors, and qualified research partners will have access to study data containing personally identifying information, or that could be used to personally identify your child. The data, including face video which has been blurred, blacked out, or replaced by animation, may be shown at research conferences and by the research sponsors for the highway and road safety purposes identified above. Under no circumstances will your child's name and other personally identifying information be associated with the video clips.
4. The personally identifying data collected in this study may be analyzed in the future for other research purposes by this project team or by other qualified researchers in a secure environment. Such efforts will require those researchers to sign a data sharing agreement which will continue to protect your child's confidentiality, and will also require additional IRB approval. The confidentiality protection provided to your child by these data sharing agreements will be as great as or greater than the level provided and described in this document. Research partners will not be permitted to copy raw data that identifies your

child, or that could be used to identify your child, or to remove it from the secure facility in which it is stored except with your consent and your child's assent (if your child is younger than 18) or without your child's consent (if your child is 18 years or older).

5. A Certificate of Confidentiality has been obtained from the National Institutes of Health. With this Certificate, the researchers and study sponsors cannot be forced to disclose information that may identify your child, even by a court subpoena, in any federal, state, or local civil, criminal, administrative, legislative, or other proceedings. However, the Certificate of Confidentiality does not prevent the researchers from disclosing voluntarily matters such as child abuse, or a participant's threatened or actual harm to self or others. In terms of a vehicle, this could also include items such as driving under the influence of drugs or alcohol, allowing an unlicensed minor to drive the vehicle, or habitually running red lights at high speed. Such behaviors may result in your child's removal from the study and reporting of the behavior to the appropriate authorities. While your child's confidentiality is protected in most cases by the Certificate, you should know that in some rare instances involving alleged improper conduct by your child or others, your child may be prevented by a court from raising certain claims or defenses unless your child agrees to waive the confidentiality protection.

WILL MY CHILD RECEIVE PAYMENT FOR PARTICIPATING IN THIS STUDY?

Total payment for your child's participation in this research will be as follows, depending on the length of enrollment. Your child is scheduled to be enrolled for _____ months. Your child is required to provide a valid social security number in order to receive his or her first payment.

1. After your child has been enrolled in the study (the vehicle has been prepared for our study and your child has completed the enrollment process, including the online questionnaires), your child will receive $100 via check or direct deposit.
2. After your child's enrollment is complete, and after your child returns to CUBRC to have the system removed from the vehicle and complete a few final questionnaires, your child will receive any final payment due via check or direct deposit. The amount of this final payment will depend on your child's length of enrollment, as follows:
   a. Four months: $100 (study total of $200).
   b. Five months: $110 (study total of $210).
   c. Six months: $152 (study total of $252).
   d. Seven months: $194 (study total of $294).

If your child discontinues participation before the four month minimum enrollment, by his or her own choice, because the vehicle owner decides to withdraw their vehicle, or because he or she is asked to leave by someone on the study team, your child will not receive any additional payment beyond the initial $100.

If your child is asked to leave due to persistent tire pressure monitoring system problems, your child will be paid $42 for each month or partial month of participation.

In addition, your child will also be entered into a drawing for $1,000 paid in the same way as your child's other compensation. One $1,000 prize will be awarded every six months for every 150 drivers currently enrolled at your child's site, and your child is guaranteed entry into the next scheduled drawing (next drawing date: _____, _____) even if your child's scheduled enrollment is less than six months.

WHAT ABOUT INSURANCE?

Please note that since your child is driving his/her own vehicle or another vehicle with the owner's permission, neither study personnel nor their respective organizations are responsible for the expenses that are caused by a crash your child may experience. In the event of a crash, your child is not responsible for any damage to the data collection system that is installed into the vehicle.

Participants in a study are considered volunteers, regardless of whether he/she receives payment for his/her participation. Under New York state law, workers compensation does not apply to volunteers; therefore, the participants are responsible for his/her own medical insurance for bodily injury. Appropriate health insurance is strongly recommended to cover these types of expenses.

If your child gets hurt in a crash, whether in or out of an automobile, the medical treatment available to your child would be that provided to any person by emergency medical services in the vicinity where the accident occurs.

The participant and their parents, guardians, or other party with standing agree that this agreement shall be construed in accordance with the laws of the Commonwealth of Virginia, notwithstanding any conflicts of law provisions. Further, any and all

claims and/or actions against Virginia Tech or the Commonwealth of Virginia shall be brought in a court of the Commonwealth of Virginia.

IS MY CHILD FREE TO WITHDRAW FROM THIS STUDY AT ANY TIME?

As a participant in this research, your child is free to withdraw at any time without penalty. If your child chooses to withdraw, he/she will receive partial payment as described in the Payment for Participation section of this form. Your child **is free to choose not to answer any questions** or respond to any tests that he/she chooses without penalty. If your child withdraws or is dismissed from the study or if the vehicle owner withdraws the vehicle from the study, we will retain data collected before the withdrawal/dismissal, but delete any data collected in the interval between when we become aware of the withdrawal/dismissal and before we are able to remove the data collection equipment. If your child chooses to end participation in the study earlier than originally planned, we will need to schedule a time to remove the data collection system from the vehicle. Your child will not receive any final payment due until we have removed the instrumentation from the vehicle.

HAS THIS RESEARCH BEEN APPROVED?

Before this experiment begins, the research must be approved by the Institutional Review Board for research involving human subjects at Virginia Tech. The research has also been approved by the IRB for the National Academies of Science. You should know that this approval has been obtained and is valid through the date listed at the bottom of this form.

HOW DO I PROVIDE MY CONSENT?

I _____ (parent of minor participant) have read and understand this consent form and conditions of my child's participation. I certify that I am the parent or legal guardian of a minor participant in the SHRP 2 Naturalistic Driving Study. As such, I certify that I have legal standing to consent to my child's participation in this study. I understand what is being asked of my child. My questions have been answered. I freely agree to allow my child to participate and certify that neither he/she nor I have been coerced into participation. I understand that my child's participation is voluntary and that my child may withdraw at any time without penalty.

I certify that either I (or my child) is the owner, co-owner, or lessee of the vehicle that will be used in the study and that I am permitting the instruments and sensors to be installed in the vehicle or that I have obtained the vehicle owner's written permission to do so. If I lease my vehicle, I certify that I have carefully reviewed my lease agreement to be sure that the installation of the instruments and sensors is allowed under the terms of my lease. I certify that my child holds a valid United States driver's license, and that the vehicle that will be used in the study has at least the minimum amount of liability insurance required by the state in which it is registered.

_____	_____	_____
Parent of Minor Participant (Print Name)	Signature	Date
_____	_____	_____
Experimenter (Print Name)	Signature	Date

==========

Should I have any questions about this research or its conduct, I may contact:

Alan Blatt	CUBRC Site Principal Investigator	(716) ***-****-*****@cubrc.org
Jon Antin	Project Manager	(540) ***-****-*****@vtti.vt.edu
David Moore	Chair, Virginia Tech Institutional Review Board for the Protection of Human Subjects Office of Research Compliance 2000 Kraft Drive, Suite 2000 (0497) Blacksburg, VA 24060	(540) ***-****-*****@vt.edu

The Parent of the Minor Participant Must Be Provided With a Copy of This Permission Form.

APPENDIX P

Site Readiness Checklist

DRAFT SHRP 2 S07 Site Readiness Inspection Checklists

Site Contractor/State: _____

S06 Personnel: _____

SHRP Staff: _____

Inspection Date: ___/___/_____

Recommendation & Remediation

☐ **Site Approved**

☐ **Remediation Measures Required–See bulleted items below** **Date Required**

- Area Item
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-
- (Attach additional sheets or documentation as necessary)

General Facilities

Yes	No	Item
☐	☐	Approved Federal Wide Assurance on file w/ U.S. Dept. of H&HS
☐	☐	Clear site identification signage
☐	☐	Facility/environment should be/feel safe for participants and S07 personnel
☐	☐	Convenient, well-marked parking with spots for visitors
☐	☐	Clean and appealing facility (e.g., comfortable waiting area, plants, water cooler or fountain, magazines and/or television available)
☐	☐	Restrooms clean and easily accessible from all participant areas
☐	☐	Adequate climate control (heat or air conditioning as appropriate)
☐	☐	Electricity (working outlets) available
☐	☐	Waiting area separated from intake area (two rooms, or one room with dividers)
☐	☐	Method of quickly relaying information to/from all site areas/facilities (i.e., via text message, e-mail, intercom, phone, or other)
☐	☐	Wheelchair (recommended)
☐	☐	Staging server connected to high speed Internet access
☐	☐	SSD docking bay for uploading vehicle data to staging server
☐	☐	High-speed Internet access well-connected to either National LambdaRail or Internet2 IP networks and capable of sustained 100Mb/sec (megabit/second) throughput with capacity for bursts of 200–300Mb/sec from S07 to S06
☐	☐	Phone line/Response plan for the Glove Box Letter and related calls

Participant Intake Area

Yes	No	Item
☐	☐	Adequate seating, desk, lighting
☐	☐	Arranged for reasonable privacy (e.g., those in waiting area cannot see or hear conversations or tasks in assessment area)
☐	☐	Must have a designated secure area to store consent forms and other paper data as necessary
☐	☐	Method to show Informed Consent video

Participant Assessment Area

Yes	No	Item
		Space
☐	☐	If arranged to allow for more than one participant at a time, adequate privacy must be insured (computer monitors facing the wall rather than interior of the room, dividers, etc.)
☐	☐	15 feet of open, non-corridor space, with 10 ft distance clearly marked on floor (e.g., with tape) within sight of assessment computer to administer Rapid Pace walking test (with level floor absent of any apparent/ obvious tripping/slipping hazards)
		Storage
☐	☐	Tools and materials
☐	☐	Standard Office Lighting
		Data/Resource Access
☐	☐	Communications – Internet (Ethernet/Wireless)
☐	☐	Mission Control Software – Mozilla Firefox
☐	☐	Issue Management (RT)
☐	☐	SHRP 2 NDS website
		Equipment
☐	☐	Basic office equipment, including comfortable chair(s)
☐	☐	Chair with no arm rests (for grip strength test)

		—Custom equipment
☐	☐	—Optec 6500 P
☐	☐	—Jamar hand dynamometer (model 5030J1)
☐	☐	—Touch screen monitor
☐	☐	—Bar code reader(s): 1 per assessment computer
☐	☐	—All-in-one scanner/copier/printer, connected
		—Software
☐	☐	—Driving Health Inventory (DHI) loaded on Assessment Computer
☐	☐	—Connor's Continuous Performance II (CPT II) loaded on Assessment Computer
☐	☐	—Easy Street Draw

Garage/Shop Area

Yes	No	Item
		Space
☐	☐	1 bay per 150 vehicles
☐	☐	Minimum bay size: approximately 38′ × 13′ × standard ceiling height
☐	☐	Level garage floor
☐	☐	Shipping and receiving area
☐	☐	Restroom access
		Storage
☐	☐	Vehicles
☐	☐	DAS storage: 10′ × 10′ (or equivalent) secure, unshared area with shelving
☐	☐	Equipment
☐	☐	Components
☐	☐	Supplies
☐	☐	Tools
		Infrastructure
☐	☐	Electricity
☐	☐	Water
☐	☐	Exhaust evacuation or CO monitor
☐	☐	Lighting
		Data/Resource access
		—Automotive repair references, such as:
☐	☐	—Online database: alldata.com
☐	☐	—S06 wiki
		—Computer-related
☐	☐	—Installation/field service laptop: 2 per 150 vehicles
☐	☐	—Bar code readers: 2 per 150 vehicles
☐	☐	—High speed Internet access
		Equipment
☐	☐	Basic automotive tools
		—Hand tools:
☐	☐	—Screwdrivers
☐	☐	—Side cutters
☐	☐	—Metric and imperial wrenches
☐	☐	—Metric and imperial sockets
☐	☐	—Pliers
☐	☐	—Trim removal tools
☐	☐	—Allen wrenches
☐	☐	—Torx drivers

—Other Tools & Materials

- ☐ ☐ Flashlights/shop lights
- ☐ ☐ Multi-meter
- ☐ ☐ Electric driver
- ☐ ☐ Tread depth gauge (Mscdirect.com part number 72461221)
- ☐ ☐ Tire Pressure gauge (Mscdirect.com part number 00576835)
- ☐ ☐ Cleaning supplies (isopropyl wipes, clean rags, tape primer)
- ☐ ☐ Specified cabin baffle for capturing night reference images

—Custom tools/fixtures:

- ☐ ☐ —Vehicle alignment panel
- ☐ ☐ —Head Unit alignment tool
- ☐ ☐ —Radar alignment lasers
- ☐ ☐ —Installer installation key (one per technician)
- ☐ ☐ —Battery tester
- ☐ ☐ —Industrial Velcro
- ☐ ☐ —Cutting razor blades

Standard equipment

- ☐ ☐ Battery charger
- ☐ ☐ Floor jack

Other

- ☐ ☐ Digital camera
- ☐ ☐ Garage area convenient for participant access

APPENDIX Q

Original Eligible Vehicle List

Original Eligible Vehicle List

Year	Make	Model	Powertrain	Year	Make	Model	Powertrain	Year	Make	Model	Powertrain
2007–2009	Acura	MDX	Gas	2008–2010	Ford	Taurus	Gas	2007–2010	Mercury	Mariner	Hybrid
2007–2009	Buick	Enclave	Gas	2007–2010	GMC	Acadia	Gas	2006–2010	Mercury	Milan	Gas
2009–2010	Buick	Lucerne	Gas	2008–2009	GMC	Sierra	Gas	2010	Mercury	Milan	Hybrid
2009–2010	Cadillac	DTS	Gas	2007–2010	GMC	Yukon	Gas	2006–2007	Mercury	Montego	Gas
2009–2010	Cadillac	Escalade	Gas	2008–2010	Honda	Accord	Gas	2008–2010	Mercury	Sable	Gas
2007–2010	Chevrolet	Equinox	Gas	2006–2010	Honda	Civic	Gas	2002–2010	Nissan	Altima	Gas
2006–2010	Chevrolet	Impala	Gas	2006–2010	Honda	Civic	Hybrid	2005–2010	Nissan	Frontier	Gas
2006–2009	Chevrolet	Malibu	Gas	2008–2010	Honda	CR-V	Gas	2003–2010	Nissan	Maxima	Gas
2006–2007	Chevrolet	Monte Carlo	Gas	2007–2010	Honda	Element	Gas	2007–2010	Nissan	Sentra	Gas
2008–2010	Chevrolet	Silverado	Gas	2009–2010	Honda	Fit	Gas	2005–2010	Nissan	Xterra	Gas
2008–2010	Chevrolet	Traverse	Gas	2007–2010	Honda	Odyssey	Gas	2006–2009	Pontiac	G6	Gas
2006–2007	Ford	500	Gas	2009–2010	Honda	Pilot	Gas	2007–2010	Pontiac	Torrent	Gas
2009–2011	Ford	Edge	Gas	2009–2010	Honda	Ridgeline	Gas	2006–2009	Saturn	Aura	Gas
2007–2009	Ford	Escape	Gas	2007–2010	Hyundai	Elantra	Gas	2007–2010	Saturn	Outlook	Gas
2007–2009	Ford	Escape	Hybrid	2006–2008	Hyundai	Sonata	Gas	2003–2011	Toyota	4Runner	Gas
2005–2010	Ford	Expedition	Gas	2010	Lexus	HS	Hybrid	2007–2010	Toyota	Camry	Gas
2006–2010	Ford	Explorer	Gas	2007–2010	Lexus	LX570	Gas	2007–2010	Toyota	Camry	Hybrid
2005–2010	Ford	F150	Gas	2010	Lexus	RX	Gas	2008–2010	Toyota	Highlander	Hybrid
2005–2010	Ford	Focus	Gas	2010	Lexus	RX	Hybrid	2004–2010	Toyota	Highlander	Gas
2006–2007	Ford	Freestyle	Gas	2007–2011	Lincoln	MKX	Gas	2007–2010	Toyota	Landcruiser	Gas
2006–2010	Ford	Fusion	Gas	2006–2010	Lincoln	MKZ	Gas	2004–2011	Toyota	Prius	Hybrid
2010	Ford	Fusion	Hybrid	2010	Lincoln	MKZ	Hybrid	2008–2010	Toyota	Sequoia	Gas
2005–2010	Ford	Mustang	Gas	2005–2010	Lincoln	Navigator	Gas	2004–2010	Toyota	Sienna	Gas
2006–2010	Ford	Ranger	Gas	2007–2010	Mercury	Mariner	Gas	2007–2010	Toyota	Tundra	Gas

APPENDIX R

Final Eligible Vehicle List

Final Eligible Vehicle List

Year	Make	Model	Power	Year	Make	Model	Power	Year	Make	Model	Power
1999–2003	Acura	CL	Gas	1991–1997	BMW	318i	Gas	1989–2005	Chevrolet	Caprice	Gas
1990–2001	Acura	Integra	Gas	1999–2000	BMW	323i	Gas	1989–2005	Chevrolet	Cavalier	Gas
1987–1995	Acura	Legend	Gas	1987–2011	BMW	325i	Gas	2005–2012	Chevrolet	Cobalt	Gas
2002–2011	Acura	MDX	Gas	2001–2011	BMW	325Xi	Gas	2004–2010	Chevrolet	Colorado	Gas
2007–2011	Acura	RDX	Gas	1996–2011	BMW	328i	Gas	1988–1996	Chevrolet	Corsica	Gas
1996–2011	Acura	RL	Gas	2000–2009	BMW	328Xi	Gas	2007–2012	Chevrolet	Corvette	Gas
2002–2006	Acura	RSX	Gas	2002–2006	BMW	330i	Gas	2011–2013	Chevrolet	Cruze	Gas
1991–2012	Acura	TL	Gas	2008–2011	BMW	335 series	Gas	2002–2013	Chevrolet	Equinox	Gas
2004–2011	Acura	TSX	Gas	1994–2003	BMW	525i	Gas	2008–2009	Chevrolet	Express	Gas
1992	Acura	Vigor	Gas	1997–2012	BMW	528i	Gas	2006–2012	Chevrolet	HHR	Gas
2010–2011	Acura	ZDX	Gas	2007	BMW	530i	Gas	1995–2012	Chevrolet	Impala	Gas
1999–2011	Audi	A4	Gas	1991	BMW	535i	Gas	1992–2006	Chevrolet	Lumina	Gas
1997–2004	Audi	A6	Gas	2008–2009	BMW	535Xi	Gas	1983–2012	Chevrolet	Malibu	Gas
2000–2004	Audi	S4	Gas	2000–2001	BMW	540i	Gas	1996–2007	Chevrolet	Monte Carlo	Gas
2000–2011	Bentley	Continental	Gas	1983	BMW	633CSI	Gas	1991–2001	Chevrolet	Prizm	Gas
2009	BMW	128i	Gas	2004	BMW	745li	Gas	1984–2005	Chevrolet	S-10	Gas
2008–2009	BMW	135i	Gas	2004	BMW	M3	Gas	1990–2013	Chevrolet	Silverado	Gas
2013	Cadillac	ATS	Gas	2006	BMW	M5	Gas	2012	Chevrolet	Sonic	Gas
1992	Cadillac	Brougham	Gas	2011–2012	BMW	SI	Gas	2012–2013	Chevrolet	Spark	Gas
2001	Cadillac	Catera	Gas	2004–2011	BMW	X3	Gas	1998–2003	Chevrolet	Suburban	Gas
2003–2012	Cadillac	CTS	Gas	2004–2012	BMW	X5	Gas	1994–2012	Chevrolet	Tahoe	Gas
1994–2004	Cadillac	DeVille	Gas	1991–2004	Buick	Century	Gas	2002–2012	Chevrolet	Trailblazer	Gas
2004	Cadillac	DHS	Gas	2007–2012	Buick	Enclave	Gas	2007–2011	Chevrolet	Traverse	Gas
2004–2012	Cadillac	DTS	Gas	2005–2012	Buick	Lacrosse	Gas	2007–2008	Chevrolet	Uplander	Gas
2002	Cadillac	Eldorado	Gas	1989–2010	Buick	LeSabre	Gas	2001–2004	Chevrolet	Venture	Gas
2002–2012	Cadillac	Escalade	Gas	2006–2011	Buick	Lucerne	Gas	2012–2013	Chevrolet	Volt	Hybrid
2003	Cadillac	Seville	Gas	1988–2005	Buick	Park Avenue	Gas	2011–2012	Chrysler	200	Gas
2005–2012	Cadillac	SRX	Gas	1988–2012	Buick	Regal	Gas	2002–2012	Chrysler	300	Gas
1995–2009	Cadillac	STS	Gas	2002–2009	Buick	Rendezvous	Gas	1996–2000	Chrysler	Cirrus	Gas

(continued on next page)

Final Eligible Vehicle List (continued)

Year	Make	Model	Power	Year	Make	Model	Power	Year	Make	Model	Power
2004–2011	Chevrolet	Astro	Gas	1995	Buick	Riviera	Gas	1994–2005	Chrysler	Concorde	Gas
				1995	Buick	Roadmaster	Gas	2005	Chrysler	Crossfire	Gas
2003–2009	Chevrolet	Avalanche	Gas	1996	Buick	Skylark	Gas	1994	Chrysler	LeBaron	Gas
1996–2012	Chevrolet	Aveo	Gas	2012	Buick	Terraza	Gas	1999	Chrysler	LHS	Gas
1991–2004	Chevrolet	Blazer	Gas	1992	Cadillac	Brougham	Gas	2000	Chrysler	New Yorker	Gas
1993–2002	Chevrolet	C1500	Gas	1991–2012	Chevrolet	Camaro	Gas	2004–2008	Chrysler	Pacifica	Gas
2001–2012	Chrysler	PT Cruiser	Gas	2007–2012	Ford	Edge	Gas	2000–2003	Ford	ZX2	Gas
1998–2012	Chrysler	Sebring	Gas	1994–2013	Ford	Escape	Gas	1996–1998	Geo	Metro	Gas
1992–2012	Chrysler	Town and Country	Gas	2007–2010	Ford	Escape	Hybrid	1992–1999	Geo	Prizm	Gas
1989–2007	Chrysler	Voyager	Gas	1989–2012	Ford	Escort	Gas	1996–2002	Geo	Tracker	Gas
2001	Daewoo	Lanos	Gas	2000	Ford	Excursion	Gas	2007–2012	GMC	Acadia	Gas
2002	Daewoo	Leganza	Gas	1997–2012	Ford	Expedition	Gas	2005–2009	GMC	Canyon	Gas
2008–2012	Dodge	Avenger	Gas	1991–2012	Ford	Explorer	Gas	2000–2004	GMC	Envoy	Gas
2005–2012	Dodge	Caliber	Gas	1997–2011	Ford	Econoline	Gas	1992–2001	GMC	Jimmy	Gas
1995–2013	Dodge	Caravan	Gas	2007–2012	Ford	Edge	Gas	1997–2003	GMC	Safari	Gas
2011–2013	Dodge	Challenger	Gas	1994–2013	Ford	Escape	Gas	2009	GMC	Sahara	Gas
1993–2012	Dodge	Charger	Gas	2007–2010	Ford	Escape	Hybrid	1995–2012	GMC	Sierra	Gas
1996–2007	Dodge	Dakota	Gas	1989–2012	Ford	Escort	Gas	2000	GMC	Sonoma	Gas
1988	Dodge	Daytona	Gas	2000	Ford	Excursion	Gas	2010–2012	GMC	Terrain	Gas
1999–2008	Dodge	Durango	Gas	1997–2012	Ford	Expedition	Gas	1997–2012	GMC	Yukon	Gas
1994–2012	Dodge	Grand Caravan	Gas	1991–2012	Ford	Explorer	Gas	1987–2012	Honda	Accord	Gas
1994–2004	Dodge	Intrepid	Gas					1989–2012	Honda	Civic	Gas
2009–2012	Dodge	Journey	Gas	1979–2012	Ford	F-150	Gas	1997–2011	Honda	Civic	Hybrid
2005–2006	Dodge	Magnum	Gas	2005–2010	Ford	F-250	Diesel	2010	Honda	Crosstour	Gas
1995–2005	Dodge	Neon	Gas	2002–2012	Ford	F-250	Gas	1996–2011	Honda	CR-V	Gas
2007–2011	Dodge	Nitro	Gas	2003–2012	Ford	F-350	Gas	1987–1990	Honda	CRX	Gas
1989	Dodge	Omni	Gas	2011–2012	Ford	Fiesta	Gas	2003–2011	Honda	Element	Gas
1995–2012	Dodge	Ram	Gas	2010–2011	Ford	Flex	Gas	2007–2012	Honda	Fit	Gas
1993	Dodge	Shadow	Gas	1989–2012	Ford	Focus	Gas	2000–2010	Honda	Insight	Gas
1995	Dodge	Spirit	Gas	2005–2007	Ford	Freestar	Gas	1996–2011	Honda	Odyssey	Gas

(continued on next page)

Final Eligible Vehicle List (continued)

Year	Make	Model	Power	Year	Make	Model	Power	Year	Make	Model	Power
1994	Dodge	Stealth	Gas	2006–2007	Ford	Freestyle	Gas	1994–1998	Honda	Passport	Gas
2000–2006	Dodge	Stratus	Gas	2010–2012	Ford	Fusion	Hybrid	2000–2011	Honda	Pilot	Gas
2012	Fiat	500	Gas	2001–2012	Ford	Fusion	Gas	1997–2000	Honda	Prelude	Gas
2005–2007	Ford	500	Gas	1989–2012	Ford	Mustang	Gas	2006–2011	Honda	Ridgeline	Gas
1995–1996	Ford	Aspire	Gas	1996	Ford	Probe	Gas	2006	Honda	S2000	Gas
1995	Ford	Bronco	Gas	1984–2012	Ford	Ranger	Gas	1998–2013	Hyundai	Accent	Gas
2013	Ford	C-Max	Hybrid	1993–2012	Ford	Taurus	Gas	2007–2009	Hyundai	Azera	Gas
1995–2002	Ford	Contour	Gas	1993–1994	Ford	Tempo	Gas	1993–2013	Hyundai	Elantra	Gas
1993–2009	Ford	Crown Victoria	Gas	1994–1997	Ford	Thunderbird	Gas	2007–2008	Hyundai	Entourage	Gas
1997–2011	Ford	Econoline	Gas	1998–2003	Ford	Windstar	Gas	2009–2012	Hyundai	Genesis	Gas
2000–2012	Hyundai	Santa Fe	Gas	2003–2012	Kia	Sedona	Gas	1993–2000	Lexus	LS400	Gas
2001–2013	Hyundai	Sonata	Gas	1999–2001	Kia	Sephia	Gas	2007	Lexus	LS460	Gas
2000–2001, 2003–2006	Hyundai	Tiburon	Gas	2004–2013	Kia	Sorento	Gas	1998	Lexus	LS Series	Gas
2002–2012	Hyundai	Tucson	Gas	2010–2012	Kia	Soul	Gas	2007–2010	Lexus	LX570	Gas
2012	Hyundai	Veloster	Gas	2001–2010	Kia	Spectra	Gas	2000–2012	Lexus	RX	Gas
2007–2008	Hyundai	Veracruz	Gas	2000–2012	Kia	Sportage	Gas	2006–2012	Lexus	RX	Hybrid
2001	Hyundai	XG300	Gas	2011	Land Rover	LR2	Gas	1996	Lexus	SC300	Gas
2008–2013	Infiniti	EX	Gas	2009	Land Rover	Range Rover Sport	Gas	2005	Lexus	V50	Gas
2004–2011	Infiniti	FX	Gas	2010	Lexus	250	Gas	2004	Lincoln	Aviator	Gas
1991–2012	Infiniti	G Series	Gas	1996–2011	Lexus	ES300	Gas	1999–2001	Lincoln	Continental	Gas
1996–2000	Infiniti	I30	Gas	2004–2006	Lexus	ES330	Gas	1978	Lincoln	Mark VII	Gas
2002	Infiniti	I35	Gas	2008–2012	Lexus	ES350	Gas	2010	Lincoln	MKT	Gas
2003–2012	Infiniti	M	Gas	2009–2010	Lexus	GS350	Gas	2001–2011	Lincoln	MKX	Gas
1998–2012	Infiniti	QX	Gas	2010	Lexus	HS	Hybrid	2010	Lincoln	MKZ	Hybrid
1979	International	Scout	Gas	2006–2012	Lexus	IS Series	Gas	2006–2012	Lincoln	MKZ	Gas
1999	Isuzu	Amigo	Gas	1994–2011	Lexus	LS300	Gas	2001–2011	Lincoln	Navigator	Gas
2006	Isuzu	Ascender	Gas	1993–2000	Lexus	LS400	Gas	1994–2006	Lincoln	Town Car	Gas
1990	Isuzu	Impulse	Gas	2007	Lexus	LS460	Gas	2006	Lincoln	Zephyr	Gas
1995–2001	Isuzu	Rodeo	Gas	1998	Lexus	LS Series	Gas	2011	Mazda	2	Gas

(continued on next page)

Final Eligible Vehicle List (continued)

Year	Make	Model	Power	Year	Make	Model	Power	Year	Make	Model	Power
2000–2001	Isuzu	Trooper	Gas	2003–2012	Kia	Sedona	Gas	2001–2012	Mazda	3	Gas
				1999–2001	Kia	Sephia	Gas	2006–2010	Mazda	5	Gas
1996	Jaguar	XJ	Gas	2004–2013	Kia	Sorento	Gas	2003–2011	Mazda	6	Gas
1990–2012	Jeep	Cherokee	Gas	2010–2012	Kia	Soul	Gas	1990–2003	Mazda	626	Gas
2006–2007	Jeep	Commander	Gas	2001–2010	Kia	Spectra	Gas	1997	Mazda	B2300	Gas
2007–2012	Jeep	Compass	Gas	2000–2012	Kia	Sportage	Gas	2007–2011	Mazda	CX-7	Gas
1993–2011	Jeep	Grand Cherokee	Gas	2011	Land Rover	LR2	Gas	2007–2010	Mazda	CX-9	Gas
2002–2011	Jeep	Liberty	Gas	2009	Land Rover	Range Rover Sport	Gas	1991–2009	Mazda	Miata	Gas
2008–2013	Jeep	Patriot	Gas	2010	Lexus	250	Gas	2002	Mazda	Millenia	Gas
1990–2012	Jeep	Wrangler	Gas	1996–2011	Lexus	ES300	Gas	1996–2003	Mazda	MPV	Gas
2005–2009	Kia	Amanti	Gas	2004–2006	Lexus	ES330	Gas	1995–2003	Mazda	Protégé	Gas
2010–2012	Kia	Forte	Gas	2008–2012	Lexus	ES350	Gas	1985–2010	Mazda	RX7	Gas
2001–2012	Kia	Optima	Gas	2009–2010	Lexus	GS350	Gas	2009	Mazda	RX8	Gas
2003	Kia	RF	Gas	2010	Lexus	HS	Hybrid	2002–2011	Mazda	Tribute	Gas
2001–2013	Kia	Rio	Gas	2006–2012	Lexus	IS Series	Gas	1987	Mercedes	190	Gas
2008–2010	Kia	Rondo	Gas	1994–2011	Lexus	LS300	Gas	1990	Mercedes	400	Gas
1997–2011	Mercedes	C Class	Gas	1981	Nissan	280ZX	Gas	2007–2009	Pontiac	G5	Gas
1995–1997	Mercedes	C280	Gas	1986–1991	Nissan	300ZX	Gas	2006–2010	Pontiac	G6	Gas
2009	Mercedes	CLK350	Gas	2003–2009	Nissan	350Z	Gas	1993–2005	Pontiac	Grand Am	Gas
1995–2011	Mercedes	E Class	Gas	1993–2013	Nissan	Altima	Gas	1996–2008	Pontiac	Grand Prix	Gas
2011–2012	Mercedes	GLK	Gas					2004	Pontiac	GTO	Gas
2008	Mercedes	GL 450	Gas	2009–2011	Nissan	Cube	Gas	2003–2004	Pontiac	Montana	Gas
1999–2011	Mercedes	M Class	Gas	1997–2011	Nissan	Frontier	Gas	2006–2008	Pontiac	Solstice	Gas
1987–2011	Mercedes	S Class	Gas	2011–2012	Nissan	Juke	Gas	1996–2005	Pontiac	Sunfire	Gas
1995–2001	Mercury	Cougar	Gas	2011	Nissan	Leaf	Gas	2006–2010	Pontiac	Torrent	Gas
1989–2011	Mercury	Grand Marquis	Gas	1995–2012	Nissan	Maxima	Gas	1996	Pontiac	Trans Am	Gas
1997–2003	Mercury	Marauder	Gas	2003–2010	Nissan	Murano	Gas	2003–2010	Pontiac	Vibe	Gas
2004–2012	Mercury	Mariner	Gas	1987–2011	Nissan	Pathfinder	Gas	2012	Porsche	911	Gas
2007–2012	Mercury	Mariner	Hybrid	1995–2005	Nissan	Quest	Gas	1986	Porsche	944	Gas
2010–2011	Mercury	Milan	Hybrid	2008–2013	Nissan	Rogue	Gas	2010	Porsche	Cayenne	Gas

(continued on next page)

Final Eligible Vehicle List (continued)

Year	Make	Model	Power	Year	Make	Model	Power	Year	Make	Model	Power
2006–2011	Mercury	Milan	Gas	1992–2013	Nissan	Sentra	Gas	1997–1998	Saab	900	Gas
2005–2007	Mercury	Montego	Gas	2010	Nissan	Titan	Gas	1995	Saab	9000	Gas
2005–2007	Mercury	Monterey	Gas	2008–2012	Nissan	Versa	Gas	2001–2010	Saab	9-3X	Gas
1999–2010	Mercury	Mountaineer	Gas	2000–2012	Nissan	Xterra	Gas	2001–2004	Saab	9-5 Sport Wagon	Gas
1990–1998	Mercury	Mystique	Gas	1995–1999	Oldsmobile	Achevia	Gas	2010	Saab	9-7X	Gas
1998–2009	Mercury	Sable	Gas	1999–2004	Oldsmobile	Alero	Gas	2008	Saturn	Astra	Gas
1998	Mercury	Tracer	Gas	1999–2001	Oldsmobile	Aurora	Gas	2006–2010	Saturn	Aura	Gas
1993–2002	Mercury	Villager	Gas	2001	Oldsmobile	Bravada	Gas	2000–2009	Saturn	Ion	Gas
1987	Merkur	XR4TI	Gas	1992–1998	Oldsmobile	Cutlass	Gas	2002	Saturn	L100	Gas
2008	Mini	Clubman	Gas	1993–1997	Oldsmobile	Eighty Eight	Gas	2001–2003	Saturn	L200	Gas
2002–2012	Mini	Cooper	Gas	1998–2002	Oldsmobile	Intrigue	Gas	2001–2004	Saturn	L300	Gas
1991	Mitsubushi	3000GT	Gas	1996	Oldsmobile	LSS	Gas	2000–2001	Saturn	LS1	Gas
1993–2009	Mitsubushi	Eclipse	Gas	1980	Oldsmobile	Omega	Gas	2002	Saturn	LW	Gas
2004–2008	Mitsubushi	Endeavor	Gas	2002–2004	Oldsmobile	Silhouette	Gas	2007–2009	Saturn	Outlook	Gas
1995–2011	Mitsubushi	Galant	Gas	1992–1994	Plymouth	Acclaim	Gas	1997–2001	Saturn	SC1	Gas
2002–2012	Mitsubushi	Lancer	Gas	1996–1999	Plymouth	Breeze	Gas	1986–1999	Saturn	SC2	Gas
1994	Mitsubushi	Mighty Max	Gas	1997–2001	Plymouth	Voyager	Gas	1995–2002	Saturn	SL	Gas
1999–2004	Mitsubushi	Mirage	Gas	2001–2004	Pontiac	Aztek	Gas	1996–2002	Saturn	SL1	Gas
1998–2003	Mitsubushi	Montero	Gas	1993–2005	Pontiac	Bonneville SSEI	Gas	1996–2002	Saturn	SL2	Gas
2003–2012	Mitsubushi	Outlander	Gas	1987	Pontiac	Firebird	Gas	1993–1999	Saturn	SW	Gas
1995	Nissan	200SX	Gas	2009	Pontiac	G3	Gas	1997	Saturn	SW2	Gas
2002–2009	Saturn	VUE	Gas	2002–2012	Toyota	Prius	Hybrid	1999–2007	Volvo	V70	Gas
2005–2012	Scion	TC	Gas	1996–2012	Toyota	RAV4	Gas	1998	Volvo	V90	Gas
1998–2006	Scion	xA	Gas	2002–2010	Toyota	Sequoia	Gas	2010–2011	Volvo	XC60	Gas
2004–2011	Scion	xB	Gas	1999–2013	Toyota	Sienna	Gas	2000–2011	Volvo	XC70	Gas
2008–2012	Scion	xD	Gas	1981	Toyota	Starlet	Gas	2007	Volvo	XC90	Gas
2008–2012	Smart	ForTwo	Gas	1985–2003	Toyota	Supra	Gas				
1996–2013	Subaru	Forester	Gas	1995–2012	Toyota	Tacoma	Gas				
1991–2013	Subaru	Impreza	Gas	1987–1997	Toyota	Tercel	Gas				
1991–2013	Subaru	Legacy	Gas	2000–2013	Toyota	Tundra	Gas				

(continued on next page)

Final Eligible Vehicle List (continued)

Year	Make	Model	Power	Year	Make	Model	Power
1991–1992	Subaru	Loyale	Gas	2009	Toyota	Venza	Gas
1995–2012	Subaru	Outback	Gas	2006–2012	Toyota	Yaris	Gas
2007–2008	Subaru	Tribeca	Gas	1994–2012	Volkswagen	Beetle	Gas
2003–2007	Suzuki	Aerio	Gas	2009–2012	Volkswagen	CC	Gas
2009	Suzuki	Equator	Gas	2007	Volkswagen	EOS	Gas
2004–2008	Suzuki	Forenza	Gas	1992–2013	Volkswagen	Golf	Gas
1999–2011	Suzuki	Grand Vitara	Gas	2005–2012	Volkswagen	GTI	Gas
1999	Suzuki	Swift	Gas	1991–2013	Volkswagen	Jetta	Gas
2008–2012	Suzuki	SX4	Gas				
2004–2006	Suzuki	Verona	Gas	1999–2008	Volkswagen	Passat	Gas
2002	Suzuki	Vitara	Gas	2004	Volkswagen	R32	Gas
2007–2008	Suzuki	XL7	Gas	2007–2009	Volkswagen	Rabbit	Gas
1987–2012	Toyota	4Runner	Gas	2009–2010	Volkswagen	Routon	Gas
1995–2012	Toyota	Avalon	Gas	2010–2011	Volkswagen	Tiguan	Gas
2006–2011	Toyota	Camry	Hybrid	1984–1992	Volvo	240	Gas
1986–2012	Toyota	Camry	Gas	1989–1992	Volvo	740	Gas
1987–2003	Toyota	Celica	Gas	1993–1997	Volvo	850	Gas
1984–2013	Toyota	Corolla	Gas	1994	Volvo	940	Gas
2000–2003	Toyota	Echo	Gas	1992–1997	Volvo	960	Gas
2007–2008	Toyota	FJ Cruiser	Gas	1999	Volvo	C70	Gas
2001–2012	Toyota	Highlander	Gas	2001–2010	Volvo	S40	Gas
2006–2012	Toyota	Highlander	Hybrid	1995–2012	Volvo	S60	Gas
1992–2010	Toyota	LandCruiser	Gas	1992–2000	Volvo	S70	Gas
2003–2011	Toyota	Matrix	Gas	1999–2004	Volvo	S80	Gas
1986–2000	Toyota	MR2	Gas	1995	Volvo	S960	Gas
1992	Toyota	Paseo	Gas	2005	Volvo	V50	Gas

APPENDIX S

Summary of Amendments

Note that Amendments 1–6 were related to the Study Design phase of the SHRP 2 NDS. Only amendments that were relevant to the Data Collection phase are summarized here.

Amendment 7 allowed for the use of vehicles not owned by the research participant as long as the vehicle owner signed a permission form. This greatly enhanced the ability to recruit young drivers. Compensation was also increased to $500 per year following a distribution scheme similar to that described in Chapters 2 and 7 for the initial $300 per year compensation.

Amendment 8 revised the owner permission letter per a NAS IRB request, and also included items to bring forms into compliance with the consistency review.

Amendment 9 revised the exit survey, discussed the Battelle call center (a parallel recruitment effort to the main study call center recruiting), and revised an e-mail/letter sent to current participants to inform them of the increased payment.

Amendment 9a was for Battelle only and was for approval of their call center.

Amendment 10 added the slogan of Crowley Webb (an advertising firm hired by the Erie County, New York, site) to recruiting materials.

Amendment 11 added materials to allow participants to extend their scheduled participation for up to 12 additional months.

Amendment 12 added materials to allow for variable enrollment periods of from 8 to 24 months (this was in March 2012, when the data collection was about halfway complete and the study was beginning to wind down).

Amendment 13 added a phrase to the variable enrollment consent forms (in its review of the Amendment 11 extension of enrollment for currently enrolled participants, the NAS IRB requested that the current phrase on the last page of each consent form, "The Participant Must Be Provided With A Copy Of This Re-Consent Form," include the added phrase, "With a Copy of the Original Signed Consent Form Attached").

Amendment 14 added language to the consent forms informing participants that vehicles with persistent tire pressure monitoring system (TPMS) issues would be removed from the study.

Amendment 15 added promotional materials such as pens and cups to the recruitment section of the protocol.

Amendment 16 allowed for variable enrollment periods of 4 to 7 months (to maximize data collection as the study wound down); removed mention of the "blanket process" from the protocol and consent forms (this was a method of capturing images of the drivers in simulated darkness to improve the driver identification process); and provided for a $25 gift card for a primary driver who was able to provide pictures of consented secondary driver(s).

Amendment 17 increased the number of primary participants to 3,300 (given that some participants dropped out fairly early in their scheduled enrollment, it became clear that the 3,000 number would be surpassed at some point late in the data collection period).

Amendment 18 allowed sites to contact secondary drivers for a photo and asked these drivers whether their contact information could be retained for follow-on studies.

APPENDIX T

SHRP 2 Vehicle Fleet by Original Equipment Manufacturer

Make	Count	Percent of Fleet
Toyota	825	24.54%
Ford	563	16.75%
Honda	459	13.65%
Nissan	298	8.86%
GM	509	15.14%
Hyundai/Kia	326	9.70%
Mazda	66	1.96%
Dodge	86	2.56%
Subaru	57	1.70%
Jeep	53	1.58%
Volkswagen	48	1.43%
Mitsubishi	23	0.68%
Volvo	16	0.48%
Suzuki	10	0.30%
BMW	8	0.24%
Mini	6	0.18%
Mercedes	4	0.12%
SAAB	3	0.09%
Audi	2	0.06%
Total	**3,362**	**100.00%**

APPENDIX U

Description of RT Queues

Queue Name	Description of Queue
Data Ingestion	Queue for processing/ingestion of HDDs
General	The default queue
Installers All Sites	This queue is to provide information to installers at all sites
Inventory	Captures inventory events and conflicts
Operations Bucket	Bucket list of operational tasks
S06 ACN	S06 Automatic Crash Notification
S06 Admin	All administrative matters related to the study
S06 DB Security	This queue is used to manage access to database and other security issues
S06 DBA	S06 Database Administration
S06 Developers	S06 Developers
S06 Emergency	S06 Emergency Action
S06 Equipment Repairs	Queue for assessment and repair of equipment
S06 Health Check	Queue for automated Health Checks
S06 Tech Support	S06 Desktop computing and software development
S06 Transerve-generated tickets	DMS Automated Emails
S06 Vehicle Hardware	S06 Vehicle Hardware (HEL)
S07 FL General	S07 CUBRC FL, Tampa, FL General/IT issues
S07 IN Admin	S07 IN Administrative Matters
S07 IN Crash	S07 IN Crash
S07 IN Emergency	S07 IN Emergency
S07 IN General	S07 University of Indiana, Bloomington, IN General/IT issues
S07 IN Hardware	S07 IN DAS Hardware
S07 IN Health Check	S07 IN Health Check
S07 IN Install	S07 IN Installation Issues
S07 IN Enrollment Assess	S07 IN Enrollment Assessment Matters
S07 IN Scheduling	S07 IN Scheduling
S07 NC Admin	S07 NC Administrative Matters
S07 NC Crash	S07 NC Crash

(continued on next page)

Queue Name	Description of Queue
S07 NC Emergency	S07 NC Emergency
S07 NC General	S07 Westat, Durham, NC General/IT issues
S07 NC Hardware	S07 NC DAS Hardware
S07 NC Health Check	S07 NC Health Check
S07 NC Install	S07 NC Installation Issues
S07 NC Enrollment Assess	S07 NC Enrollment Assessment Matters
S07 NC Scheduling	S07 NC Scheduling
S07 NY General	S07 CUBRC NY, Buffalo, NY General/IT issues
S07 PA Admin	S07 PA Administrative Matters
S07 PA Crash	S07 PA Crash
S07 PA Emergency	S07 PA Emergency
S07 PA General	S07 Penn State University, State College, PA General/IT issues
S07 PA Hardware	S07 PA DAS Hardware
S07 PA Health Check	S07 PA Health Check
S07 PA Install	S07 PA Installation Issues
S07 PA Enrollment Assess	S07 PA Enrollment Assessment Matters
S07 PA Scheduling	S07 PA Scheduling
S07 WA Admin	S07 WA Administrative Matters
S07 WA Crash	S07 WA Crash
S07 WA Emergency	S07 WA Emergency
S07 WA General	S07 Battelle, Seattle, WA General/IT issues
S07 WA Hardware	S07 WA DAS Hardware
S07 WA Health Check	S07 WA Health Check
S07 WA Install	S07 WA Installation Issues
S07 WA Enrollment Assess	S07 WA Enrollment Assessment Matters
S07 WA Scheduling	S07 WA Scheduling
ShipReceive	SHRP 2 Shipping and Receiving Queue
SHRP 2 Staff	SHRP 2 Staff
SHRP 2 Forums	Invision Power Board Forums Queue
Test	Queue for testing how things work
Vehicle Eligibility	Queue for tickets requesting additions to the eligible vehicle list and questions concerning advanced vehicle features

APPENDIX V

Driver Demographics Questionnaire

Appendix V - Demographic Questionnaire SHRP2 NDS

There are 21 questions in this survey

Demographic Data

1 What is your gender:

Please choose **only one** of the following:

- ○ Female
- ○ Male

2 What is your date of birth?

Please enter a date:

3 What do you consider your ethnicity to be?

Please choose **only one** of the following:

- ○ Hispanic or Latino
- ○ Not Hispanic or Latino

4 What do you consider your race to be?

Please choose **all** that apply:

- ○ Black or African American
- ○ White
- ○ Asian
- ○ American Indian or Alaska Native
- ○ Native Hawaiian or Other Pacific Islander
- ○ Other:

5 What is your country of birth?

Please choose **only one** of the following:

- ○ United States
- ○ Other

6 What is the highest level of education you have completed?

Please choose **only one** of the following:

- ○ Some high school
- ○ High school diploma or G.E.D.
- ○ Some education beyond high school but no degree
- ○ College degree
- ○ Some graduate or professional school, but no advanced degree (e.g., J.D.S., M.S. or Ph.D.)
- ○ Advanced degree (e.g., J.D.S., M.S. or Ph.D.)

7 What is your marital status?

Please choose **only one** of the following:

- ○ single
- ○ married
- ○ divorced
- ○ widow(er)
- ○ unmarried partners

8 What is your current household status?

Please choose **only one** of the following:

- ○ Two-parent household
- ○ One-parent household
- ○ Other

9 Is your primary household:

Please choose **only one** of the following:

- ○ Owned
- ○ Rented

10 What is your current work status?

Please choose **only one** of the following:

- ○ Not working outside the home
- ○ Part-time
- ○ Full-time

11 What is your current job title or profession?

Please write your answer here:

12 What is your family's annual household income (from all sources and before taxes)?

Please choose **only one** of the following:

- ○ Under $29,000
- ○ $30,000 to $39,999
- ○ $40,000 to $49,999
- ○ $50,000 to $69,999
- ○ $70,000 to $99,999
- ○ $100,000 to $149,999
- ○ $150,000 +

13 How many people <u>including yourself</u> live in your household?

Please write your answer here:

14 Of these, how many are:

Please write your answer(s) here:

Less than 16 years old?

16 - 20?

21 - 25?

26 - 30?

31 - 35?

36 - 40?

41 - 45?

46 - 50?

51 - 55?

56 - 60?

61 - 65?

65 +

15 How many vehicles are there in your household?

Please write your answer here:

16 What is your ZIP Code?

Please write your answer here:

17 How long have you lived in your neighborhood?

Please choose **only one** of the following:

- ○ Less than 1 year
- ○ 1 to 5 years
- ○ more than 5 years

18 Approximately how many miles did you drive last year?

Please write your answer here:

19 Do you use the study vehicle for any business purposes (such as pizza delivery or realtor activities)?

Please choose **only one** of the following:

- ○ Yes
- ○ No

20 If 'Yes', please indicate the business purpose.

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '19 [19]' (Do you use the study vehicle for any business purposes (such as pizza delivery or realtor activities)?)

Please write your answer here:

21 At what age did you receive your driver's license (i.e., when did you drive legally by yourself)?

Please choose **only one** of the following:

- ○ < 15
- ○ 15
- ○ 15.5
- ○ 16
- ○ 16.5
- ○ 17
- ○ 17.5
- ○ 18
- ○ > 18

Submit your survey.
Thank you for completing this survey.

APPENDIX W

Driving History Questionnaire

DRIVING HISTORY

A note on privacy
This survey is anonymous.
The record kept of your survey responses does not contain any identifying information about you unless a specific question in the survey has asked for this. If you have responded to a survey that used an identifying token to allow you to access the survey, you can rest assured that the identifying token is not kept with your responses. It is managed in a separate database, and will only be updated to indicate that you have (or haven't) completed this survey. There is no way of matching identification tokens with survey responses in this survey.

There are 16 questions in this survey

DH 1

1 Over the past five years, what is your average annual mileage (estimate)?

Please choose **only one** of the following:

- ○ less than 5,000 miles
- ○ 5,000 - 10,000 miles
- ○ 10,000 - 15,000 miles
- ○ 15,000 - 20,000 miles
- ○ 20,000 - 25,000 miles
- ○ 25,000 - 30,000 miles
- ○ more than 30,000 miles

2 How many years have you been driving?

Please write your answer here:

3 Describe the kind(s) of driver training that you have received prior to getting a license as well as throughout your driving experience.

Please choose **all** that apply:

- [ ] Informal driver training offered by a parent, family member or friend
- [ ] Driver's Education offered through school
- [ ] Driver's Education offered through private company
- [ ] Operated farm equipment or lawn tractors
- [ ] Motor sports experience
- [ ] Post-licensure driver skills training/enhancement
- [ ] Other:

4 In the past year, how many moving or traffic violations have you had?

Please choose **only one** of the following:

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ more than 5

5 What type of violations were involved?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '4 [4a]' (In the past year, how many moving or traffic violations have you had?)

Please write your answer here:

6 In the past year, how many crashes have you been in?

Please choose **only one** of the following:

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ more than 5

7 Accident 1 Severity (select highest or most severe option applicable)

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Injury
- ○ Tow-away (any vehicle)
- ○ Police-reported
- ○ Damage (any), but no police report

8 Were you at fault?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

9 Accident 2 Severity (select highest or most severe option applicable)

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Injury
- ○ Tow-away (any vehicle)
- ○ Police-reported
- ○ Damage (any), but no police report

10 Were you at fault?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

11 Accident 3 Severity (select highest or most severe option applicable)

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Injury
- ○ Tow-away (any vehicle)
- ○ Police-reported
- ○ Damage (any), but no police report

12 Were you at fault?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

13 Accident 4 Severity (select highest or most severe option applicable)

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Injury
- ○ Tow-away (any vehicle)
- ○ Police-reported
- ○ Damage (any), but no police report

14 Were you at fault?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

15 Accident 5 Severity (select highest or most severe option applicable)

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Injury
- ○ Tow-away (any vehicle)
- ○ Police-reported
- ○ Damage (any), but no police report

16 Were you at fault?

Only answer this question if the following conditions are met:
° Answer was greater than or equal to 'more than 5' at question '6 [5]' (In the past year, how many crashes have you been in?)

Please choose **only one** of the following:

- ○ Yes
- ○ No

Submit your survey.
Thank you for completing this survey.

APPENDIX X

Exit Survey

Exit Survey

There are 17 questions in this survey

questions

1 Please answer the following questions as accurately as possible. You may choose to take some time to think about each item. Remember, all responses are kept completely confidential.

2 On average, how much life stress did you feel during your participation in the study?

Please choose **only one** of the following:

- ○ Almost no stress
- ○ Slight stress
- ○ Moderate stress
- ○ High stress
- ○ Extremely high stress

3 How much is your driving affected by stress?

Please choose **only one** of the following:

- ○ Not affected
- ○ Slightly affected
- ○ Moderately affected
- ○ Very affected
- ○ Extremely affected

4 To what degree do you feel your participation in the study altered your driving behaviors?

Please choose **only one** of the following:

- ○ Not altered
- ○ Slightly altered
- ○ Moderately altered
- ○ Very altered
- ○ Extremely altered

5 You indicated that your driving was affected by your participation in the study - in what way was it affected?

Only answer this question if the following conditions are met:
° Answer was 'Extremely altered' or 'Very altered' or 'Moderately altered' or 'Slightly altered' at question '4 [4]' (To what degree do you feel your participation in the study altered your driving behaviors?)

Please write your answer here:

6 How would you rate how safely you drove in the past year compared to all of your previous years of driving?

Please choose **only one** of the following:

- ○ Much more safely
- ○ Somewhat more safely
- ○ About the same
- ○ Somewhat less safely
- ○ Much less safely

7 How would you rate your driving ability compared to the average driver?

Please choose **only one** of the following:

- ○ Much better
- ○ Somewhat better
- ○ About the same
- ○ Somewhat worse
- ○ Much worse

8 How do you restrict your driving?

Please choose **all** that apply:

- ☐ Avoid driving at night
- ☐ Avoid highway or interstate travel
- ☐ Avoid left turns across traffic, where possible
- ☐ Avoid high traffic volumes
- ☐ Avoid driving in unfamiliar areas
- ☐ Other

9 Please Describe:

Only answer this question if the following conditions are met:
° Answer was at question '8 [8]' (How do you restrict your driving?)

Please write your answer here:

10 How likely are you to give up driving altogether within the next 12 months?

Please choose **only one** of the following:

- ○ Very unlikely
- ○ Somewhat unlikely
- ○ Neither likely nor unlikely
- ○ Somewhat likely
- ○ Very likely

11 Is there any event or incident that happened in the past year where you pushed the critical incident button that you would like to tell us about?

Please choose **only one** of the following:

- ○ Yes
- ○ No

12 Approximate Date

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '11 [11]' (Is there any event or incident that happened in the past year where you pushed the critical incident button that you would like to tell us about?)

Please write your answer here:

13 Approximate time

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '11 [11]' (Is there any event or incident that happened in the past year where you pushed the critical incident button that you would like to tell us about?)

Please write your answer here:

14 Description

Only answer this question if the following conditions are met:
° Answer was 'Yes' at question '11 [11]' (Is there any event or incident that happened in the past year where you pushed the critical incident button that you would like to tell us about?)

Please write your answer here:

15 How would you rate your experiences participating in this study?

Please choose **only one** of the following:

- ○ Very favorable
- ○ Somewhat favorable
- ○ Neither favorable nor unfavorable
- ○ Somewhat unfavorable
- ○ Very unfavorable

16 Is there anything in particular that you would like to bring to our attention?

Please write your answer here:

17 Thank you for your participation!

Submit Your Survey.
Thank you for completing this survey.

TRB OVERSIGHT COMMITTEE FOR THE STRATEGIC HIGHWAY RESEARCH PROGRAM 2*

CHAIR: **Kirk T. Steudle,** *Director, Michigan Department of Transportation*

MEMBERS

H. Norman Abramson, *Executive Vice President (retired), Southwest Research Institute*
Alan C. Clark, *MPO Director, Houston–Galveston Area Council*
Frank L. Danchetz, *Vice President, ARCADIS-US, Inc. (deceased January 2015)*
Malcolm Dougherty, *Director, California Department of Transportation*
Stanley Gee, *Executive Deputy Commissioner, New York State Department of Transportation*
Mary L. Klein, *President and CEO, NatureServe*
Michael P. Lewis, *Director, Rhode Island Department of Transportation*
John R. Njord, *Executive Director (retired), Utah Department of Transportation*
Charles F. Potts, *Chief Executive Officer, Heritage Construction and Materials*
Ananth K. Prasad, *Secretary, Florida Department of Transportation*
Gerald M. Ross, *Chief Engineer (retired), Georgia Department of Transportation*
George E. Schoener, *Executive Director, I-95 Corridor Coalition*
Kumares C. Sinha, *Olson Distinguished Professor of Civil Engineering, Purdue University*
Paul Trombino III, *Director, Iowa Department of Transportation*

EX OFFICIO MEMBERS

Victor M. Mendez, *Administrator, Federal Highway Administration*
David L. Strickland, *Administrator, National Highway Transportation Safety Administration*
Frederick "Bud" Wright, *Executive Director, American Association of State Highway and Transportation Officials*

LIAISONS

Ken Jacoby, *Communications and Outreach Team Director, Office of Corporate Research, Technology, and Innovation Management, Federal Highway Administration*
Tony Kane, *Director, Engineering and Technical Services, American Association of State Highway and Transportation Officials*
Jeffrey F. Paniati, *Executive Director, Federal Highway Administration*
John Pearson, *Program Director, Council of Deputy Ministers Responsible for Transportation and Highway Safety, Canada*
Michael F. Trentacoste, *Associate Administrator, Research, Development, and Technology, Federal Highway Administration*

* Membership as of January 2015.

SAFETY TECHNICAL COORDINATING COMMITTEE*

CHAIR: **Forrest M. Council,** *Senior Research Scientist, Highway Safety Research Center, University of North Carolina*

MEMBERS

Timothy E. Barnett, *State Safety Engineer, Alabama Department of Transportation*
James A. Bonneson, *Senior Principal Engineer, Kittelson and Associates*
Leanna Depue, *Director, Traffic and Highway Safety Division, Missouri Department of Transportation*
Bradley M. Estochen, *State Traffic Safety Engineer, Minnesota Department of Transportation*
Jurek Grabowski, *Research Director, AAA Foundation for Traffic Safety*
Jeffrey Greenberg, *Senior Technical Leader, Ford Motor Company*
Joanne Harbluk, *Human Factors Specialist, Transport Canada*
Brent Jennings, *Highway Safety Manager, Idaho Transportation Department*
Alan F. Karr, *Director, National Institute of Statistical Sciences*
Bani K. Mallick, *Distinguished Professor, Department of Statistics, Texas A&M University*
John C. Milton, *Director, Enterprise Risk & Safety Management, Washington State Department of Transportation*
Harlan J. Onsrud, *Professor, School of Computing & Information Science*
Michael Perel, *Safety Knowledge Engineer*
Charles W. Reider, *Chief Safety Engineer, Nevada Department of Transportation*
David Shinar, *Professor, Department of Industrial Engineering and Management, Ben Gurion University of the Negev*
Alison Smiley, *President, Human Factors North, Inc.*
Thomas M. Welch, *State Transportation Safety Engineer (retired), Office of Traffic and Safety, Iowa Department of Transportation*

AASHTO LIAISONS

Kelly Hardy, *Safety Program Manager, American Association of State Highway and Transportation Officials*
Pam Hutton, *SHRP 2 Implementation Manager, American Association of State Highway and Transportation Officials*
Jim McDonnell, *Program Director for Engineering, American Association of State Highway and Transportation Officials*

FHWA LIAISONS

Monique Evans, *Director, Office of Safety Technologies, Federal Highway Administration*
Michael Griffith, *Director, Office of Safety Integration, Federal Highway Administration*

AUTO INDUSTRY LIAISONS

Michael Cammisa, *Director, Safety, Association of Global Automakers*
Scott Schmidt, *Director, Safety and Regulatory Affairs, Alliance of Automobile Manufacturers*

EUROPEAN SAFETY LIAISON

Fred Wegman, *Managing Director, SWOV Institute for Road Safety Research, Netherlands*

FMCSA LIAISON

Martin Walker, *Chief, Research Division, Federal Motor Carrier Safety Administration*

NHTSA LIAISONS

Richard Compton, *Director, Office of Behavioral Safety Research, National Highway Traffic Safety Administration*
Tim Johnson, *Director, Office of Human-Vehicle Performance Research, National Highway Traffic Safety Administration*
Seymour Stern, *Team Leader, State Based Systems, National Highway Traffic Safety Administration*

* Membership as of July 2014.

Related SHRP 2 Research

- Naturalistic Driving Study: Development of the Roadway Information Database (S04A)
- Design of the In-Vehicle Driving Behavior and Crash Risk Study (S05)
- Naturalistic Driving Study: Collecting Data on Cell Phone Use (S06)
- Naturalistic Driving Study: Field Data Collection (S07)
- Analysis of Naturalistic Driving Study Data: Safer Glances, Driver Inattention, and Crash Risk (S08A)
- Analysis of Naturalistic Driving Study Data: Offset Left-Turn Lanes (S08B)
- Analysis of Naturalistic Driving Study Data: Roadway Departures on Rural Two-Lane Curves (S08D)
- Naturalistic Driving Study: Descriptive Comparison of the Study Sample with National Data (S31)
- Naturalistic Driving Study: Alcohol Sensor Performance (S31)
- Naturalistic Driving Study: Linking the Study Data to the Roadway Information Database (S31)