Naturalistic Driving Study: Technical Coordination and Quality Control
ACKNOWLEDGMENT
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, which is administered by the Transportation Research Board of the National Academies.

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NATURALISTIC DRIVING STUDY: TECHNICAL COORDINATION AND QUALITY CONTROL

Prepared for
The Second Strategic Highway Research Program
Transportation Research Board
of
the National Academies

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Virginia Tech Transportation Institute
Blacksburg, VA
May 2014
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The research reported in this document was performed under the Second Strategic Highway Research Program (SHRP 2) Project S06: *Technical Coordination and Quality Control* (S06), by the Virginia Tech Transportation Institute (VTTI) at Virginia Tech. VTTI was the prime contractor for this study.

Thomas Dingus, Ph.D., is the Director of VTTI and served as Principal Investigator for this study. Without Dr. Dingus’ singular vision and leadership, this project would not have been possible. Dr. Jonathan M. Hankey, Senior Associate Director for Research and Development at VTTI, served as Associate Principal Investigator. Dr. Hankey served as VTTI’s chief liaison with project sponsors and advisory boards, leading the efforts to address critical problems and keep the project on track. Jon Antin, Ph.D., Director of the 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. Dr. 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 to this extensive research effort. VTTI appreciates and acknowledges the following: Ann M. Brach, Ph.D., Director, SHRP 2 for her unflagging support of this research effort since its infancy; Kenneth L. Campbell, Ph.D., Chief Program Officer of Safety Research, for his thoughtful counsel and tireless encouragement as the project evolved from concept to conduct to completion; James H. Hedlund, Ph. D., Special Consultant for Safety Coordination, for serving as a liaison to the greater research community and providing sound and insightful guidance throughout; Andrew T. Horosko, Special Consultant for Safety Research, for his meticulous review of project reports and coordination with the data collection site contractors; Walter J. Diewald, Ph. D., Senior Program Officer for Safety Research, for his management of the data acquisition system procurement and institutional review board efforts; and Charles R. Fay, Senior Program Officer for Safety Research, for artfully coordinating the roadway information data collection and select technical groups. 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 in conjunction with the preparation of this report. Of note, special acknowledgement is extended to Elizabeth G. Eichelberger, Project Coordinator for the SHRP 2 NDS, who coordinated logistical efforts from the Study Design phase to the completion of the project and Kelly E. Stulce, Project Assistant, who facilitated much of the operational and reporting activity throughout the study. Loren Stowe, Senior Research Associate, directed the acquisition of over $12 million of data collection equipment. Doug McGraw, Senior Database Administrator, and Clark Gaylord, Chief Information Officer, designed and developed the complex database infrastructure and the network infrastructure that permitted the secure transfer of data throughout the study. Dr. Miguel Perez, Director of the Center for Data Reduction and Analysis Support, conducted quality assessments of the data, and sorted and categorized data such that its usability to future researchers will remain viable for years to come.
Additional Virginia Tech and Coordination Contractor staff provided valuable contributions to support the NDS study. The bounty of technical expertise of the following individuals provided a strong foundation to 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 below each played a role of great significance which merits their inclusion herein: 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 warrant special recognition. Their cooperation and commitment to following the NDS study protocols has 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,
- From Penn State University: Paul Jovanis, Phil Garvey, Betsy Jeschke, Robin Tallon, Zolton Rado, Billy Johns and the remaining intake, assessment and installation staff.
ABSTRACT

The goal of the study was to collect and provision a naturalistic data set accessible to transportation safety researchers. Six study sites were selected to maintain geographical diversity. The goal was to have 1,950 cars on the road simultaneously collecting data continuously for two or more years. The data acquisition system was designed to be unobtrusive, robust, and automatic. It could not cause permanent damage or a safety hazard, it had to perform machine-to-machine (M2M) communications, and it could not interfere with vehicle operations. Data were collected by several integrated video and sensor channels. The Coordination Contractor, the Virginia Tech Transportation Institute (VTTI), coordinated the study, developing, procuring, and configuring all hardware and software elements, and providing training for use of same. A major role of the Coordination Contractor was to manage the secure flow of data to their final repository. Checks and redundancies were established to ensure no data loss. Quality processes were put into place to identify data anomalies and correct them where possible. Participants were men and women of all driving ages, and ethical protocols were implemented to ensure standard human subjects protections. The study collected two petabytes of data from 3,000 participants, encompassing 50 million miles of naturalistic driving data that can be mined for a generation.
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
- Tampa, Florida: Center for Urban Transportation Research – University of South Florida (CUTR-USF)
- Seattle, Washington: Battelle Memorial Institute (Battelle)
- Durham, North Carolina: Westat
- Central Indiana: Indiana University
- Central Pennsylvania: Penn State University

FIGURE ES.1  Site locations and each one’s nominal DAS allocations of the 1,950 total.

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.

**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 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, whereas 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 where 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**

In order 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 were
purchased for the SHRP 2 NDS; additional quantities of several strategically chosen parts were purchased for logistical or replacement purposes.

FIGURE ES.2 DAS kit components (featuring from upper left and moving clockwise: NextGen Main Unit, Head Unit and Network Box, the RIB, and the radar assembly).

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

DAS sensors and capabilities included:

- Multiple Video and Still Views
- Machine-Vision-Based Applications
- Accelerometers (x, y, and z axes)
• Rate Sensors (x, y, and z axes)
• Global Positioning System (GPS)
• Forward Radar
• Illuminance Sensor
• Passive Cabin Alcohol Presence Sensor
• Incident Pushbutton
• Turn Signal State
• 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.

![Quad Image of Video Views](image)

FIGURE ES.4 Quad image of video views (note: driver in the image above is a non-participant employed by the Coordination Contractor).

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 de-installation. 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 de-installation 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 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, Sub-Prime, Legacy, and Basic, as described in TABLE ES.1. The parameter ID or PID refers to the codes used to interpret the network data.
### TABLE ES.1 SHRP 2 NDS Vehicle Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Vehicles Included</th>
<th>Vehicle Network Information Collected</th>
<th>Vehicle Count</th>
<th>% of fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime</td>
<td>Vehicles for which PIDs were available</td>
<td>Speed, plus wiper activation, brake actuation, headlight activation, turn signal activation, and steering data, as available</td>
<td>1,717</td>
<td>51%</td>
</tr>
<tr>
<td>Sub-Prime</td>
<td>Generally vehicles manufactured after 2009 for which PIDs were not available</td>
<td>Speed and accelerator position</td>
<td>488</td>
<td>15%</td>
</tr>
<tr>
<td>Legacy</td>
<td>Vehicles manufactured between 1996 and 2008</td>
<td>Speed and accelerator position</td>
<td>736</td>
<td>22%</td>
</tr>
<tr>
<td>Basic</td>
<td>Vehicles manufactured prior to 1996 without vehicle networks</td>
<td>None</td>
<td>421</td>
<td>13%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>3,362</td>
<td>100%</td>
</tr>
</tbody>
</table>

**REPORTS**

A wide variety of reports were 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 which 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 contributes one vehicle-month of data for each full month of participation in the study, regardless of the actual number of driving miles or hours represented during that time period. It is true to state that driving distance or 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). Also, 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 they 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 would commence automatic upload of the data from each inserted drive. Once a drive’s data had been 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 its original encrypted state until it was queued for processing in the workflow system. At that time, it was decrypted in order to perform any transformations required prior to loading the data set into its ultimate repository. FIGURE ES.7 illustrates the transfer of data from 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 had been transferred, decrypted, and ingested, they were protected by role-based security that limited a user’s access based on his or her Institutional Review Board (IRB)-approvals in the case of access to personally identifying information (PII) or based on his or her 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 in 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 are described below.

Sensor Data

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

- **Not present**: 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**: 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](https://insight.shrp2nds.us)). Boundary values (i.e., lower, upper, both) could be specified independently for each variable.

- **Simple Dependency**: 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**: Similar to a simple dependency, but with more complex conditions allowed; whereas 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 in order to output a good quality score.

- **Duplicates**: Whether a particular variable had two entries on the collected data under the same timestamp. If that were the case, the data quality for the timestamp in which this occurred was considered “bad.”

- **Spike Identification**: 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**

<table>
<thead>
<tr>
<th>Camera View</th>
<th>Ideal</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face Camera</td>
<td>Complete, clear view of the driver’s face, including eyes and mouth; camera should be positioned to exclude views of backseat passengers.</td>
<td>A clear view of the face facilitates eye-glance analysis and evaluation of distraction associated with secondary tasks of talking, eating, and singing.</td>
</tr>
<tr>
<td>Forward Camera</td>
<td>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, with the horizon just above the center line.</td>
<td>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.</td>
</tr>
<tr>
<td>Instrument Panel View</td>
<td>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.</td>
<td>A clear view of the hands and center console facilitates analysis of distractions resulting from secondary tasks such as adjusting cabin temperature or radio, cell phone usage, and reaching for objects.</td>
</tr>
<tr>
<td>Rear Camera</td>
<td>High-quality video of the traveled roadway; traveled roadway and following traffic and traffic lights should be visible, with roadway centered horizontally, with horizon just above center vertically.</td>
<td>A clear view of the traveled roadway facilitates analysis of traffic density and potential hazards posed by following traffic.</td>
</tr>
</tbody>
</table>
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
- 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. While assuring the quality of the time series data and video collected via the DAS was a central focus of the overall quality efforts, considerable efforts were also devoted to assuring the quality of all 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). Without such baseline knowledge, a statistical outliers approach was employed wherein extreme values were distrusted and discarded, except where independent verification would suggest otherwise. With this Interquartile Range (IR) approach, any value ≤ [Q1 − (1.5 × IQR)] or ≥ [Q3 + 1.5 × 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. 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 many 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.

**TABLE ES.3 Primary Participants with 4 Months in the Study**

<table>
<thead>
<tr>
<th>Site</th>
<th>Primary Participant Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>NY</td>
<td>719</td>
</tr>
<tr>
<td>FL</td>
<td>698</td>
</tr>
<tr>
<td>WA</td>
<td>676</td>
</tr>
<tr>
<td>NC</td>
<td>504</td>
</tr>
<tr>
<td>IN</td>
<td>239</td>
</tr>
<tr>
<td>PA</td>
<td>256</td>
</tr>
<tr>
<td>Total</td>
<td><strong>3,092</strong></td>
</tr>
</tbody>
</table>

Vehicle Installations

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

**FIGURE ES.8 Number of installed vehicles over time.**
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.

![Bar chart showing primary participants across age groups](image)

FIGURE ES.9  Primary participants across age groups relative to original target.

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.10  SHRP 2 vehicle fleet by type.

Manufacturer

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

FIGURE ES.11  SHRP 2 fleet distribution by manufacturer.

CRASHES

Five hundred and thirty-two possible crash events were identified in the data set. Potential crashes were unearthed via a variety of means, including participant reports, automatic crash notification (ACN) algorithms on the DAS, and running similar ACN algorithms on
ingested data. Once identified as possible events, classification as actual crashes was verified via video review. For each instance where 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:

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

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

![FIGURE ES.12 Evaluated crash events by crash severity.](chart)

Severity I: 29
Severity II: 80
Severity III: 79
Severity IV: 184
Total: 372
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 upon 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 synchs, indicating—with video verification—which trips might include 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 (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.
FIGURE ES.13  Total participants versus participants who agreed to be contacted for future studies.

CONCLUSIONS

The 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 three-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 in order 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 underway, 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 in order 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), requests by participants 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 very little, if any, actual contact, are issues researchers must thoughtfully prepare to confront.

Another consideration in the planning of the project timeline is the question of whether to conduct initial data analyses concurrent with data collection or after it has been concluded. SHRP 2’s Safety Technical Coordinating Committee authorized initial analyses prior to 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 dataset is complete. Data analysis on an incomplete and constantly changing data set is frustrating for the analyst and could possibly lead to misleading conclusions. In addition, data sharing while the dataset is being built is also disruptive and inefficient for to 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 was undertaken to plan all aspects of the SHRP 2 NDS. Its outcome was a comprehensive study plan for the SHRP 2 NDS incorporating 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, S05: 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 provides a summary of the oversight and coordination efforts for the Second Strategic Highway Research Program (SHRP 2) Naturalistic Driving Study (NDS) with special emphasis on the SHRP 2 Project S06 Technical Coordination and Quality Control Study. The goal of this report is to capture the key elements of the study so that it could be replicated (or improved upon) if a consortium of individuals so desired 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 de-installation
- 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
- Design of the inventory management software and protocols

In addition to the above-noted 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 in the 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 two 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 set 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 may 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](https://insight.shrp2nds.us)). As of December 20, 2013, registration is required to access the site, and 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 also be found in the Time Series Data Dictionary in the SHRP 2 Data Access website ([https://insight.shrp2nds.us](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
  - Lane Tracker
- Accelerometers (x, y, and z axes)
- Rate Sensors (x, y, and z axes)
- Global Positioning System (GPS)
  - Latitude, Longitude, Elevation, Time, Velocity
- Forward Radar
  - X and Y positions
  - 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
  - Anti-Lock Braking System (ABS)
  - Gear position
  - Steering wheel angle
  - Speed
  - Horn
  - Seat Belt Information
  - Airbag deployment
Demographics – A variety of basic demographics data were collected from each participant during 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 two-hour window, coinciding with vehicle installation. Questionnaires could be filled in at the installation site or later, as per the participant’s needs, and 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.

TABLE 1.1 Assessment Questionnaires Administered

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep Habits</td>
<td>A questionnaire designed to determine the participant’s sleeping patterns, habits, and level of fatigue (Appendix B)</td>
</tr>
<tr>
<td>Risk Perception</td>
<td>A questionnaire designed to gauge the participant’s perception of dangerous or unsafe driving behaviors or scenarios (Appendix C)</td>
</tr>
<tr>
<td>Barkley’s Quick Screen</td>
<td>A short, clinical, ADHD screening assessment. This screening instrument operationalizes ADHD symptoms in terms of specific behaviors. (Appendix D)</td>
</tr>
<tr>
<td>Sensation Seeking</td>
<td>A survey comprised of 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)</td>
</tr>
<tr>
<td>Driving Knowledge</td>
<td>A test of knowledge of driving laws and appropriate behaviors (Appendix F)</td>
</tr>
<tr>
<td>Medical Conditions &amp; Medications</td>
<td>The medical conditions and medications questionnaire is an instrument designed to obtain information from participants regarding their self-reported medical history. The questions are focused on the identification of conditions that could affect driving performance and safety. (Appendix G)</td>
</tr>
<tr>
<td>Modified Manchester Driver Behavior</td>
<td>The modified Manchester Driver Behavior Questionnaire is 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)</td>
</tr>
</tbody>
</table>
### TABLE 1.2 Vision Tests

<table>
<thead>
<tr>
<th>Near/Far</th>
<th>Visual Ability</th>
<th>Monocular/Binocular</th>
<th>“Day”/”Night”</th>
<th>Glare/No Glare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Far</td>
<td>Acuity</td>
<td>Binocular</td>
<td>Day</td>
<td>Glare</td>
</tr>
<tr>
<td>Near</td>
<td>Acuity</td>
<td>Binocular</td>
<td>Day</td>
<td>No Glare</td>
</tr>
<tr>
<td></td>
<td>Contrast Sensitivity</td>
<td>Monocular</td>
<td>Day</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contrast Sensitivity</td>
<td>Monocular</td>
<td>Night</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Depth Perception</td>
<td>Binocular</td>
<td>Night</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Color Perception</td>
<td>Binocular</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peripheral Vision</td>
<td>Monocular</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 1.3 Cognitive Assessments

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clock Drawing</td>
<td>Dementia Screen</td>
<td>The participant was presented with pencil and paper; on the paper was a circle and nothing else. They were 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.”</td>
</tr>
<tr>
<td>Connor’s Continuous Performance Test v. 5 (CPT II)</td>
<td>Executive Function</td>
<td>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.</td>
</tr>
<tr>
<td>Visualizing Missing Information - Motor Free Visual Perception Test</td>
<td>Visual-Cognitive</td>
<td>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.</td>
</tr>
<tr>
<td>Visual Information Processing Speed / Useful Field of View (UFOV®)</td>
<td>Visual-Cognitive</td>
<td>Participants were briefly presented one of two very similar target stimuli (truck or car icon which differed only slightly) in the center of the display. In addition to this, a second simultaneously presented target icon that is the same as the central target was presented in one</td>
</tr>
</tbody>
</table>
Assessment Type Description

of eight possible peripheral locations at varying eccentricities in a 35-degree region around the central visual field. Participants had to both identify what the central target was, as well as 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 & B) Visual-Cognitive Participants used a touch screen to connect in order (i.e., 1-2-...n) a series of randomly arranged numbers (part A) then a series of randomly arranged numbers and letters in alternating progressing sequences (i.e., 1-A-2-B-3...etc., part B). Time-to-completion of the entire series is recorded.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip Strength</td>
<td>Upper Body</td>
<td>Left- and right-hand grip strength measurement conducted using the Jamar® Hydraulic Hand Dynamometer</td>
</tr>
<tr>
<td>Rapid Pace Walk</td>
<td>Lower Body</td>
<td>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.</td>
</tr>
</tbody>
</table>

**TABLE 1.4 Physical Ability Metrics**

**Vehicle Information** – In addition to make, model, year, and vehicle category (i.e., car, van, sport utility vehicle [SUV], 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 synched 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 factors related to crash severity (i.e., injuries, speed, and property damage), roadway factors, driver age and driver condition (i.e. drowsy, emotional, focused, etc.).

A Level I 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 (PAR, redacted to remove any personally identifying information); publically 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 II Post Hoc Crash Investigation included everything involved in a Level I 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 into a single “document” all of the Level I or II post hoc crash data for a single crash instance as a Portable Document Format (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.

DAS Management

The management of the DAS involved the 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 prior to being released for use as a field ready system. In addition, constrained DAS resources had to be continually redistributed across the Site Contractors, 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 security
protocols to 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 and relied 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 at a high level operations at both the New York and Florida sites). 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 below.

<table>
<thead>
<tr>
<th>Data Item</th>
<th>Good Quality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NETWORK SPEED</td>
<td>97.35</td>
</tr>
<tr>
<td>ACCELERATOR Position</td>
<td>97.65</td>
</tr>
<tr>
<td>TURN SIGNAL Status</td>
<td>94.29</td>
</tr>
<tr>
<td>BRAKE PEDAL</td>
<td>96.15</td>
</tr>
<tr>
<td>Usable FACE VIDEO (i.e., &gt; 80% per vehicle)</td>
<td>99.08</td>
</tr>
<tr>
<td>Usable FORWARD video (i.e., &gt; 80% for car)</td>
<td>97.61</td>
</tr>
<tr>
<td>Usable REAR video (i.e., &gt; 80% per vehicle)</td>
<td>94.07</td>
</tr>
<tr>
<td>Usable LAP video (i.e., &gt; 80% per vehicle)</td>
<td>99.26</td>
</tr>
<tr>
<td>Usable IMU (Acceleration, x-axis)</td>
<td>99.27</td>
</tr>
<tr>
<td>Usable GPS (speed only)</td>
<td>96.06</td>
</tr>
</tbody>
</table>

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 non-sensor/non-driving 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.
Reporting

A required component of the Coordination Contractor’s role included the reporting on an array of project activities. A wide variety of reports were 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 were 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 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 RFPs, evaluated 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 direction 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, and is followed by summaries of outcomes, lessons learned, and future research implications.

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

The preparation phase describes those activities that were necessary to accomplish prior to the start of data collection from both a study-wide perspective and in terms of the readiness of each individual site. The data collection phase describes that 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 utilized to collect, secure, and protect the data, and assess their quality.

The cell phone records chapter of this document describes the standalone 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.
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 would be 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 IRBs 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 prior to 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 prior to the participant coming in for formal enrollment.
  - Use a Frequently Asked Questions (FAQ) format 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.
  
  o 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 plan to include minors in the study as well as its high-profile nature (i.e., thousands of participants located across the United States). 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 prior to any of the other four sites granting 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; 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 included clarification of the withdrawal/dismissal protocol, expanding recruitment methods, allowing semi-annual drawings for prizes for all enrolled participants (disallowed by the Seattle, Washington, site due to conflict with state law), and creating a mechanism whereby leased vehicles could be included 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 de-identified 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 participants 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 in fact neither a consented primary nor a consented secondary driver.

While secondary drivers or other non-consented 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

Initial study design called for participants to enroll for either one or two 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](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 would be politely dismissed in a way that deflected attention from the teen (i.e., the site manager would indicate that there was an incompatibility between the vehicle and study equipment and offer 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 Forms in Appendices J, K, and N with final compensation schemes described in later chapters of this report):

- Primary drivers enrolled for one year were compensated at $300 per year, paid in three installments (increased to $500 per year beginning summer 2011).
- Primary drivers enrolled for two 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. In order 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:

- 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 rear and right of the vehicle
  - **Occasional Still Photo of Cabin (permanently blurred)**
  - **Machine-Vision-Based Applications**
    - Head Pose Monitor
    - Lane Tracker
  - **Accelerometers (x, y, and z axes)**
  - **Rate Sensors (x, y, and z axes)**
  - **Global Positioning System (GPS)**
    - Latitude, Longitude, Elevation, Time, Velocity
  - **Forward Radar**
    - X and Y positions
    - 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
    - Anti-Lock Braking System (ABS)
    - Gear position
• Steering wheel angle
• Speed
• Horn
• Seat Belt Information
• Airbag deployment

• Define procedures required to change instrumentation mid-study.
• Assess tradeoffs.

Consequently, the procurement process was 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, 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 sub-head arm. The radar was mounted to the front license plate frame and was the most vulnerable component. The Radar Interface Box was located under the hood of the vehicle and utilized Bluetooth technology to communicate with the NextGen. The Network Box was utilized 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 system assembly. The primary selection was for a CM to produce the PCB assemblies, and perform assembly and test procedures for individual system components along with the full system. A Request for Proposal (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 as demonstrated below.

The selection committee established the criteria and their relative weighting (listed below in TABLE 2.1), and these were used throughout the selection process to evaluate the candidates.
TABLE 2.1 Selection Criteria Weighting Scale

<table>
<thead>
<tr>
<th></th>
<th>Maximum Point Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ability to Meet Delivery Requirements</td>
</tr>
<tr>
<td>2</td>
<td>Services Offered</td>
</tr>
<tr>
<td>3</td>
<td>Price of Goods</td>
</tr>
<tr>
<td>4</td>
<td>Price of Services</td>
</tr>
<tr>
<td>5</td>
<td>Prototype Evaluation</td>
</tr>
<tr>
<td>6</td>
<td>Small, Women and Minority SWaM Utilization</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

Final Vendor Selection

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

TABLE 2.2 Vendor Selection Criteria, and Final Scores

<table>
<thead>
<tr>
<th></th>
<th>ACDI</th>
<th>Alt B</th>
<th>Alt C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ability to Meet Delivery Requirements</td>
<td>8.2</td>
<td>8.3</td>
</tr>
<tr>
<td>2</td>
<td>Services Offered</td>
<td>8.3</td>
<td>8.3</td>
</tr>
<tr>
<td>3</td>
<td>Price of Goods</td>
<td>35.0</td>
<td>30.2</td>
</tr>
<tr>
<td>4</td>
<td>Price of Services</td>
<td>20.0</td>
<td>18.4</td>
</tr>
<tr>
<td>5</td>
<td>Prototype Evaluation</td>
<td>13</td>
<td>4.0</td>
</tr>
<tr>
<td>6</td>
<td>SWaM Utilization</td>
<td>10</td>
<td>10.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>94.4</td>
<td>79.1</td>
</tr>
</tbody>
</table>

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

Telemetry Service Integration and Procurement

Each NextGen featured cellular machine-to-machine (M2M) modem technology which 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 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 utilizing 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 de-installation; 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, respectively. 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, battery chargers, etc. IRB issues were discussed at a high level, including current progress on attainment of the Certificate of Confidentiality from NIH. Finally, custom software, including its purpose and a high-level introduction on how to use it, was included in the discussion. 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 two 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 K). The checklist encompassed the following areas: general facilities (e.g., signage, parking, waiting areas, etc.), participant enrollment (e.g., privacy, secure storage for hardcopy documents, etc.), participant assessment (e.g., sufficient and safe space for the rapid pace walk, suitable space and equipment if running two or more participants simultaneously, etc.), and the garage/shop area (e.g., space sufficiency, suitable carbon dioxide [CO2] exhaust/ventilation, accessible DAS storage, etc.). Each element on the checklist was either validated as approved or noted as an area for remediation prior to commencing data collection.

Training

To ensure consistent understanding of human subjects’ protection structures and protocols across sites, each individual who interacted with a human participant (or who may have 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
• Out-processing (de-enrollment)

Institutional Review Board & 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 freely pass 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 a traffic stop or crash, etc. Although the study equipment is unobtrusive, it was possible that an officer may have still noticed and asked 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
• 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 one-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 IRB training. Best practices were shared with trainees in of 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/de-installation 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, three days of training covering all aspects of the installation, maintenance, and de-installation activity 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 de-installation, 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 by trainees during the three-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 approximately two weeks prior to the start of installations at that site to maximize retention while still permitting time to perform practice installations and de-installations. In addition, Coordination Contractor representatives traveled to each Site Contractor location for the first three 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
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, where access was controlled using role-based security protocols. Coordination Contractor and SHRP 2 staff members were able to view information on the following study elements: participants, vehicles, and components across all sites; however, personally identifying participant information was not available to these user groups. In contrast, Site Contractors were able to see the same categories of information, including personally identifying information, but restricted to 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.

![FIGURE 2.3 MCS screen capture.](image)

**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 contained therein by means of an individualized dashboard view, pictured in FIGURE 2.4 below. Each issue was identified in the form of a ticket and placed into a work queue based upon which entity was deemed most appropriate to take responsibility for that particular work item. RT was structured based on a series of queues, which were virtual containers of categorized tickets or issues that needed to be worked 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 by the Site Contractors and served as a way to communicate to them 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, there were a number of queues that were managed by 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, Hardware Repairs, etc. 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, or view all unowned tickets, generate a ticket, monitor queues of which he or she was a member, or search for a specific ticket.

FIGURE 2.4 Request Tracker dashboard.

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 upon 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, utilizing Google Voice™, a free technology 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 one 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 of 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 utilize 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) were featured on the “home” page.

While this was a publically 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.

FIGURE 2.5 DrivingStudy.org.

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 suppliers, building kits, and supporting the varying
installation scheduling needs of sites. TABLE 2.3 below 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.
### TABLE 2.3 Kit Projections by Site Contractor Data Collection Site

<table>
<thead>
<tr>
<th>Site Contractor Data Collection Site</th>
<th>Nominal Quantity of Designated Kits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NY</td>
<td>450</td>
</tr>
<tr>
<td>FL</td>
<td>450</td>
</tr>
<tr>
<td>WA</td>
<td>450</td>
</tr>
<tr>
<td>NC</td>
<td>300</td>
</tr>
<tr>
<td>IN</td>
<td>150</td>
</tr>
<tr>
<td>PA</td>
<td>150</td>
</tr>
</tbody>
</table>

Throughout the study, weekly assessments of equipment supplies at sites were conducted, thereby 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.

As described previously and shown in FIGURE 2.6 below, each DAS kit comprised six main components (NextGen Main Unit, Head Unit, radar, Radar Interface Box, 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 moving clockwise, are the NextGen, Head Unit, Network Box, Radar Interface Box, 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 the plastic housings for the main components as well. Each DAS kit was bench tested by the equipment manufacturer to ensure the operability of the equipment prior to shipping.
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 synching during analysis.

During the installation process, software packages specific to the unique combination of vehicle year/make/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 which allowed for the 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 On-board Diagnostic 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 Radar Interface Box, which significantly reduced the amount of time needed to perform the installation as 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 2.7 Head Unit assembly.

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 included ones to measure ambient illuminance, acceleration in three dimensions, yaw rate, and the presence of alcohol in the cabin. In addition, the Head Unit included a button that the participant could press which opened a 30-second audio channel so an event of interest could be described and marked the data stream for later analysis.
Installation Equipment and Software

Custom vehicle management software was developed in order to facilitate the installation, de-installation, and mid-study 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 therein was stored on a local database installed on the laptop. After each installation, maintenance, or de-installation 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 where 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 prior to 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 de-installation 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. Lastly, the participant was brought back to the vehicle to take driver images inside the vehicle (to aid the post hoc process whereby each analyzed trip file is definitively associated with a consented driver) and to conduct an inspection of the vehicle verifying that no damage was caused by the installation process.

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

Similarly, custom software was utilized by hardware technicians during mid-study visits, during which time they conducted routine data drive swaps or other DAS maintenance. Using the vehicle and component barcodes in conjunction with the maintenance software allowed the Coordination Contractor to maintain accurate inventory records as components were replaced mid-study. 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 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.
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 these 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 below) was selected to measure a variety of visual abilities, 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 below) was utilized to measure participants’ grip strength, used 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 utilized for this purpose. The computer was loaded with Driving Health® Inventory (DHI) software and Connor’s Continuous Performance II (CPT II) version 5. The DHI software featured several tests of visual-cognitive ability which 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

In order to efficiently transfer collected driving data 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 ensued that 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, one 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 S07 to identify participants, their vehicles, any components installed in those vehicles, and participant assessment data.

Preliminary planning for SHRP 2 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, 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 de-installations 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 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 efficiently transfer data 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 (mbps). Once the study was underway and data drive (128 GB solid-state drives (SSD)) swaps reached a steady state, the Coordination Contractor was receiving 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 either at a Site or Coordination Contractor facility.
barcode system was developed in which a component’s bar code was scanned as it was installed or de-installed. 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) one merely scanned the box barcode 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 prior to 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 which 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 over-sample 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. 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. Competence to grant informed consent (or for minors, informed assent with consent granted by parent or guardian)
5. Must have an eligible vehicle (note: eligible vehicles list grew as the study progressed)
6. Must have a suitable vehicle (i.e., in terms of mechanical soundness and anticipated life, cleanliness/hygiene, and freedom from other concerns (e.g., leaks or presence of illegal materials, etc.))

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 one year, whereas others would be recruited for a two-year duration. The objective of over-sampling 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 study-wide sampling plan; each data collection site was only responsible for a subset of the overall design proportional to its nominal DAS unit allocation percentage as indicated in TABLE 2.3 shared previously.
### TABLE 2.4 Initial Study-wide Sample Design

<table>
<thead>
<tr>
<th>Gender Age Range</th>
<th>Age Group Description</th>
<th>One Year</th>
<th>Two Years</th>
<th>Total Participants</th>
<th>DAS Units</th>
<th>Vehicle-Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 16-17</td>
<td>Minor Teen</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>M 18-20</td>
<td>Adult Teen</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>M 21-25</td>
<td>Young Adult</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>M 26-35</td>
<td>Adult</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>M 36-50</td>
<td>Middle Adult</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>M 51-65</td>
<td>Mature Adult</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>M 66-75</td>
<td>Younger Older</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>M 76+</td>
<td>Older-Older</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>F 16-17</td>
<td>Minor Teen</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>F 18-20</td>
<td>Adult Teen</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>F 21-25</td>
<td>Young Adult</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>F 26-35</td>
<td>Adult</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>F 36-50</td>
<td>Middle Adult</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>F 51-65</td>
<td>Mature Adult</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>F 66-75</td>
<td>Younger Older</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>F 76+</td>
<td>Older Older</td>
<td>72</td>
<td>28</td>
<td>172</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Any</td>
<td>Advanced Vehicle</td>
<td>0</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>700</td>
</tr>
<tr>
<td></td>
<td>Technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>1,152</td>
<td>798</td>
<td>3,102</td>
<td>1,950</td>
<td>3,900</td>
</tr>
</tbody>
</table>

Site Selection Factors – Study sites were selected by a SHRP 2 Expert Technical 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, 3 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 6 sites (Antin 2011). It should be noted that data collection site selection could not be based solely on a desire to 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 is illustrated in FIGURE 2.11.
Data collection sites were managed by the respective organizations listed in TABLE 2.5.

### TABLE 2.5 Data Collection Site Contractors

<table>
<thead>
<tr>
<th>Site Center</th>
<th>Managing Organization(s)</th>
<th>Nominal DAS Units Allocation &amp; Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo, N.Y.</td>
<td>CUBRC, Inc.® supported by CalSpan Corp.</td>
<td>450 (23%)</td>
</tr>
<tr>
<td>Tampa, Fla.</td>
<td>CUBRC, Inc.® supported by Center for Urban Transportation Research, University of South Florida</td>
<td>450 (23%)</td>
</tr>
<tr>
<td>Seattle, Wash.</td>
<td>Battelle</td>
<td>450 (23%)</td>
</tr>
<tr>
<td>Durham, N.C.</td>
<td>Westat</td>
<td>300 (15%)</td>
</tr>
<tr>
<td>Bloomington, Ind.</td>
<td>Transportation Research Center, University of Indiana</td>
<td>150 (8%)</td>
</tr>
<tr>
<td>State College, Pa.</td>
<td>Larson Institute, Penn State University</td>
<td>150 (8%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1,950 (100%)</strong></td>
</tr>
</tbody>
</table>
At the outset of the study, all recruitment activities were conducted and coordinated by the Virginia Tech Center for Survey 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 fall-back position if Tiers 1 and 2 were to prove less successful or efficient than desired. The Tier 1 approach utilized random cold-calling, wherein numbers (procured by VT CSR management) within site boundaries were called at random. Tier 2 entailed focused random calling, whereby 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 L) was determined by those vehicles for which various original equipment manufacturers (i.e., OEMs, 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 publically available, whereas others are strictly proprietary. Each OEM that provided proprietary PIDs to the Coordination Contractor entered into a non-disclosure 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 M. Note that recruiting obstacles ultimately necessitated an expansion of the list to include vehicles for which PIDs were not obtained, but where 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,
Weekly Operations Team Conference Call

The Coordination Contractor hosted a weekly Operations Team meeting including 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, 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, de-installations, 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 upon 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 de-installation 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 prior to data collection.

Coordination of Multiple IRBs

Once the study was underway, 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 & 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 at most monthly, some less frequently.

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 3, six amendments were required prior to the first participants being enrolled in the study. Once the study was underway, operational logistics and alterations in sample design strategies resulted in an additional twelve amendments (about one every three 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 study-wide (e.g., allowing for varying periods of participation beyond the initially envisioned one or two-
year periods). Appendix J includes a brief description of each of the amendments submitted and approved during the data collection phase of the study.

**Adverse Events**

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

There were eight adverse events reported to the various IRBs in the course of the project, all in the less-than-serious unanticipated problem category. A typical reporting process was for the involved site personnel to report 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, and the final Adverse Event Report would be submitted to the VT IRB within five business days of the Coordination Contractor becoming aware of the event, 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 their own IRB to meet their 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 non-participant 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 requested 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 his or her own driving habits. In seventeen cases, concerns were alleviated without the review of video. In five cases, video was unavailable. In the eleven 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: industry wide 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 both in the price and availability of the 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 thereby 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 may 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 that 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 impacting the vehicle’s network.

**Software Upgrades**

*Shakedown Software*

In early 2011, study leadership recognized the need to capture and rectify any installation problems prior to the vehicle leaving 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, utilizing 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 would populate 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 participant-vehicles that had been non-responsive 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 due to being 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 de-installation 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 the 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, de-installations, 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 that each site was to have three to six weeks of equipment to support installation and maintenance activities. To establish a basis for DAS supplies, it was decided that a site’s inventory status would be considered based upon scheduled activities scheduled over the upcoming three-week period, actual activities undertaken over the previous three-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 the site 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 activities at data collection sites. Information was procured from the data collection sites on a weekly basis, but could conceivably prove out-of-date even as soon as close of business on the day it was received due to cancellations, reschedulings, etc. 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 de-installation. This incongruity required the Coordination Contractor to not only 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.
### TABLE 3.1  Example Site Performance Summary

<table>
<thead>
<tr>
<th>Site Performance Summary</th>
<th>NY</th>
<th>FL</th>
<th>WA</th>
<th>NC</th>
<th>IN</th>
<th>PA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles on road</td>
<td>438</td>
<td>443</td>
<td>423</td>
<td>303</td>
<td>158</td>
<td>147</td>
<td>1,912</td>
</tr>
<tr>
<td>June-July installations</td>
<td>11</td>
<td>14</td>
<td>6</td>
<td>4</td>
<td>10</td>
<td>7</td>
<td>52</td>
</tr>
<tr>
<td>Scheduled June-July installations</td>
<td>22</td>
<td>15</td>
<td>21</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>70</td>
</tr>
<tr>
<td>% of scheduled June-July installations performed</td>
<td>50</td>
<td>93</td>
<td>29</td>
<td>50</td>
<td>1000</td>
<td>233</td>
<td>74</td>
</tr>
<tr>
<td>June-July deinstallations</td>
<td>13</td>
<td>20</td>
<td>13</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>61</td>
</tr>
<tr>
<td>Scheduled June-July deinstallations</td>
<td>12</td>
<td>5</td>
<td>10</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>39</td>
</tr>
<tr>
<td>% of June-July deinstallations performed</td>
<td>108</td>
<td>400</td>
<td>130</td>
<td>100</td>
<td>300</td>
<td>120</td>
<td>156</td>
</tr>
<tr>
<td>Full kits on shelf</td>
<td>11</td>
<td>18</td>
<td>17</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>76</td>
</tr>
<tr>
<td>Partial kits on shelf</td>
<td>4</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Kits en route to site</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total kits at site</td>
<td>453</td>
<td>461</td>
<td>448</td>
<td>313</td>
<td>168</td>
<td>157</td>
<td>2,000</td>
</tr>
<tr>
<td>% of allocated inventory at site</td>
<td>100</td>
<td>102</td>
<td>106</td>
<td>101</td>
<td>108</td>
<td>101</td>
<td>96</td>
</tr>
</tbody>
</table>

**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 below, 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**

<table>
<thead>
<tr>
<th>Site</th>
<th>Maintenance Items Next Three Weeks</th>
<th>Surplus/Shortage After Maintenance Activities of Next Three Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSDs</td>
<td>NextGens</td>
</tr>
<tr>
<td>NY</td>
<td>4</td>
<td>18.6</td>
</tr>
<tr>
<td>FL</td>
<td>11</td>
<td>30.4</td>
</tr>
<tr>
<td>WA</td>
<td>15</td>
<td>28</td>
</tr>
<tr>
<td>NC</td>
<td>0</td>
<td>39</td>
</tr>
<tr>
<td>IN</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>PA</td>
<td>0</td>
<td>39</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>172</td>
</tr>
</tbody>
</table>

The surplus figures, indicated by positive numbers, and shortage figures, denoted by negative numbers, were automatically generated based on an algorithm grounded in the following base 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
- 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 below, 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.
TABLE 3.3 Sample Site Contractor Inventory Assessment

<table>
<thead>
<tr>
<th>Component</th>
<th>Quantity Good</th>
<th>Quantity in Need of Repair/Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Kit</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>NextGen</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Head Unit (HU)</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>RIB</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Radar</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Network box</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Legacy Network Box</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Rear camera</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Antenna</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>OBD-II cable</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Legacy OBD-II cable</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>RIB power cable</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Network Box power cable</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>NextGen power cable</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>RIB/radar cable</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Network Box/DAS cable</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Head Unit (HU)/DAS cable</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Solid-state drive</td>
<td>7</td>
<td>0</td>
</tr>
</tbody>
</table>

The kit builder tab, pictured in TABLE 3.4, afforded an efficient means for Coordination Contractor staff managing equipment provision for multiple locations to readily assess the study-wide 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.

**TABLE 3.4 Kit Builder**

<table>
<thead>
<tr>
<th>Site</th>
<th>NY</th>
<th>FL</th>
<th>WA</th>
<th>NC</th>
<th>IN</th>
<th>PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>NextGen</td>
<td>26</td>
<td>16</td>
<td>10</td>
<td>0</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Head unit (HU)</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>6</td>
<td>-4</td>
<td>6</td>
</tr>
<tr>
<td>RIB</td>
<td>3</td>
<td>8</td>
<td>-4</td>
<td>5</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Radar</td>
<td>-4</td>
<td>-1</td>
<td>-6</td>
<td>5</td>
<td>-3</td>
<td>3</td>
</tr>
<tr>
<td>Network box</td>
<td>4</td>
<td>12</td>
<td>3</td>
<td>17</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Legacy Network Box</td>
<td>-16</td>
<td>-9</td>
<td>-3</td>
<td>2</td>
<td>-9</td>
<td>0</td>
</tr>
<tr>
<td>Rear camera</td>
<td>7</td>
<td>2</td>
<td>-10</td>
<td>8</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Antenna</td>
<td>-3</td>
<td>9</td>
<td>30</td>
<td>21</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>OBD cable</td>
<td>3</td>
<td>24</td>
<td>36</td>
<td>45</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Legacy OBD cable</td>
<td>-17</td>
<td>-7</td>
<td>-1</td>
<td>7</td>
<td>-2</td>
<td>7</td>
</tr>
<tr>
<td>RIB power cable</td>
<td>1</td>
<td>15</td>
<td>-9</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Net Box power cable</td>
<td>1</td>
<td>13</td>
<td>-10</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>NextGEN power cable</td>
<td>1</td>
<td>12</td>
<td>-8</td>
<td>2</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>RIB/radar cable</td>
<td>1</td>
<td>16</td>
<td>-7</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Netbox/DAS cable</td>
<td>1</td>
<td>4</td>
<td>-7</td>
<td>0</td>
<td>-3</td>
<td>2</td>
</tr>
<tr>
<td>HU/DAS cable</td>
<td>1</td>
<td>11</td>
<td>-8</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Solid State Drive</td>
<td>-16</td>
<td>4</td>
<td>30</td>
<td>8</td>
<td>15</td>
<td>27</td>
</tr>
</tbody>
</table>

The kit builder pictured above in TABLE 3.4 was featured in the June 20, 2012, Site Contractor supply estimation report and was used to construct a plan that would ultimately lead to the completion of 52 kits at three project sites from previously non-integrated 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 in order to provide adequate support for installation and maintenance activities and maintain appropriate inventory levels study-wide. These efforts were planned using the Site Contractor supply estimation tool described in the previous section and implemented with the primary study goals of maximizing data collection efforts and maintaining the health of the vehicle fleet in mind. 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 may 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 in order to share designated network resources at the Coordination Contractor. This arrangement allowed the Coordination Contractor’s technical support staff to access shrp2nds domain resources (desktops, laptops, site servers, etc.)

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 in order 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 designed 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 one month in advance of the hoped-for first vehicle installation. This process was continued across all sites, during which 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., on the order of < 2%) and overall cost per recruit. Further, a major efficiency-limiting factor was identified by VT CSR management 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, whereby 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, and it was continued 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 at least 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 of approaches devised by the Site Contractors to be efficiently shared with the others and deployed as appropriate. Site contractor recruiting tactics included at least the following:

- Flyers:
  - Distributed at student centers on campus
  - Distributed at Division of Motor Vehicles
  - Distributed at private schools
  - Tailored to specific demographic groups
  - Distributed on cars

- Facebook/Twitter/LinkedIn
- Facebook–targeted ads
- Banner ad on traffic website
- State Department of Transportation Website
- Craigslist
- Local news spot
- Television advertisement
- Posters in high schools
- Contacting local school boards
- Offering high school science classes tour of facility
- Parent Teacher Association/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 slides for presentations
- Radio advertisements
- Radio station events
- Professional marketers
- Newspapers
  - Classifieds
  - Non-classifieds
  - University/papers
- Mass e-mail
- Local movie banner advertisements
- Cable news feed
- Instrumented vehicle for events
- Collegiate summer orientation
- Vehicle wrap or magnet
- Sending additional letter to follow up on stale leads
- Postcards

Recruitment was tracked in terms of recruitment medium:

(1) Calls out – The individual was called by VT CSR personnel, whether random cold, focused random cold, or calling people on an OEM-provided list.

(2) Calls in – The participant called a toll-free number based on having seen an ad or flyer.

(3) Web-based screening tool (WBST) – Developed around February 2011 by VT CSR staff

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

<table>
<thead>
<tr>
<th>Age Group</th>
<th>PA</th>
<th>IN</th>
<th>NC</th>
<th>WA</th>
<th>FL</th>
<th>NY</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calls Out</td>
<td>16-17</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>18-20</td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>21-25</td>
<td>13</td>
<td>10</td>
<td>13</td>
<td>11</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>26-35</td>
<td>47</td>
<td>45</td>
<td>93</td>
<td>56</td>
<td>86</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>36-50</td>
<td>138</td>
<td>109</td>
<td>284</td>
<td>191</td>
<td>222</td>
<td>283</td>
</tr>
<tr>
<td></td>
<td>51-65</td>
<td>208</td>
<td>168</td>
<td>284</td>
<td>243</td>
<td>297</td>
<td>370</td>
</tr>
<tr>
<td></td>
<td>66-75</td>
<td>86</td>
<td>68</td>
<td>142</td>
<td>190</td>
<td>213</td>
<td>191</td>
</tr>
<tr>
<td></td>
<td>76+</td>
<td>37</td>
<td>29</td>
<td>42</td>
<td>91</td>
<td>111</td>
<td>88</td>
</tr>
<tr>
<td>Subtotal</td>
<td>531</td>
<td>434</td>
<td>867</td>
<td>787</td>
<td>951</td>
<td>1,054</td>
<td>4,624</td>
</tr>
</tbody>
</table>

| 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 |

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, Sub-Prime, Legacy, and Basic as described in greater detail below.
Prime

The Coordination Contractor, through negotiations with various OEMs independent of this project, procured On-board Diagnostic Parameter IDs (OBD-II PIDs) such that acquisition of network variables, including Controller Area Network (CAN) speed, turn signal, brake light, and headlight information, was accomplished to facilitate 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.

Sub-Prime

“Sub-Prime” 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. Sub-Prime vehicles were installed with a standard DAS configuration, identical to that used in Prime vehicles.

Legacy

“Legacy” vehicles, like their Sub-Prime counterparts, provided a reduced set of network data in comparison to that generated by the Prime vehicles. Legacy vehicles were those manufactured prior to 2009 and employed an older communications network for On-Board 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

Basic vehicles were pre-1996 manufactured vehicles 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.
### TABLE 3.6 SHRP 2 NDS Vehicle Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Definition</th>
<th>Vehicle Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime</td>
<td>Vehicles included on the original eligible vehicle list for which the Coordination Contractor procured PIDs</td>
<td>1,717</td>
</tr>
<tr>
<td>Sub-Prime</td>
<td>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</td>
<td>488</td>
</tr>
<tr>
<td>Legacy</td>
<td>Vehicles Manufactured between 1996 and 2008, employing an older network for vehicle communications</td>
<td>736</td>
</tr>
<tr>
<td>Basic</td>
<td>Vehicles manufactured prior to 1996</td>
<td>421</td>
</tr>
</tbody>
</table>

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 its 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.

**Goal-Based Recruitment Strategy**

As recruitment progressed, early summaries showed that recruits roughly mirrored the driving population at large in terms of age distribution, which means 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 U.S. for 2011. Once study leaders realized that recruitment at the ends of the driver age spectrum was lacking and that these were among the most interesting participants from risk and behavioral perspectives, 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, wherever possible, Site Contractors were asked to similarly prioritize the installations of vehicle network classifications in the following order: 1st: Prime, 2nd: Sub-Prime/Legacy, 3rd: Basic. In addition, 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 (i.e., a DAS kit collecting data from a vehicle [any driver, any vehicle] is preferable to that same DAS kit sitting on a shelf).
FIGURE 3.1 Distribution of the age of participants as of April 2012 plotted against that of drivers in the U.S. for 2011.

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 is quite likely that individuals other than the consented participant might drive the vehicle. This presents both a significant problem as well as a tremendous opportunity.

The significant problem is that when an unconsented individual drives an instrumented vehicle, data, including potentially identifying face video are being continuously recorded during that trip. Of course, this recording of data and video occurs automatically, with no known way to prevent or stop it. This becomes a serious issue when one considers that 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 must ultimately be expunged, without ever being analyzed or otherwise used in any research protocol or related activity.
On the other hand, there is a tremendous opportunity in that, if one or more individuals other than the primary participant were expected to drive the vehicle on a fairly regular basis (e.g., the participant’s close family members), then these individuals may 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 they were asked 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, whereby 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 were 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 below shows the number of the known secondary drivers by age group across the sites. Note that even if a secondary driver is consented, and thus provides data which can be analyzed, we must still have a reference image which can be used 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. This is due to the fact that secondary drivers typically never came to the Site Contractor facility and often provided incomplete information on their intake forms.
FIGURE 3.2 Consented secondary drivers by age-gender group across site irrespective of reference image.

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.

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

Multiple Primary Participants

It was initially decided that only one primary participant per household should be permitted. However, in a concerted attempt to recruit more teens and other young drivers into the study, it was later agreed that if there was a young driver in the household (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 treated, essentially, in every respect as primary participants, including the collection of all assessment data. 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.

![Bar chart showing number of households by site](image)

**FIGURE 3.4** Number of households with multiple primary drivers by site.

**ADMINISTRATIVE TOOLS AND PROCESSES**

**Software Additions and Improvements**

Throughout the course of the SHRP 2 NDS, several improvements were identified which could positively influence the efficiency with which the study processes could be managed. Of particular added value, inventory, telemetry plans for the DAS, and participant management tools were addressed in mid-study 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 were to be found with a component which affected data quality, then it may also 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, initially for Coordination Contractor staff to respond to hotline-generated issues during after-hours calls. Later, it became a heavily relied on software tool that streamlined the diagnosis of all vehicle and component issues. This software program was used by the Coordination Contractor 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, de-installations, as well as shipping and receiving activities.
FIGURE 3.5 shows an example of component history detail using the Component Information Tool.

![Component Information Tool](image)

**FIGURE 3.5 Example of component-level information via the Component Information Tool.**

*Component Shipping Tool*

Due in large part to the fact that 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 to a shipping box via barcode scanning protocols so that shipments could be tracked at box and component levels. This mid-study 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 de-installation phase of the project.

*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 between the Coordination Contractor and the Site Contractors. 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 below illustrates the Coordination Contractor’s communications model.
Weeky Operations Team Conference Call

As was discussed in Chapter 3’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 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 members of 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 signoffs. 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 Third 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 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—which 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 Fourth, Fifth, Sixth, Seventh, and Eighth 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 to gather and disseminate objective information to the nation related to pre-crash, crash, and exposure on the nation’s highways.

Bi-Annual SHRP 2 Committee Meetings

The Coordination Contractor staff provided technical input and presentations bi-annually 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 who were 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 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
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; thus, providing the Recruitment Reports was 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.

There were times when awareness of the reasons why a potential recruit did not qualify upon initial screening via the Web-based tool or through the VT CSR proved to be an impetus to the advancement of the study. For example, in the months preceding the expansion of the Eligible Vehicle List to include Sub-Prime, Legacy, and Basic vehicles, a number of prospective participants were initially rejected because their vehicles were not yet considered eligible for installation, such as is the case in the graph taken from the April 28, 2011, recruitment report pictured below in FIGURE 3.7. The majority of recruits initially rejected were disqualified due to vehicle eligibility issues. Reports like these helped study administrators to 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.

![Figure 3.7 Reasons for recruit ineligibility in Fla., April 2011.](image)

**FIGURE 3.7 Reasons for recruit ineligibility in Fla., April 2011.**

*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, video quality problems, or in need of a solid-state drive 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 “# Verified Good,” “# 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, as 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 because files verified as bad could be correlated with specific vehicles and appropriate remedies could be applied.

### TABLE 3.7 Vehicle Metrics Portion of Operations Metrics

<table>
<thead>
<tr>
<th>Data Item</th>
<th>9/25/2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># Verified</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>NETWORK SPEED reported</td>
<td>1,325</td>
</tr>
<tr>
<td>ACCELERATOR Position reported</td>
<td>541</td>
</tr>
<tr>
<td>TURN SIGNAL Status reported</td>
<td>528</td>
</tr>
<tr>
<td>BRAKE PEDAL reported</td>
<td>525</td>
</tr>
<tr>
<td>Usable FACE VIDEO (i.e., &gt; 80% per vehicle)</td>
<td>1,506</td>
</tr>
<tr>
<td>Usable FORWARD video (i.e., &gt; 80% for car)</td>
<td>1,496</td>
</tr>
<tr>
<td>Usable REAR video (i.e., &gt; 80% per vehicle)</td>
<td>1,351</td>
</tr>
<tr>
<td>Usable LAP video (i.e., &gt; 80% per vehicle)</td>
<td>1,405</td>
</tr>
<tr>
<td>Usable Inertial Measurement Unit (Acceleration, x-axis)</td>
<td>1,489</td>
</tr>
<tr>
<td>Usable GPS (speed only)</td>
<td>1,098</td>
</tr>
</tbody>
</table>

### Data Volume Reports

One metric of the total quantity of data collected was the “vehicle-time period” (e.g., vehicle-month or vehicle-year). 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 or 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 both provide a metric for study progress toward the sample design goal of 3,900 DAS-years and 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. Generation of the vehicle-months portion of the report involved calculation of the number of vehicle-months collected by each vehicle in the study and a projection of how many additional vehicle-months each participant would be expected to
accumulate based upon a set of guidelines and assumptions about how long each participant would be 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 flexibility in making 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 represents 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/minute (min), and an average speed of 30 miles per hour (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 upon 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 upon 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 recruited participant pool. An example report is included in TABLE 3.8 below. 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.

<table>
<thead>
<tr>
<th>TABLE 3.8 Site Priority Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4/9/2013</strong></td>
</tr>
<tr>
<td><strong>SHRP 2 Fleet Snapshot</strong></td>
</tr>
<tr>
<td>Vehicles On Road</td>
</tr>
<tr>
<td>Communicating</td>
</tr>
<tr>
<td><strong>% of Installed Vehicles Communicating</strong></td>
</tr>
<tr>
<td>SSD Recording Data</td>
</tr>
<tr>
<td><strong>% of Installed Vehicles Recording Data</strong></td>
</tr>
<tr>
<td><strong>MAJOR FLEET ISSUES</strong></td>
</tr>
<tr>
<td>Not Communicating</td>
</tr>
<tr>
<td>SSD Not Decrementing/Not Recording Data</td>
</tr>
<tr>
<td>Failing to Deliver Advanced Health Checks</td>
</tr>
<tr>
<td>Communicating in Excess</td>
</tr>
<tr>
<td>History of Excessive Communication Requiring Attention</td>
</tr>
<tr>
<td>SSD &gt;90% Full</td>
</tr>
<tr>
<td><strong>% of vehicle fleet with SSD exceeding 90%</strong></td>
</tr>
<tr>
<td>4/9/2013</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td><strong>S07 SITE PROGRESS</strong></td>
</tr>
<tr>
<td>Priority 1 issues identified in Previous Report (2-22-13)</td>
</tr>
<tr>
<td>Priority 1 Issues completed from previous report (2-22-13)</td>
</tr>
<tr>
<td>% of Priority 1 Issues Completed from previous report (2-22-13)</td>
</tr>
<tr>
<td>Priority 1 Issues remaining from previous report</td>
</tr>
<tr>
<td>Action taken (e.g. participant called)</td>
</tr>
<tr>
<td>No action noted</td>
</tr>
</tbody>
</table>

*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 below.
### TABLE 3.9 Maintenance Priority Levels

<table>
<thead>
<tr>
<th>Priority Level</th>
<th>Definition</th>
<th>Examples</th>
</tr>
</thead>
</table>
| 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 two 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 |

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 where a consented participant had been confirmed as the driver, and counts 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 de-installations 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 below. 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.

![Reported Vehicles on Road per Database as of 1/28/2013](image)

**FIGURE 3.9** Quality metrics showing vehicles on the road relative to nominal targets for each site (i.e., 450 for NY, FL, and WA; 300 for NC; and 150 for IN & PA).

*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 upon being scanned. A total of four inventory
exercises were conducted during the course of the project. The first one was conducted in fall
2012, and the exercise was repeated again in spring 2013 and fall 2013. At the conclusion of the
SHRP 2 NDS and following the de-installation of all study vehicles, a final inventory exercise
was conducted. The outcomes of the fall 2013 inventory exercise are summarized below in
TABLE 3.10. The final inventory accounting will be conducted after delivery of this report and
submitted at a later time.

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 again be utilized. Of note, items that have been labeled as “Missing” are presumed to be
temporarily missing or misplaced until such time as the Site Contractor reports information that
may change the status to “Stolen” or “Decommissioned.”

### TABLE 3.10 Inventory Exercise Summary

<table>
<thead>
<tr>
<th></th>
<th>Fall 2012</th>
<th>Spring 2013</th>
<th>Fall 2013</th>
<th>Final Accounting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Purchased</td>
<td>12,902</td>
<td>12,902</td>
<td>13,152</td>
<td>13,152</td>
</tr>
<tr>
<td>Quantity Missing</td>
<td>62</td>
<td>38</td>
<td>75</td>
<td>TBD</td>
</tr>
<tr>
<td>Percent Missing</td>
<td>0.48%</td>
<td>0.29%</td>
<td>0.57%</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Additionally, components can be 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%).
- 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 below).

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, while 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 ever feel the 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 based on AD group membership and group membership was granted (or removed) as needed by a select group of research scientists.
FIGURE 4.1 Data collection and ingestion workflow.

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 had been 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 (PII) 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 case one facility were to suffer a disaster of any sort, though they 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 RSA algorithm. In order 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, where 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 therefore was 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, as well as steering data.

Considerable effort was expended in mapping the network data elements in the database for each unique year/make/model combination and involved. 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 for 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 in order 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 non-driving data including 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 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 may 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:** Whether at least one data point was captured for a variable within a particular file. If a variable was not present for a file, no other checks for that variable were necessary.
- **Bounds:** Whether the values recorded for a given variable were within the bounds defined in the data dictionary. Boundary values (i.e., lower, upper, both) could be specified independently for each variable.
- **Simple Dependency:** 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:** Similar to a simple dependency, but with more complex conditions allowed. Whereas 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 in order to output a good quality score.

- **Duplicates:** 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:** 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 the 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.
### TABLE 4.1 Camera Views – Ideal Descriptions and Purposes

<table>
<thead>
<tr>
<th>Camera View</th>
<th>Ideal</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Face Camera</strong></td>
<td>Complete, clear view of the driver’s face, including eyes and mouth; camera should be positioned to exclude views of backseat passengers.</td>
<td>Clear view of face facilitates eye-glance analysis and evaluation of distraction associated with secondary tasks of talking, eating, and singing.</td>
</tr>
<tr>
<td><strong>Forward Camera</strong></td>
<td>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, with the horizon just above the center line.</td>
<td>Clear view of forward roadway facilitates evaluation of traffic density, visibility, road conditions, and time of day, recognition of potential hazards posed by oncoming traffic and activities of drivers in surrounding vehicles.</td>
</tr>
<tr>
<td><strong>Instrument Panel Camera</strong></td>
<td>High-quality video of the distance from the driver 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.</td>
<td>Clear view of hands and center console facilitates analysis of distractions resulting from secondary tasks such as adjusting cabin temperature or radio, cell phone usage, and reaching for objects.</td>
</tr>
<tr>
<td><strong>Rear Camera</strong></td>
<td>High-quality video of the traveled roadway; traveled roadway and following traffic and traffic lights should be visible, with roadway centered horizontally, with horizon just above center vertically.</td>
<td>Clear view of traveled roadway facilitates analysis of traffic density and potential hazards posed by following traffic.</td>
</tr>
</tbody>
</table>

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, were 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, upon confirmation 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 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 below, that 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

While assuring the quality of the time series data and video collected via the DAS was a central focus of the overall quality efforts, considerable efforts were also devoted to assuring the quality of all 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). Without such baseline knowledge, a statistical outliers approach was deployed wherein extreme values were distrusted and discarded, except where independent verification would suggest otherwise. With this Interquartile Range (IQR) approach, any value ≤ \([Q1 - (1.5 \times \text{IQR})]\) or ≥ \([Q3 + 1.5 \times \text{IQR}]\) 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

Where 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 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 utilized 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. In cases where participants could not be contacted for verification, a NULL value was assigned in place of the anomalous data. For those participants that could be contacted and the data for a given variable could be corrected or verified, amended data were inserted. TABLE 4.2 below provides the test and rationale for age, age of licensure, years driven, miles driven in previous year, and date of birth.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of years driving</td>
<td>Greater than the age of participant</td>
</tr>
<tr>
<td>Birth date</td>
<td>Less than 16 years from today’s date</td>
</tr>
<tr>
<td>Miles driven in previous year</td>
<td>Greater than 150,000 miles a year</td>
</tr>
<tr>
<td>License age</td>
<td>Less than 14 years old</td>
</tr>
</tbody>
</table>

**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% (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.
TABLE 4.3 Completed Assessment and Related Surveys for Participants Who Were in the Study for at Least One Day

<table>
<thead>
<tr>
<th>Survey</th>
<th>Participants</th>
<th>Completed surveys</th>
<th>% Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographic Questionnaire</td>
<td>3,254</td>
<td>3,244</td>
<td>99.7</td>
</tr>
<tr>
<td>Driving History Questionnaire</td>
<td>3,254</td>
<td>3,245</td>
<td>99.7</td>
</tr>
<tr>
<td>Berkley’s Questionnaire</td>
<td>3,254</td>
<td>3,245</td>
<td>99.7</td>
</tr>
<tr>
<td>Driving Knowledge Questionnaire</td>
<td>3,254</td>
<td>3,240</td>
<td>99.6</td>
</tr>
<tr>
<td>Frequency of Risky Behavior Questionnaire</td>
<td>3,254</td>
<td>3,241</td>
<td>99.6</td>
</tr>
<tr>
<td>Hand Strength Assessment</td>
<td>3,254</td>
<td>3,239</td>
<td>99.5</td>
</tr>
<tr>
<td>Medical Conditions and Medications</td>
<td>3,254</td>
<td>3,243</td>
<td>99.7</td>
</tr>
<tr>
<td>Modified Manchester Questionnaire</td>
<td>3,254</td>
<td>3,237</td>
<td>99.5</td>
</tr>
<tr>
<td>Optic Assessment</td>
<td>3,254</td>
<td>3,244</td>
<td>99.7</td>
</tr>
<tr>
<td>Perception of Risk Questionnaire</td>
<td>3,254</td>
<td>3,236</td>
<td>99.4</td>
</tr>
<tr>
<td>Sensation Seeking Questionnaire</td>
<td>3,254</td>
<td>3,235</td>
<td>99.4</td>
</tr>
<tr>
<td>Sleep Pattern Questionnaire</td>
<td>3,254</td>
<td>3,232</td>
<td>99.3</td>
</tr>
</tbody>
</table>

Health and Sleep Related Questionnaires. The Health and Sleep related questionnaires included the both Medical and Medication and the Sleep Questionnaires. The Medical and Medication questionnaires were primarily validated for anomalous data within three main variables. These variables included height, weight, and neck size. Other data quality efforts included the standardization of free-text answer entries. The Sleep related questionnaire was also validated for extreme and anomalous data. Both sets of questionnaires utilized statistical procedures to determine outliers.

TABLE 4.4 below illustrates the statistical boundaries that were 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: once in the Medical and Medications survey and again on the Exit Medical and Medications survey. Data were verified using low and high extremes and, when appropriate, Site Contractors were contacted to verify.

TABLE 4.4 Participant Information Validation (Height, Weight, Neck)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low Extreme</th>
<th>High Extreme</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height (in.)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>54</td>
<td>84</td>
<td>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.</td>
</tr>
<tr>
<td>Female</td>
<td>48</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td><strong>Weight (lbs.)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>100</td>
<td>525</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>80</td>
<td>525</td>
<td></td>
</tr>
<tr>
<td><strong>Neck Size (in.)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>10</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>8</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>
Connor’s Continuous Performance Test II (CPT II). The verification procedures were utilized 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 for 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 re-administer the assessment to that participant during the DAS de-installation session if possible.

Clock Drawing Test. Verification procedures were also utilized to process and validate participant 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 that did not complete the assessment were flagged and marked as needing to complete the assessment at de-installation, if possible. For those that needed to complete the clock drawing exercise at de-installation, the site was instructed to write on the assessment that it had been completed at de-installation. 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 ten tests, three of its visual-cognitive tests were used in this study:

- Visualizing Missing Information
- Visual Information Processing Speed (UFOV®)
- 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 were requested to have the participants complete the series of tests at de-installation, where 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 requested to have the participants complete the test at a later time, 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 below illustrates the high fence that was used.
### TABLE 4.5 Grip Strength Boundaries

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low Extreme</th>
<th>High Extreme</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Grip (lbs.)</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right 1st attempt</td>
<td>0</td>
<td>186</td>
<td>Applied statistics (3*Interquartile Range)</td>
</tr>
<tr>
<td>Right 2nd attempt</td>
<td>0</td>
<td>185</td>
<td></td>
</tr>
<tr>
<td>Left 1st attempt</td>
<td>0</td>
<td>186</td>
<td></td>
</tr>
<tr>
<td>Left 2nd attempt</td>
<td>0</td>
<td>185</td>
<td></td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right 1st attempt</td>
<td>0</td>
<td>114</td>
<td></td>
</tr>
<tr>
<td>Right 2nd attempt</td>
<td>0</td>
<td>112</td>
<td></td>
</tr>
<tr>
<td>Left 1st attempt</td>
<td>0</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>Left 2nd attempt</td>
<td>0</td>
<td>115</td>
<td></td>
</tr>
</tbody>
</table>

*Vehicle Characteristics and Features*

A variety of vehicle characteristics were collected from each vehicle that was enrolled in the study. These characteristics included 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
- Applying statistical measures to tire pressure and tire tread depth, battery voltage, battery cranking amps, and battery date to identify anomalous data

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 that had a battery date that was 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), but allowed for batteries that may be equipped with higher cranking amps and voltage. The boundary of 100 psi was determined based on the fact that normal passenger vehicle tires require no more than 35 psi. The high extreme of 100 psi is typical in semi-tractor trailer tires; however, this high range allows for larger vehicles such as large super duty pick-up trucks. Vehicle odometer readings were only screened for extreme values, such as no mileage or extremely high mileage. TABLE 4.6 below illustrates the boundaries for identifying extreme outliers and anomalous data that were collected.
### TABLE 4.6. Vehicle-based Information Validation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cutoff if applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odometer Start</td>
<td>None unless extreme (e.g. 999,999)</td>
</tr>
<tr>
<td>Odometer End</td>
<td>Based on each vehicle and months in study</td>
</tr>
<tr>
<td>Left Front Tire Pressure</td>
<td>Greater than 100 PSI</td>
</tr>
<tr>
<td>Left Rear Tire Pressure</td>
<td>Greater than 100 PSI</td>
</tr>
<tr>
<td>Right Front Tire Pressure</td>
<td>Greater than 100 PSI</td>
</tr>
<tr>
<td>Right Rear Tire Pressure</td>
<td>Greater than 100 PSI</td>
</tr>
<tr>
<td>Battery Voltage</td>
<td>More than 16 V</td>
</tr>
<tr>
<td>Battery Cranking Amps</td>
<td>More than 2000 A</td>
</tr>
<tr>
<td>Battery Date</td>
<td>Less than year make of vehicle, or greater than date reviewed</td>
</tr>
</tbody>
</table>
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 where 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 synchs, 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 cellphones, borrowed cellphones, or cellphones 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 (VZW) and AT&T Inc. (AT&T), 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 the driving records: three to five months of records were compensated $50. Those that provided six or more months of records 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. Also, 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.

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.

**TABLE 5.1 Data Retention Periods for Four Major Cell Phone Service Providers (as of 1/16/2014)**

<table>
<thead>
<tr>
<th>Provider</th>
<th>Maximum Data Retention in Months</th>
<th>Records Obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Call Data</td>
<td>Text</td>
</tr>
<tr>
<td>Verizon</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>AT&amp;T</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Participant provided</td>
<td>Varies</td>
<td>Varies</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>

Thus, the amount of data collected from each individual varied based on a variety of factors. Some of these key factors are listed below:

- 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 above
- Whether or not text, picture, or video messages were included in each month of data
- The participant’s ability to generate the data (i.e., for those where 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, and 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 participants.
CHAPTER 6. OUTCOMES

HUMAN 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 de-identified and non-identifying data to be retained for up to 40 years, and for de-identified 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 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 mid-study 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 with 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 de-enrollment 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 one 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

A final total of 13,152 components were purchased for the SHRP 2 NDS. Quantities of each of the main components are indicated in TABLE 6.1 below. 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 in order to accommodate the time delay of the process. Additionally, the front radar was the most vulnerable component and 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.

<table>
<thead>
<tr>
<th>Component</th>
<th>Study Quantity Purchased</th>
</tr>
</thead>
<tbody>
<tr>
<td>NextGen</td>
<td>2,085</td>
</tr>
<tr>
<td>Storage Devices</td>
<td>2,462</td>
</tr>
<tr>
<td>Head Units</td>
<td>2,085</td>
</tr>
<tr>
<td>Network Boxes</td>
<td>2,235</td>
</tr>
<tr>
<td>Radar</td>
<td>2,200</td>
</tr>
<tr>
<td>RIB</td>
<td>2,085</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13,152</strong></td>
</tr>
</tbody>
</table>

Repair Statistics

Equipment repairs were performed by either the Coordination Contractor or the CM, depending on a variety of factors, including warranty status and expediency. The Coordination Contractor performed 1,641 or 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 many as 3 years. For the purpose of participant counts provided in this chapter, a criterion of at least 4 months has been applied.

Primary Participants

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

![FIGURE 6.1 Number of primary participants enrolled across sites (4 month minimum enrollment criterion).]

Secondary Participants

In addition to primary drivers, secondary drivers were also enrolled as participants in the study. As was outlined in detail in Chapter 4, in order 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 found received at this time for those individuals.
Total Vehicles Installed

Three thousand, three hundred sixty-two vehicles were instrumented across the six data collection sites, as presented in FIGURE 6.3. This number exceeds the number of primary participants as FIGURE 6.1 only includes participants that 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 the vehicle de-instrumentation commenced in earnest in September 2013, with some early de-installations accomplished in August of that year due to college students returning to school. The last vehicle was de-installed on December 16, 2013. While some vehicles were installed for only one year, other vehicles were installed for two 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.

FIGURE 6.4 SHRP 2 installed vehicles over time.

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 as per 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 SHRP 2 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).

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. It shows that the average number was fairly consistent across the age groups with a slight but inconsistent upward trend with increasing age.

![Graph showing average number of vehicle-years per participant across recruitment age groups.]

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

**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 study-wide. Notably, the proportions of all vehicle types were very 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, Sub-Prime 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 vehicles as a recruiting stratagem for older and younger drivers did not appreciably dilute the data set.
FIGURE 6.9  Vehicles by Network data classification.

OEM Distribution

FIGURE 6.10 below present a view of the SHRP 2 vehicle fleet broken down by OEM. These data are presented in tabular form in Appendix N.

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 4, 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 one day of participation or more criterion).

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

![Vehicle-Years Acquired and Primary Participants by Site](image1)

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

One of the factors which 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. As this is the source of a possible confound, FIGURE 6.13 was constructed to characterize how the vehicle model year distributions varied across recruitment age groups.

![Vehicle-Years Acquired and Primary Participants by Sample Cell](image2)
REQUEST TRACKER SUMMARY STATISTICS

In order 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 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 O). Each queue was monitored by a unique set of individuals who were most capable of addressing the issues therein. 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%, and 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, which generally fell into one of three high-level categories (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.
- DAS operating in a manner inconsistent with normal functions (e.g., excessively connecting, which might represent a loose cable).
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%) did require 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 below shows the breakdown of the major issue categories.
FIGURE 6.15 Nature of issues assigned to site contractors.

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 below shows the comparison of fleet size by site and percentage of tickets issued.

FIGURE 6.16 Comparison of tickets issued to site contractors relative to site size.
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 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 ten drawings for training/calibration purposes. Their scores were compared against reference scores provided by Coordination Contractor researchers. The sample was selected to illustrate:

- That most drawings are expected to be very good or perfect.
- 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 a possible cognitive deficit (with increasing numbers representing possibly increased levels of deficit). Scores of 1 or 2 were considered to not represent any particular indication of a cognitive problem.

**TABLE 6.2 Clock Drawing Scoring Rubric (adapted from Shulman et al. 1993)**

<table>
<thead>
<tr>
<th>Score</th>
<th>Error Level</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Perfect</td>
<td>a) No errors in the task (will also accept well-placed tick marks for numbers other than 12, 3, 6, and 9 as perfect)</td>
</tr>
</tbody>
</table>
| 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 |
Based on the scoring rubric and procedures noted above, the percent of participants for whom the Clock Drawings indicated no cognitive deficit are 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 percent of no-deficit individuals was the oldest group, as would be expected.

![Proportion of Scores in the 1-2 Range](image)

**FIGURE 6.17** Clock drawing scores, percent with no indication of cognitive deficit.

**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 where it was established that a crash had occurred, it 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:

<table>
<thead>
<tr>
<th>Score</th>
<th>Error Level</th>
<th>Examples</th>
</tr>
</thead>
</table>
| 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 |
- Level 1: Airbag/injury/rollover, high delta-V crash
- Level 2: Police-reportable crash
- Level 3: Physical contact with another object
- 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 below presents the number of assessed crash events across categories. This pyramidal shape in this figure is intended to help in illustrating the fact 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.
CHAPTER 7. LESSONS LEARNED

HUMAN SUBJECTS PROTECTION LESSONS LEARNED

One of the key lessons learned 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 prior to the first vehicle going 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 (at least 98 unique consent forms were approved and being used by the end of the study, with the number possibly several hundred considering all site-based variations!), across the six sites and six actively involved IRBs proved a daunting effort.

Lengthy IRB Approval Processes

Large, complex, multi-site 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 prior to 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 once 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 are 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. Non-identifying and de-identified 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 upon 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 3 and 4, 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 is that a large, long-term, multi-site 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 discussed above. 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 a lesson learned was that compensation has to be substantial to attract and fairly compensate participants for the nature and extent of a study of this nature, and that this is especially true if you hope to attract younger participants including teens.

**Study Challenges**

**Border Crossing**

As noted in the Informed Consent, 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 may 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, as 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 is a properly signed and dated consent form. However, when reviewing and analyzing actual data, a reference image for the secondary driver is also necessary, as 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, and so these otherwise valid trips would need to be excluded from the database until such time, if ever, that a reference image can be found or procured. There was a disparity between those for whom both informed consent and a usable reference image were secured. 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., where 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 requested 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 whereby 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, etc.) 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 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 was 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, and thus the biggest challenge was timing. These milestones included completion of the DAS design, the establishment of a new CM partnership featuring a new product line, and the start of installations. There were substantial difficulties with simultaneously and 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 in 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 rather than applying work-arounds as was done.

Launch of New Product and CM

Moving a product from prototype to production has its own set of challenges. It often requires small design changes to allow for effective manufacturing in a production environment that are not 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 their standard operating procedures that have been implemented to aid in the production process. Trying to learn to work within these structures while at the same time launching a new product adds complexity since there is no prior knowledge of business processes or the manufacturing process for that specific product. Consequently, working with a new CM on a new product adds 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. Towards 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 their 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, significant time was spent on site at the CM by VTTI personnel 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 four to six 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% where it had been greater than 95%. On another occasion, at the conclusion of a large contract, a significant lay-off occurred, which reduced the number of people available to work on the DAS and that were trained 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 becomes a problem when there is a disruption to the supply chain. This factor also had a major impact on the manufacturing process and kit delivery. One that was already mentioned was the shift in the industry standard from the PATA interface to SATA, 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 impact production schedules. The following provide 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 will 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 impact supply chain. Early during the initial release, the one plant that made 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 vendor was cut to a fraction of the normal supply, as they had to distribute this limited supply across all of their customers. This impacted 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, among its more tragic impacts on human lives. They were 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, we were 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, there were a number of design modifications that 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 you have with the product (the DAS and the large scale of the study) and the process (manufacturing), 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 there was 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 impacted the repair process in two unique ways. First, because of the total duration of the production run, warranty work was being requested prior to 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 it was complete. This, however, created a larger backlog of repair items that took a significant amount of time to clear.

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

  For all these delays caused by business practices outside our 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 was discussed in Chapter 4, 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 installing vehicles and managing participants. TABLE 7.1 illustrates the discrepancy between planned installation and de-installation 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 Actual versus Scheduled Activities March 2013

<table>
<thead>
<tr>
<th></th>
<th>Installations</th>
<th></th>
<th></th>
<th>De-installations</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Site</td>
<td>Scheduled</td>
<td>Performed</td>
<td></td>
<td>Site</td>
<td>Scheduled</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NY</td>
<td>19</td>
<td>16</td>
<td>84</td>
<td>NY</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>FL</td>
<td>21</td>
<td>19</td>
<td>90</td>
<td>FL</td>
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</tr>
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<td></td>
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<td>17</td>
<td>68</td>
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<td>4</td>
</tr>
<tr>
<td></td>
<td>NC</td>
<td>22</td>
<td>12</td>
<td>54</td>
<td>NC</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>IN</td>
<td>0</td>
<td>1</td>
<td>NA</td>
<td>IN</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>PA</td>
<td>8</td>
<td>10</td>
<td>125</td>
<td>PA</td>
<td>3</td>
</tr>
</tbody>
</table>

### 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 the noted 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 fulltime 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

<table>
<thead>
<tr>
<th>ROLE/FUNCTION</th>
<th>FTE Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Validating consented driver images.</td>
<td>44</td>
</tr>
<tr>
<td>DAS focused maintenance, troubleshooting, training with installation focus.</td>
<td>27</td>
</tr>
<tr>
<td>Software upgrades for vehicles.</td>
<td></td>
</tr>
<tr>
<td>Quality control of DAS-based and participant-based variables</td>
<td>20</td>
</tr>
<tr>
<td>Maintenance and technical support to computer operations, database</td>
<td>16</td>
</tr>
<tr>
<td>Purchase, monitoring and supply of DAS equipment inventory</td>
<td>7</td>
</tr>
<tr>
<td>Administration of study logistics and reporting</td>
<td>6</td>
</tr>
<tr>
<td>Study oversight and IRB</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td><strong>124</strong></td>
</tr>
</tbody>
</table>

Technical Support

The Coordination Contractor established a separate trusted domain (shrp2nds) and provisioned SHRP 2 users under that domain in order 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 (desktops, laptops, site servers, etc.) 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 in order 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 located on the campus of Virginia Tech. Ideally, they should be geographically distant from one another in case a large-scale disaster (i.e., flood, hurricane, tornado, earthquake, etc.) were to strike in the general vicinity of the campus. This was not the result of poor planning but rather was 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, requiring file server storage to double in capacity and database storage to triple 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. Even though the Coordination Contractors technical staff had significant cumulative experience with networking, hardware,
software and database architecture, implementation, configuration, maintenance, and troubleshooting – those skills were focused within a few key individuals. Over the course of this project (and as a matter of necessity), there has been widespread cross-pollination of the expertise 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 were comprised of system architects, network engineers, data center engineers, system administrators, developers and statisticians.

One should not underestimate the need for an efficient workflow system to manage the processing and the tracking of the huge volume of files generated during this project. One should think of workflow agents as simple robots who 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 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 aged 16–25 and 76 and older.
FIGURE 7.2 Vehicles driven by younger and older drivers contributing at least four months of data by class.

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 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.

FIGURE 7.3 Installations among younger and older drivers with the addition of 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 aged 35 and under accessed the study via the Web-based screener, while participants aged 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.

![Breakdown of mode of expression of interest in participation by age group.](image)

**FIGURE 7.4** Breakdown of mode of expression of interest in participation by age group.

**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 impact overall study progress. When considering the impact of participants who fail to show up for an appointment, it is also important to note that it costs virtually as much in terms of staff resources for a non-replaced no-show as it does to perform an actual installation. Thus, no-shows are also 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 being 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 SHRP 2, incentives took the form of offering 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.
Missing Participants

During the conduct of the SHRP 2 NDS, there were a few occasions whereby a participant may have been 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 utilized 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 potentially assess if 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. A total of 10 participants were reported to the Coordination Contractor as “missing.” In many cases, participants were located; however, at study end, a total of 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 due to the vehicle being 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 underway. While 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 of these 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 very 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 not only demonstrated the feasibility of conducting a study of this nature but also that the resulting highly complex data set could be successfully mined and analyzed by a variety of researchers from a variety of perspectives.

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 who responded to an initial request for qualifications (RFQ), and 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 two or more years. Study sites and the nominal number of DAS kits managed at each site are depicted in FIGURE 2.11 in Chapter 2 above.

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 which exposed them to extremes in heat, cold, and moisture. Additionally, the DAS had to 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. It had to automatically begin continuous data collection when the vehicle was started and stop when the vehicle was turned off, and it had to collect data from the vehicle’s onboard network, as available. It had to be installed and de-installed in way which would not permanently damage or change the vehicle in any way; it had to be installed so that it would not cause a safety hazard, even in the event of a serious crash; it had to be able to communicate via cell technology automated health checks, programs, and a variety of video and data snippets; and it had to be integrated in such a way that it would neither affect nor interfere with the vehicle’s operation or handling in any way. It had to be unobtrusive enough to largely be ignored by participants, and it had to 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 two 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 human subjects protections, including a Certificate of Confidentiality, were in place, and work with all of 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 approvals for a series of amendments which continued virtually to the end of the data collection period.

In all of this, 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.

In addition, a 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 being stored on servers at their 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 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 where 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. That is, the overarching goal was to collect a very large, extremely rich, and detailed store of data which are expected 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 for the past decade.

**Follow-on Studies**

Each participant was asked upon study exit 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 them 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. As participants exited the driving study, they were given the opportunity to participate in this follow-on effort. The Cell Phone Records Study entailed acquiring as much participant cell phone data as possible—voice and text only—during the course of their 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 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.

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


APPENDIX A. ASSESSMENT PROTOCOLS

SHRP2 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 (see appendices for training guides and equipment manuals).

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.

<table>
<thead>
<tr>
<th>Check Box</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑</td>
<td>Clock Drawing Test paper w/ participant ID bar code</td>
</tr>
<tr>
<td>☑</td>
<td>Provided Assessment Computer with Conner’s Continuous Performance Test (CPT II) and Driving Health Inventory software</td>
</tr>
<tr>
<td>☑</td>
<td>Optec 6500P Vision Test Apparatus</td>
</tr>
<tr>
<td>☑</td>
<td>Jamar Grip Strength Test Apparatus</td>
</tr>
<tr>
<td>☑</td>
<td>Computer with Internet connection to access questionnaires</td>
</tr>
</tbody>
</table>
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 participants 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. Connors’ 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 ParticipantID 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 not wear them while performing any of the tests.
   - If the participant indicates that s/he wears specific glasses for night driving, s/he should wear them for the night condition vision tests.
   - Participants should not wear sunglasses for any of the vision tests.

6. **Test Far Visual Acuity**
   - Set up OPTEC
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. What is the lowest line you can read? Please read the letters on that line to me.

- 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. What is the lowest line you can read? Please read the letters on that line.

- Note that participants should not 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


*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.

<table>
<thead>
<tr>
<th>All tests set on FAR for RIGHT eye, Night Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
</tr>
<tr>
<td>Dial 5</td>
</tr>
<tr>
<td>Dial 6</td>
</tr>
<tr>
<td>Dial 7</td>
</tr>
<tr>
<td>Dial 8</td>
</tr>
<tr>
<td>Dial 9</td>
</tr>
</tbody>
</table>

• Set Up OPTEC
  o Right eye off
  o Left eye on
  o Far switch
  o Night lighting
  o Glare off
  o 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.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dial 5</td>
<td>Row A</td>
</tr>
<tr>
<td>Dial 6</td>
<td>Row B</td>
</tr>
<tr>
<td>Dial 7</td>
<td>Row C</td>
</tr>
<tr>
<td>Dial 8</td>
<td>Row D</td>
</tr>
<tr>
<td>Dial 9</td>
<td>Row E</td>
</tr>
</tbody>
</table>

10. Test Stereo Depth Perception

• Set up OPTEC
  o Right eye on
  o Left eye on
  o Far switch
  o Day lighting
  o Glare Off
  o 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 towards 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.

- 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.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dial 5</td>
<td>Row A</td>
</tr>
<tr>
<td>Dial 6</td>
<td>Row B</td>
</tr>
<tr>
<td>Dial 7</td>
<td>Row C</td>
</tr>
<tr>
<td>Dial 8</td>
<td>Row D</td>
</tr>
<tr>
<td>Dial 9</td>
<td>Row E</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dial 5</td>
<td>Row A</td>
</tr>
<tr>
<td>Dial 6</td>
<td>Row B</td>
</tr>
<tr>
<td>Dial 7</td>
<td>Row C</td>
</tr>
<tr>
<td>Dial 8</td>
<td>Row D</td>
</tr>
<tr>
<td>Dial 9</td>
<td>Row E</td>
</tr>
</tbody>
</table>
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.

   - 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 |

A-13
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

*Variations from this position significantly influence results

**Note that the apparatus Jamar should be recalibrated once per year (i.e., prior to the second round of installations) – see VTTI for details.**
• Demonstrate to participant how to perform the Jamar assessment

*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. You need to squeeze it as hard as you can for me to get an accurate reading, like 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. Squeeze it as hard as you can…harder, harder. <when you, the experimenter, see the needle begin to move in the other direction, say> good, now you can relax.*

• 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? Squeeze it as hard as you can…harder, harder. <when you, the experimenter, see the needle begin to move in the other direction, say> good, now you can relax.*

• 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 (2\textsuperscript{nd} Time)**

• Follow protocol in #19 above
22. **Perform Jamar Test on Left Hand (2\textsuperscript{nd} 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**

<table>
<thead>
<tr>
<th>Check Box</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Questionnaires to complete</td>
</tr>
<tr>
<td></td>
<td>Sensation Seeking Scale</td>
</tr>
<tr>
<td></td>
<td>Barkley’s Quick Screen</td>
</tr>
<tr>
<td></td>
<td>Demographics Questionnaire</td>
</tr>
<tr>
<td></td>
<td>Perception of Risk</td>
</tr>
<tr>
<td></td>
<td>Driving History</td>
</tr>
<tr>
<td></td>
<td>Driving Knowledge</td>
</tr>
<tr>
<td></td>
<td>Frequency of Risky Behavior</td>
</tr>
<tr>
<td></td>
<td>Integrated Features Identification</td>
</tr>
<tr>
<td></td>
<td>Medical Conditions and Medications</td>
</tr>
<tr>
<td></td>
<td>Modified Manchester Driver Behavior</td>
</tr>
<tr>
<td></td>
<td>Sleep Questionnaire</td>
</tr>
</tbody>
</table>

A-21
APPENDIX B. SLEEP HYGIENE QUESTIONNAIRE

Please circle, check, or fill in the best answer as applicable.

Using the following rating scale, to what extent do you currently experience the following?

<table>
<thead>
<tr>
<th>None</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Snoring</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>Difficulty Falling Asleep</td>
</tr>
<tr>
<td>Difficulty Staying Asleep</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>Difficulty Waking Up</td>
</tr>
<tr>
<td>Daytime Sleepiness</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>Getting too little sleep</td>
</tr>
</tbody>
</table>

1. When you are working:
   a. What time do you usually go to bed _____:____ am/pm?
   b. What time do you usually wake up _____:____ am/pm?
   c. ______ Not applicable

2. When you are not working:
   a. What time do you usually go to bed _____:____ am/pm?
   b. What time do you usually wake up _____:____ am/pm?

3. Do you keep a fairly regular sleep schedule?
   ______ Yes
   ______ No

4. About how many hours of actual sleep do you usually get per day? ________

5. How would you characterize yourself as a sleeper?
   ______ Light
   ______ Normal
   ______ Heavy

6. Do you ever choose to sleep not in a bed, but sitting up or reclining?
   ______ Yes
   ______ No
7. Do you usually nap during the day (or between major sleep periods)?
   ___ Yes
   ___ No

8. Do you feel uncomfortably sleepy during the day or find that you fall asleep in unusual or inappropriate situations?
   ___ Every Day
   ___ More than once per week
   ___ About once a week
   ___ A few times a month
   ___ About once a month
   ___ Rarely
   ___ Never

9. Do you drink caffeinated beverages on a daily basis (e.g., coffee, tea, soda)?
   ___ Yes
   ___ No
   If yes, about how many 8oz. cups or glasses per day? __________

10. How often do you drink alcohol?
    ___ Every Day
    ___ More than once per week
    ___ About once a week
    ___ A few times a month
    ___ About once a month
    ___ Rarely
    ___ Never

11. Do you smoke cigarettes, cigars, pipe or chew or snuff tobacco?
    ___ Yes
    ___ No
If yes, how much or how often (e.g., a pack/day, a pouch/week, etc.)?
____________________________________________________________________________________

12. Have you ever been diagnosed with any of the following primary sleep disorders?
   ___ Narcolepsy
   ___ Sleep Apnea
   ___ Periodic Limb Movement
   ___ Restless Leg Syndrome
   ___ Insomnia

13. Which of the following sleep aids do you use on a regular basis?
   ___ Sleeping Pills
   ___ Continuous Positive Airway Pressure (CPAP) Machine
   ___ Nasal opening strips (e.g., Breathe Right®)
   ___ White background noise
   ___ Other? Please explain:
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
### APPENDIX C. CARDS AND DEJOY RISK PERCEPTION QUESTIONNAIRES

<table>
<thead>
<tr>
<th>In the past 12 months while driving, how often did you...</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Crash Risk* (1-7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>run a red light?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>drive when sleepy and find it hard to keep your eyes open?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>take risks while driving because it’s fun, such as driving fast on curves or “getting air”?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>change lanes suddenly to get ahead in traffic?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>speed for the thrill of it?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>not yield the right of way?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>make illegal turns?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>follow a car very closely or “tailgate”?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>follow emergency vehicles when the siren is on?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>take more risks because you are in a hurry?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>drive at your normal speed during bad driving conditions such as road construction, rain, ice, or snow?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>pass other cars on the right side or on the shoulder of the road?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>try to be the first off the line when a light turns green?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>accelerate when a traffic light turns yellow?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>drive shortly after drinking alcohol or using recreational drugs?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>drink alcohol or use recreational drugs while driving?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Question</td>
<td>Score</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>17</td>
<td>cut off, honk or yell at other drivers who drive too slowly or cut you off?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>18</td>
<td>get very angry at other drivers?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>19</td>
<td>drive to reduce tension?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>20</td>
<td>do other things while driving, like use cell phone, eat or drink, put on makeup, read things, or smoke cigarettes?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>21</td>
<td>take your eyes off the road to adjust the CD player or pick something up from the floor?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>22</td>
<td>take your eyes off the road to talk to passengers?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>23</td>
<td>race other cars or drivers?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>24</td>
<td>not check the rearview mirror when passing another car or merging onto the highway?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>25</td>
<td>drive 10-20 mph over limit?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>26</td>
<td>drive more than 20 mph over limit?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>27</td>
<td>not yield to pedestrians?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>28</td>
<td>drive too fast for conditions?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>29</td>
<td>drive without wearing a safety belt?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>30</td>
<td>turn without signalling?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>31</td>
<td>drive with badly worn tires?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>32</td>
<td>pass where visibility was obscured?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>33</td>
<td>not make a full stop at stop sign?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

**Crash Risk Rating Scale**

1. No Greater Risk
4. Moderately Greater Risk
7. Much Greater Risk
APPENDIX D. BARKLEY’S ADHD QUICK SCREEN
Russell A. Barkley, Ph.D. ©2006

Name_______________________________   Date__________________

Instructions
Please circle the number next to each item that best describes your behavior DURING THE PAST 6 MONTHS.

Items:

<table>
<thead>
<tr>
<th>Item</th>
<th>Never or Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very Often</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Easily distracted</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Have difficulty organizing tasks and activities</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Lose things necessary for tasks or activities</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Have difficulty awaiting my turn</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Feel restless</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Have difficulty engaging in leisure activities or doing fun things quietly</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

For Office Use:
Add up the scores for each item. Enter Total Score Here _________________
APPENDIX E. SENSATION SEEKING SCALE

(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
<table>
<thead>
<tr>
<th>Q#</th>
<th>State</th>
<th>Question</th>
<th>Answer</th>
<th>Question Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td><strong>Night driving is dangerous because:</strong></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>A. Some traffic signs are less visible at night.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>B. More vehicles are on the road at night.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>C. The distance we can see ahead is reduced.</td>
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<tr>
<td></td>
<td></td>
<td>D. Street lights tend to blur our vision.</td>
<td></td>
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<tr>
<td>2</td>
<td></td>
<td><strong>You are coming to an intersection with a yellow flashing light. You should:</strong></td>
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<tr>
<td></td>
<td></td>
<td>A. Stop and wait for the light to change.</td>
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<tr>
<td></td>
<td></td>
<td>B. Make a U-turn; the intersection is closed.</td>
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<td></td>
<td></td>
<td>C. Slow down and drive carefully through the intersection.</td>
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<td></td>
<td></td>
<td>D. Prepare to stop; the light is about to turn red.</td>
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<td>3</td>
<td></td>
<td><strong>A steady downward green arrow over a traffic lane means you:</strong></td>
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<tr>
<td></td>
<td></td>
<td>A. May use the lane.</td>
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<tr>
<td></td>
<td></td>
<td>B. Are not permitted to use the lane.</td>
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<td></td>
<td></td>
<td>C. Must change to a different lane.</td>
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<td></td>
<td></td>
<td>D. May use the lane for left turns only.</td>
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<td>4</td>
<td></td>
<td><strong>The maximum speed limit on a rural Interstate Highway is:</strong></td>
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<tr>
<td></td>
<td></td>
<td>A. 55 miles per hour.</td>
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<td></td>
<td>B. 60 miles per hour.</td>
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<td></td>
<td>C. 65 miles per hour.</td>
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<td></td>
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<td>D. 75 miles per hour.</td>
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<td>5</td>
<td></td>
<td><strong>When you see or hear an emergency vehicle coming, you should:</strong></td>
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<td></td>
<td></td>
<td>A. Stop immediately and let the vehicle pass.</td>
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<td></td>
<td></td>
<td>B. Drive as far toward the right side of the road as it is safe and stop.</td>
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<td></td>
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<td>C. Proceed slowly and permit the vehicle to pass.</td>
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<tr>
<td></td>
<td></td>
<td>D. Keep moving slowly, staying to the right side of the road.</td>
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<tr>
<td>6</td>
<td></td>
<td><strong>Dim your lights when you are within 200 feet of:</strong></td>
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<tr>
<td></td>
<td></td>
<td>A. A vehicle you are approaching from behind.</td>
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<tr>
<td></td>
<td></td>
<td>B. An official vehicle.</td>
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<tr>
<td></td>
<td></td>
<td>C. An oncoming vehicle.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>D. An intersection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q#</td>
<td>State</td>
<td>Question</td>
<td>Answer</td>
<td>Question Category</td>
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<td>----</td>
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<tr>
<td>7</td>
<td></td>
<td><em>This sign means:</em>&lt;br&gt;A. One-way traffic&lt;br&gt;B. Intersection ahead.&lt;br&gt;C. Merging traffic from the right.&lt;br&gt;D. Highway curves ahead.</td>
<td></td>
<td></td>
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<tr>
<td>8</td>
<td></td>
<td><em>This sign is used to warn drivers about:</em>&lt;br&gt;A. Upcoming intersections.&lt;br&gt;B. Changes in traffic lanes.&lt;br&gt;C. Road curves ahead.&lt;br&gt;D. Road construction.</td>
<td></td>
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<tr>
<td>9</td>
<td></td>
<td><em>If you are stopped by a police officer, your should:</em>&lt;br&gt;A. Get your paperwork ready before the officer reaches your car.&lt;br&gt;B. Unbuckle your seat belt and lower your window.&lt;br&gt;C. Get out of your car and walk toward the patrol car.&lt;br&gt;D. Stay in your vehicle with your hands on the steering wheel, and wait for the officer to approach you.</td>
<td></td>
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<tr>
<td>10</td>
<td></td>
<td><em>You have the right-of-way when you are:</em>&lt;br&gt;A. Entering a traffic circle&lt;br&gt;B. Backing out of a driveway&lt;br&gt;C. Leaving a parking space&lt;br&gt;D. Already in a traffic circle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td><em>You should always park further than ___ feet away from a fire hydrant:</em>&lt;br&gt;A. 5&lt;br&gt;B. 10&lt;br&gt;C. 15&lt;br&gt;D. 20</td>
<td></td>
<td></td>
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<tr>
<td>12</td>
<td></td>
<td><em>The basic color for various traffic control devices used in construction and maintenance work areas is:</em>&lt;br&gt;A. Red&lt;br&gt;B. Orange&lt;br&gt;C. Yellow&lt;br&gt;D. Blue</td>
<td></td>
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<tr>
<td>13</td>
<td></td>
<td><em>A broken yellow line beside a solid yellow line indicates:</em></td>
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<tr>
<td>Q#</td>
<td>State</td>
<td>Question</td>
<td>Answer</td>
<td>Question Category</td>
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<tr>
<td>14</td>
<td></td>
<td><strong>What is the proper way to enter an expressway from the entrance ramp?</strong></td>
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<tr>
<td></td>
<td></td>
<td>A. Slow on your way down the entrance ramp until it is clear to proceed.</td>
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<td></td>
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<td>B. Go down the ramp and cross over to the traffic lane as soon as possible.</td>
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<td>C. Use the acceleration lane to blend into the traffic.</td>
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<td>D. Go down to the bottom of the ramp and stop until it is safe to enter the expressway.</td>
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<td>15</td>
<td></td>
<td><strong>When changing lanes, you can check your blind spot by:</strong></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>A. Turning your head and looking over your shoulder</td>
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<td></td>
<td></td>
<td>B. Using the inside rearview mirror.</td>
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<td>C. Using the outside rearview mirror.</td>
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<td></td>
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<td>D. Using both inside and outside rearview mirrors.</td>
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<tr>
<td>16</td>
<td></td>
<td><strong>On long trips you can prevent drowsiness by:</strong></td>
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<tr>
<td></td>
<td></td>
<td>A. Turning on your car radio.</td>
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<td></td>
<td></td>
<td>B. Slowing down so you can react better.</td>
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<td></td>
<td></td>
<td>C. Stopping at regular intervals for a rest.</td>
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<td></td>
<td></td>
<td>D. Moving your eyes from side to side as you drive.</td>
<td></td>
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<tr>
<td>17</td>
<td></td>
<td><strong>City driving is more dangerous than expressway driving because of the:</strong></td>
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<tr>
<td></td>
<td></td>
<td>A. Lower speed limits.</td>
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<td></td>
<td></td>
<td>B. Narrower driving lanes.</td>
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<tr>
<td></td>
<td></td>
<td>C. Cross traffic and pedestrians.</td>
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<td></td>
<td></td>
<td>D. Worse road conditions in bad weather.</td>
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<tr>
<td>18</td>
<td></td>
<td><strong>You are approaching an intersection with a traffic signal and the light changes from green to yellow. You should:</strong></td>
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<tr>
<td></td>
<td></td>
<td>A. Consider it the same as a caution sign and continue through the intersection.</td>
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<tr>
<td></td>
<td></td>
<td>B. Stop immediately.</td>
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<td></td>
<td></td>
<td>C. Stop before entering the intersection unless you are too close to stop safely.</td>
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<tr>
<td></td>
<td></td>
<td>D. Speed up to get through the intersection before the red light comes on.</td>
<td></td>
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<tr>
<td>19</td>
<td></td>
<td><strong>You have allowed the wheels of your vehicle to run off the</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Q#</th>
<th>State</th>
<th>Question</th>
<th>Answer</th>
<th>Question Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td></td>
<td><strong>Bicycles are</strong></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>A. considered vehicles and have the same rights-of-way as motor vehicles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B. required to stay on sidewalks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C. considered vehicles but do not have the same rights-of-way as motor vehicles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D. required to stay on bicycle paths.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX G. SHRP2 FIELD STUDY: OFF-SITE DETAILED MEDICAL HISTORY

1. General Information
   a. Age
   b. Gender  Male  Female
   c. Height  ______  feet  ______ inches
   d. Weight  _________  lbs

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:
   a. if you were treated for the condition within the past year (e.g., a doctor’s office visit, hospitalization, or surgery)
   b. if you are currently on medication for the condition
   c. if you are using an aid related to the condition (e.g., corrective lenses, a hearing aid, or a cane).

2. Vision Conditions:
   a. Near sighted  □Yes  □No
   b. Far sighted  □Yes  □No
   c. Astigmatism  □Yes  □No
   d. Reading glasses needed  □Yes  □No
   e. Cataracts  □Yes  □No
   f. Glaucoma  □Yes  □No
   g. Color blindness  □Yes  □No
   h. Blind in one eye  □Yes  □No
   i. Poor night vision  □Yes  □No
   j. Detached retina  □Yes  □No
   k. Tunnel (no peripheral) vision  □Yes  □No
   l. Lasik or similar surgery  □Yes  □No
   m. Other vision conditions  □Yes  □No
      Please Describe: ______________________________

3. Hearing Conditions
   a. Difficulty hearing, but no hearing aid  □Yes  □No
   b. Hearing aid  □Yes  □No
   c. Deafness  □Left ear  □Right ear
   d. Other hearing conditions  □Yes  □No
      Please Describe: ______________________________

4. Heart Conditions
   a. Angina  □Yes  □No
   b. Angioplasty  □Yes  □No
   c. Heart attack  □Yes  □No
   d. Bypass surgery  □Yes  □No
   e. Pacemaker  □Yes  □No
   f. Congestive heart failure  □Yes  □No
g. Hypertension (high blood pressure) □ Yes □ No
h. Hypotension (low blood pressure) □ Yes □ No
i. Other heart conditions □ Yes □ No

Please Describe: ________________________________________

5. Stroke and Similar Brain Conditions
   a. Stroke □ Yes □ No
   b. TIA (mini-strokes) □ Yes □ No
c. Brain aneurysms □ Yes □ No
d. Brain hemorrhage □ Yes □ No
e. Brain surgery □ Yes □ No
f. Traumatic brain injury □ Yes □ No
g. Other brain conditions □ Yes □ No
   Please Describe: ________________________________________

6. Vascular (Blood Vessel) Conditions
   a. Peripheral aneurysms (in legs, arms, hands, feet) □ Yes □ No
   b. Aortic aneurysm □ Yes □ No
c. Deep vein thrombosis (blood clots) □ Yes □ No
d. Other vascular conditions □ Yes □ No
   Please Describe: ________________________________________

7. Nervous System and Sleep Conditions
   a. Epilepsy (describe) □ Yes □ No
   b. Narcolepsy □ Yes □ No
c. Sleep apnea □ Yes □ No
d. Parkinson’s Disease □ Yes □ No
e. Multiple Sclerosis □ Yes □ No
f. Migraines □ Yes □ No
g. Dizziness □ Yes □ No
h. Brain tumors □ Yes □ No
   i. Peripheral Neuropathy (numbness and tingling in hands, feet, arms, and legs)
      □ Yes □ No
   j. Other nervous system conditions □ Yes □ No
   Please Describe: ________________________________________

8. Respiratory Conditions
   a. Asthma □ Yes □ No
   b. COPD (Chronic Obstructive Pulmonary Disease) □ Yes □ No
c. Other respiratory conditions □ Yes □ No
   Please Describe: ________________________________________

9. Diabetes and Other Metabolic Conditions
   a. Type 1: Insulin dependent □ Yes □ No
   b. Type 2: Non-insulin dependent □ Yes □ No
c. Type 2: Insulin dependent □ Yes □ No
d. Hyperthyroidism □ Yes □ No

e. Hypothyroidism □ Yes □ No

f. Other metabolic conditions □ Yes □ No

Please Describe: ____________________________________________

10. Kidney Conditions

a. Chronic kidney failure □ Yes □ No

Please Describe: ____________________________________________

b. Other kidney conditions □ Yes □ No

Please Describe: ____________________________________________

11. Musculoskeletal (Muscle and Bone) Conditions

a. Limited Flexibility (e.g., to check blind spots) □ Yes □ No

Please Describe: ____________________________________________

b. Severe arthritis □ Yes □ No

Please Describe: ____________________________________________

c. Artificial limbs □ Yes □ No

Please Describe: ____________________________________________

d. Paralysis □ Yes □ No

Please Describe: ____________________________________________

e. Muscle and movement disorders □ Yes □ No

Please Describe: ____________________________________________

f. Other musculoskeletal conditions □ Yes □ No

Please Describe:

12. Cancer □ Yes □ No

Please Describe: ____________________________________________

13. Psychiatric Conditions

a. Anxiety or panic attacks □ Yes □ No

b. Depression □ Yes □ No

c. ADD/ADHD/Tourette’s syndrome □ Yes □ No

d. Personality disorders □ Yes □ No

e. Psychotic illness □ Yes □ No

f. Bipolar illness □ Yes □ No

g. Other psychiatric conditions □ Yes □ No

Please Describe: ____________________________________________
14. Current medications
Many medications can affect driving. Please indicate which medications you are currently taking in the spaces below, using the examples as a guide.

<table>
<thead>
<tr>
<th>Brand Name</th>
<th>Generic Name</th>
<th>Dosage</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Motrin</td>
<td>ibuprofen</td>
<td>400 mg</td>
<td>twice per day</td>
</tr>
<tr>
<td>Example: Synthroid</td>
<td>levothyroxine</td>
<td>.15mg</td>
<td>once per day</td>
</tr>
</tbody>
</table>

- [ ] Yes   [ ] No

- [ ] Yes   [ ] No

- [ ] Yes   [ ] No

Please Describe: _________________________________________________

b. Other medical issues or concerns not reflected above that may affect your driving
Please Describe:
_____________________________________________________________________________________
_____________________________________________________________________________________

Please Describe: _________________________________________________

G-4
<table>
<thead>
<tr>
<th>Behavior</th>
<th>Never</th>
<th>Hardly Ever</th>
<th>Occasionally</th>
<th>Quite Often</th>
<th>Frequently</th>
<th>Nearly All The Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attempt to drive away from traffic lights in the wrong gear</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Become impatient with a slow driver in the fast lane and pass on the right</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Drive especially close to a car in front as a signal to the driver to go faster or get out of the way</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Attempt to pass someone that you hadn't noticed to be making a left turn</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Forget where you left your car in a parking lot</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Turn on one thing, such as your headlights, when you mean to switch on something else, such as the windshield wipers</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Realize that you have no clear recollection of the road along which you have just been traveling</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Cross an intersection knowing that the traffic lights have already changed from yellow to red</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Fail to notice that pedestrians are crossing when turning onto a side street from a main road</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Angered by another driver's behavior, you catch up to them with the intention of giving him/her “a piece of your mind.”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Misread the signs and turn the wrong direction on a one-way street</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Behavior</td>
<td>Scale</td>
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<tr>
<td>-------------------------------------------------------------------------</td>
<td>-------</td>
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</tr>
<tr>
<td>Disregard the speed limits late at night or early in the morning</td>
<td>0 1 2 3 4 5</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>When turning right, nearly hit a bicyclist who is riding along side of</td>
<td>0 1 2 3 4 5</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>you</td>
<td></td>
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</tr>
<tr>
<td>Attempting to turn onto a main road, you pay such close attention to</td>
<td>0 1 2 3 4 5</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>traffic on the road you are entering that you nearly hit the car in</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>front of you that is also waiting to turn.</td>
<td></td>
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</tr>
<tr>
<td>Drive even though you realize you might be over the legal blood alcohol</td>
<td>0 1 2 3 4 5</td>
<td></td>
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<tr>
<td>limit</td>
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</tr>
<tr>
<td>Have an aversion to a particular class of road user, and indicate your</td>
<td>0 1 2 3 4 5</td>
<td></td>
<td></td>
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<tr>
<td>hostility by whatever means you can</td>
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</tr>
<tr>
<td>Underestimate the speed of an oncoming vehicle when attempting to</td>
<td>0 1 2 3 4 5</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>pass a vehicle in your own lane</td>
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</tr>
<tr>
<td>Hit something when backing up that you had not previously seen</td>
<td>0 1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intending to drive to destination A, you 'wake up' to find yourself on</td>
<td>0 1 2 3 4 5</td>
<td></td>
<td></td>
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<tr>
<td>a road to destination B, perhaps because destination B is a more</td>
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</tr>
<tr>
<td>common destination.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Get into the wrong lane approaching an intersection</td>
<td>0 1 2 3 4 5</td>
<td></td>
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</tr>
<tr>
<td>Miss “Yield” signs, and narrowly avoid colliding with traffic having</td>
<td>0 1 2 3 4 5</td>
<td></td>
<td></td>
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<tr>
<td>the right of way</td>
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<td></td>
</tr>
<tr>
<td>Fail to check your rearview mirror before pulling out, changing lanes,</td>
<td>0 1 2 3 4 5</td>
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<tr>
<td>etc.</td>
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</tr>
<tr>
<td>Get involved in unofficial 'races' with other drivers</td>
<td>0 1 2 3 4 5</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Brake to quickly on a slippery road or steer the wrong way into a skid</td>
<td>0 1 2 3 4 5</td>
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</tbody>
</table>
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
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 [B] (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 [B] (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 [B] (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

[Space for answer]
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"
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"
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 [B]' (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 [B]' (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 [B]' (How many passengers were in the vehicle (do not count the driver)?)

Please write your answer here:

[Blank space]
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"
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 (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:

[Blank space for answer]
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"
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<td>6' 6&quot;</td>
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<tr>
<td>6' 7&quot;</td>
</tr>
</tbody>
</table>
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 [B] (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"
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"
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 [B] (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 [B] (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 [B] (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"
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 (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: 

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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: [ ]
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 [ ]
63 Regulatory Signs

Only answer this question if the following conditions are met:
* Answer was 'Yes' at question '81 [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 '81 [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 '81 [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
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 (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 jackknife
- 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 [B1]' (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 jackknife
- [ ] 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 jackknife
- 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 [81] (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 jackknife
- 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 [B1]' (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 jackknife
- 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 '5 lateral movements' at question '75 [81]' (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 jackknife
- 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 [81] (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 jackknife
- 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 (B1) (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 jackknife
- 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 [B1]' (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 jackknife
- Non-contact trailer swing
- Unknown
- Other (specify) [ ]

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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 (81) (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 jackknife
- 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 (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 (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 98 (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 '88 [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 (stosh)
- 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)
- Boyfriend/girlfriend
- Husband/wife
- Parent/child
- Other relative
- No relationship/stranger
- Unknown
- Not applicable
- Other (specify)  

https://surveys.shrp2.hds.us/admin/admin.php?action=showprintablesurvey&sid=37584
**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 (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) [blank]

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) [blank]

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) [blank]
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 travelling 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 appurtenance (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
☐ Preceding 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 [184]' (Did you ever take any form of Driver Education?)

Please choose only one of the following:

- None
- Driving school
- Company
- Military
- Community college, etc
- Professional/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
- 8-10 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 (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 (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

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- 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:
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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 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       (540) ***_****
******@vt.edu       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

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

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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:

6. 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
7. 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.
8. Drive as you normally would.
9. Let us or the primary participant know if you notice any unusual warning light activity, for example, warning lights that go on or off.
10. 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.
11. 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:

6. 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.

7. 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.
8. 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.

9. 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

____________________________ _____________________________ ________
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Should I have any questions about this research or its conduct, I may contact:

Alan Blatt  CUBRC Site Principal Investigator  (716) 204-5138
  blatt@cubrc.org

Jon Antin  Project Manager  (540) 231-1579
  jantin@vti.vt.edu

David Moore  (540) 231-4991
  moored@vt.edu  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

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)

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(“The SHRP 2 Naturalistic Driving Study”)

SPONSORS: National Academies of Science, Transportation Research Board,
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The United States Department of Transportation

INVESTIGATORS: Tom Dingus, Jon Hankey, Jon Antin, Suzie Lee, and Lisa Eichelberger:
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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.
7. 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.

8. 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.

9. 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.

10. Allow our technicians to drive the vehicle as needed during the installation and testing process.
11. 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).

12. 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):
   f. Seek emergency help the way that you normally would.
   g. 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.
   h. Call us at (716) 204-5138 or (716) 204-5177 to notify us as soon as it is safe to do so.
   i. 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.
   j. 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:

5. **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.

6. **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.

7. **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).
8. **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).

9. **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).

10. **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.

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**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:

10. 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.
11. All data collected from other drivers who have not signed a consent form, will be deleted. No identifying information will be collected on passengers.

12. 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.

13. 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.

14. 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.

3. 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.

4. 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) 204-5138
blatt@cubrc.org
The Participant Must Be Provided With A Copy Of This Assent 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:

12. Have the vehicle equipped (see the section below: “What will my child have to do to get the vehicle equipped for the study?”).

13. Drive as he/she normally would.

14. 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.

15. 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.

16. 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.

17. 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.

18. 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?

13. 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.

14. 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.

15. 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.

16. Allow our technicians to drive the vehicle as needed during the installation and testing process.

17. 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).

18. 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?

8. 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.

9. Drive as he/she normally would for the duration of his/her enrollment.

10. 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.

11. 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.

12. 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.

13. Let us know if you or your child notices any unusual warning light activity, for example, warning lights that go on or off.
14. 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.
15. 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?

4. 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.

5. 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.

6. 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:

11. **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.

12. **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.
13. **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).

14. **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).

15. **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).

16. **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:

15. 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.

16. All data collected from other drivers who have not signed a consent form will be deleted. No identifying information will be collected on passengers.

17. 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.

18. 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).

19. 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.

5. 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.

6. 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) 204-5138
blatt@cubrc.org

Jon Antin    Project Manager    (540) 231-1579
jantin@vtti.vt.edu

David Moore    (540) 231-4991
moored@vt.edu    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

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
  •
  •
  •
  •
  •
  •
  •
  •
  •
  •

P-1
(Attach additional sheets or documentation as necessary)

## General Facilities

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Approved Federal Wide Assurance on file w/ U.S. Dept of H&amp;HS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clear site identification signage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facility/environment should be/feel safe for participants and S07 personnel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Convenient, well-marked parking with spots for visitors</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Clean and appealing facility (e.g., comfortable waiting area, plants, water cooler or fountain, magazines and/or television available)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Restrooms clean and easily accessible from all participant areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adequate climate control (heat or air conditioning as appropriate)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electricity (working outlets) available</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waiting area separated from intake area (two rooms, or one room with dividers)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Method of quickly relaying information to/from all site areas/facilities (i.e., via text message, e-mail, intercom, phone, or other)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wheelchair (recommended)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Staging server connected to high speed Internet access</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SSD docking bay for uploading vehicle data to staging server</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phone line / Response plan for the Glove Box Letter and related calls</td>
</tr>
</tbody>
</table>

## Participant Intake Area

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Adequate seating, desk, lighting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arranged for reasonable privacy (e.g., those in waiting area cannot see or hear conversations or tasks in assessment area)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Must have a designated secure area to store consent forms and other paper data as necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Method to show Informed Consent video</td>
</tr>
</tbody>
</table>
### Participant Assessment Area

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td><strong>Space</strong></td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>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.)</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>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)</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td><strong>Storage</strong></td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Tools and materials</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Standard Office Lighting</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td><strong>Data/Resource Access</strong></td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Communications – Internet (Ethernet/Wireless)</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Mission Control Software – Mozilla Firefox</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Issue Management (RT)</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>SHRP 2 NDS website</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td><strong>Equipment</strong></td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Basic office equipment, including comfortable chair(s)</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>Chair with no arm rests (for grip strength test)</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td><strong>-Custom equipment</strong></td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>-- Optec 6500 P</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>-- Jamar hand dynamometer (model 5030J1)</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>-- Touch screen monitor</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>-- Bar code reader(s): 1 per assessment computer</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>-- All-in-one scanner/copier/printer, connected</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td><strong>-Software</strong></td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>-- Driving Health Inventory (DHI) loaded on Assessment Computer</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>-- Connor’s Continuous Performance II (CPT II) loaded on Assessment Computer</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>-- Easy Street Draw</td>
</tr>
</tbody>
</table>
## Garage/Shop Area

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Space</strong></td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  1 bay per 150 vehicles</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Minimum bay size: approximately 38’ x 13’ x standard ceiling height</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Level garage floor</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Shipping and receiving area</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Restroom access</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Storage</strong></td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Vehicles</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  DAS storage: 10’x10’ (or equivalent) secure, unshared area with shelving</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Equipment</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Components</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Supplies</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Tools</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Infrastructure</strong></td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Electricity</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Water</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Exhaust evacuation or CO monitor</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  Lighting</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Data/Resource access</strong></td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  - Automotive repair references, such as:</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  -- Online database: alldata.com</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  -- S06 wiki</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  - Computer-related</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  -- Installation/field service laptop: 2 per 150 vehicles</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  -- Bar code readers: 2 per 150 vehicles</td>
</tr>
<tr>
<td></td>
<td>□</td>
<td>□  -- High speed Internet access</td>
</tr>
</tbody>
</table>
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
## Eligible Vehicle List

<table>
<thead>
<tr>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Powertrain</th>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Powertrain</th>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Powertrain</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009-2010</td>
<td>Buick</td>
<td>Lucerne</td>
<td>Gas</td>
<td>2008-2009</td>
<td>GMC</td>
<td>Sierra</td>
<td>Gas</td>
<td>2010</td>
<td>Mercury</td>
<td>Milan</td>
<td>Hybrid</td>
</tr>
<tr>
<td>2009-2010</td>
<td>Cadillac</td>
<td>Escalade</td>
<td>Gas</td>
<td>2008-2010</td>
<td>Honda</td>
<td>Accord</td>
<td>Gas</td>
<td>2008-2010</td>
<td>Mercury</td>
<td>Sable</td>
<td>Gas</td>
</tr>
<tr>
<td>2007-2010</td>
<td>Chevrolet</td>
<td>Equinox</td>
<td>Gas</td>
<td>2006-2010</td>
<td>Honda</td>
<td>Civic</td>
<td>Gas</td>
<td>2002-2010</td>
<td>Nissan</td>
<td>Altima</td>
<td>Gas</td>
</tr>
<tr>
<td>2006-2010</td>
<td>Chevrolet</td>
<td>Impala</td>
<td>Gas</td>
<td>2006-2010</td>
<td>Honda</td>
<td>Civic</td>
<td>Hybrid</td>
<td>2005-2010</td>
<td>Nissan</td>
<td>Frontier</td>
<td>Gas</td>
</tr>
<tr>
<td>2008-2010</td>
<td>Chevrolet</td>
<td>Silverado</td>
<td>Gas</td>
<td>2009-2010</td>
<td>Honda</td>
<td>Fit</td>
<td>Gas</td>
<td>2005-2010</td>
<td>Nissan</td>
<td>Xterra</td>
<td>Gas</td>
</tr>
<tr>
<td>Year</td>
<td>Make</td>
<td>Model</td>
<td>Powertrain</td>
<td>Year</td>
<td>Make</td>
<td>Model</td>
<td>Powertrain</td>
<td>Year</td>
<td>Make</td>
<td>Model</td>
<td>Powertrain</td>
</tr>
<tr>
<td>----------</td>
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<td>-----------</td>
<td>------------</td>
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<td>----------</td>
<td>----------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>2009</td>
<td>Ford</td>
<td>Escape</td>
<td>Hybrid</td>
<td>2010</td>
<td>Make</td>
<td>Model</td>
<td>Powertrain</td>
<td>Year</td>
<td>Make</td>
<td>Model</td>
<td>Powertrain</td>
</tr>
<tr>
<td>2005-2010</td>
<td>Ford</td>
<td>F150</td>
<td>Gas</td>
<td>2010</td>
<td>Lexus</td>
<td>RX</td>
<td>Gas</td>
<td>2008-2010</td>
<td>Toyota</td>
<td>Highlander</td>
<td>Hybrid</td>
</tr>
<tr>
<td>2005-2010</td>
<td>Ford</td>
<td>Focus</td>
<td>Gas</td>
<td>2010</td>
<td>Lexus</td>
<td>RX</td>
<td>Hybrid</td>
<td>2004-2010</td>
<td>Toyota</td>
<td>Highlander</td>
<td>Gas</td>
</tr>
<tr>
<td>2010</td>
<td>Ford</td>
<td>Fusion</td>
<td>Hybrid</td>
<td>2010</td>
<td>Lincoln</td>
<td>MKZ</td>
<td>Hybrid</td>
<td>2008-2010</td>
<td>Toyota</td>
<td>Sequoia</td>
<td>Gas</td>
</tr>
</tbody>
</table>
# APPENDIX R. FINAL ELIGIBLE VEHICLE LIST

## Eligible Vehicle List

<table>
<thead>
<tr>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Power</th>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Power</th>
<th>Year</th>
<th>Make</th>
<th>Model</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002-2011</td>
<td>Acura</td>
<td>MDX</td>
<td>Gas</td>
<td>2001-2011</td>
<td>BMW</td>
<td>325Xi</td>
<td>Gas</td>
<td>2004-2010</td>
<td>Chevrolet</td>
<td>Colorado</td>
<td>Gas</td>
</tr>
<tr>
<td>1992</td>
<td>Acura</td>
<td>Vigor</td>
<td>Gas</td>
<td>1997-2012</td>
<td>BMW</td>
<td>528i</td>
<td>Gas</td>
<td>2006-2012</td>
<td>Chevrolet</td>
<td>HHR</td>
<td>Gas</td>
</tr>
<tr>
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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 herein.

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 Chapter 3 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 their 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 OEM

<table>
<thead>
<tr>
<th>Make</th>
<th>Count</th>
<th>% of fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toyota</td>
<td>825</td>
<td>24.54%</td>
</tr>
<tr>
<td>Ford</td>
<td>563</td>
<td>16.75%</td>
</tr>
<tr>
<td>Honda</td>
<td>459</td>
<td>13.65%</td>
</tr>
<tr>
<td>Nissan</td>
<td>298</td>
<td>8.86%</td>
</tr>
<tr>
<td>GM</td>
<td>509</td>
<td>15.14%</td>
</tr>
<tr>
<td>Hyundai/Kia</td>
<td>326</td>
<td>9.70%</td>
</tr>
<tr>
<td>Mazda</td>
<td>66</td>
<td>1.96%</td>
</tr>
<tr>
<td>Dodge</td>
<td>86</td>
<td>2.56%</td>
</tr>
<tr>
<td>Subaru</td>
<td>57</td>
<td>1.70%</td>
</tr>
<tr>
<td>Jeep</td>
<td>53</td>
<td>1.58%</td>
</tr>
<tr>
<td>Volkswagen</td>
<td>48</td>
<td>1.43%</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>23</td>
<td>0.68%</td>
</tr>
<tr>
<td>Volvo</td>
<td>16</td>
<td>0.48%</td>
</tr>
<tr>
<td>Suzuki</td>
<td>10</td>
<td>0.30%</td>
</tr>
<tr>
<td>BMW</td>
<td>8</td>
<td>0.24%</td>
</tr>
<tr>
<td>Mini</td>
<td>6</td>
<td>0.18%</td>
</tr>
<tr>
<td>Mercedes</td>
<td>4</td>
<td>0.12%</td>
</tr>
<tr>
<td>SAAB</td>
<td>3</td>
<td>0.09%</td>
</tr>
<tr>
<td>Audi</td>
<td>2</td>
<td>0.06%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,362</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>
## APPENDIX U. DESCRIPTION OF RT QUEUES

<table>
<thead>
<tr>
<th>Queue Name</th>
<th>Description of Queue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Ingestion</td>
<td>Queue for processing/ingestion of HDDs</td>
</tr>
<tr>
<td>General</td>
<td>The default queue</td>
</tr>
<tr>
<td>Installers All Sites</td>
<td>This queue is to provide information to installers at all sites</td>
</tr>
<tr>
<td>Inventory</td>
<td>Captures inventory events and conflicts</td>
</tr>
<tr>
<td>Operations Bucket</td>
<td>Bucket list of operational tasks</td>
</tr>
<tr>
<td>S06 ACN</td>
<td>S06 Automatic Crash Notification</td>
</tr>
<tr>
<td>S06 Admin</td>
<td>All administrative matters related to the study</td>
</tr>
<tr>
<td>S06 DB Security</td>
<td>This queue is used to manage access to database and other security issues</td>
</tr>
<tr>
<td>S06 DBA</td>
<td>S06 Database Administration</td>
</tr>
<tr>
<td>S06 Developers</td>
<td>S06 Developers</td>
</tr>
<tr>
<td>S06 Emergency</td>
<td>S06 Emergency Action</td>
</tr>
<tr>
<td>S06 Equipment Repairs</td>
<td>Queue for assessment and repair of equipment</td>
</tr>
<tr>
<td>S06 Health Check</td>
<td>Queue for automated Health Checks</td>
</tr>
<tr>
<td>S06 Tech Support</td>
<td>S06 Desktop computing and software development</td>
</tr>
<tr>
<td>S06 Transerve-generated tickets</td>
<td>DMS Automated Emails</td>
</tr>
<tr>
<td>S06 Vehicle Hardware</td>
<td>S06 Vehicle Hardware (HEL)</td>
</tr>
<tr>
<td>S07 FL General</td>
<td>S07 CUBRC FL, Tampa, FL General / IT issues</td>
</tr>
<tr>
<td>S07 IN Admin</td>
<td>S07 IN Administrative Matters</td>
</tr>
<tr>
<td>S07 IN Crash</td>
<td>S07 IN Crash</td>
</tr>
<tr>
<td>S07 IN Emergency</td>
<td>S07 IN Emergency</td>
</tr>
<tr>
<td>S07 IN General</td>
<td>S07 University of Indiana, Bloomington, IN General / IT issues</td>
</tr>
<tr>
<td>S07 IN Hardware</td>
<td>S07 IN DAS Hardware</td>
</tr>
<tr>
<td>S07 IN Health Check</td>
<td>S07 IN Health Check</td>
</tr>
<tr>
<td>S07 IN Install</td>
<td>S07 IN Installation Issues</td>
</tr>
<tr>
<td>S07 IN Enrollment Assess</td>
<td>S07 IN Enrollment Assessment Matters</td>
</tr>
<tr>
<td>S07 IN Scheduling</td>
<td>S07 IN Scheduling</td>
</tr>
<tr>
<td>S07 NC Admin</td>
<td>S07 NC Administrative Matters</td>
</tr>
<tr>
<td>S07 NC Crash</td>
<td>S07 NC Crash</td>
</tr>
<tr>
<td>S07 NC Emergency</td>
<td>S07 NC Emergency</td>
</tr>
<tr>
<td>S07 NC General</td>
<td>S07 Westat, Durham, NC General / IT issues</td>
</tr>
<tr>
<td>S07 NC Hardware</td>
<td>S07 NC DAS Hardware</td>
</tr>
<tr>
<td>S07 NC Health Check</td>
<td>S07 NC Health Check</td>
</tr>
<tr>
<td>S07 NC Install</td>
<td>S07 NC Installation Issues</td>
</tr>
<tr>
<td>S07 NC Enrollment Assess</td>
<td>S07 NC Enrollment Assessment Matters</td>
</tr>
<tr>
<td>S07 NC Scheduling</td>
<td>S07 NC Scheduling</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>S07 NY General</td>
<td>S07 CUBRC NY, Buffalo, NY General / IT issues</td>
</tr>
<tr>
<td>S07 PA Admin</td>
<td>S07 PA Administrative Matters</td>
</tr>
<tr>
<td>S07 PA Crash</td>
<td>S07 PA Crash</td>
</tr>
<tr>
<td>S07 PA Emergency</td>
<td>S07 PA Emergency</td>
</tr>
<tr>
<td>S07 PA General</td>
<td>S07 Penn State University, State College, PA General / IT issues</td>
</tr>
<tr>
<td>S07 PA Hardware</td>
<td>S07 PA DAS Hardware</td>
</tr>
<tr>
<td>S07 PA Health Check</td>
<td>S07 PA Health Check</td>
</tr>
<tr>
<td>S07 PA Install</td>
<td>S07 PA Installation Issues</td>
</tr>
<tr>
<td>S07 PA Enrollment Assess</td>
<td>S07 PA Enrollment Assessment Matters</td>
</tr>
<tr>
<td>S07 WA Admin</td>
<td>S07 WA Administrative Matters</td>
</tr>
<tr>
<td>S07 WA Crash</td>
<td>S07 WA Crash</td>
</tr>
<tr>
<td>S07 WA Emergency</td>
<td>S07 WA Emergency</td>
</tr>
<tr>
<td>S07 WA General</td>
<td>S07 Battelle, Seattle, WA General / IT issues</td>
</tr>
<tr>
<td>S07 WA Hardware</td>
<td>S07 WA DAS Hardware</td>
</tr>
<tr>
<td>S07 WA Health Check</td>
<td>S07 WA Health Check</td>
</tr>
<tr>
<td>S07 WA Install</td>
<td>S07 WA Installation Issues</td>
</tr>
<tr>
<td>S07 WA Enrollment Assess</td>
<td>S07 WA Enrollment Assessment Matters</td>
</tr>
<tr>
<td>S07 WA Scheduling</td>
<td>S07 WA Scheduling</td>
</tr>
<tr>
<td>ShipReceive</td>
<td>SHRP 2 Shipping and Receiving Queue</td>
</tr>
<tr>
<td>SHRP 2 Staff</td>
<td>SHRP 2 Staff</td>
</tr>
<tr>
<td>SHRP 2 Forums</td>
<td>Invision Power Board Forums Queue</td>
</tr>
<tr>
<td>Test</td>
<td>Queue for testing how things work</td>
</tr>
<tr>
<td>Vehicle Eligibility</td>
<td>Queue for tickets requesting additions to the eligible vehicle list and questions concerning advanced vehicle features</td>
</tr>
</tbody>
</table>
ABBREVIATIONS

CFR
Code of Federal Regulations

A
amps

ABS
Anti-lock Brake System

ACDI
American Computer Development, Inc.

ACN
Automatic Crash Notification

AD
Active Directory

ADHD
Attention Deficit Hyperactivity Disorder

AES
Advanced Encryption Standard

AIAM
Association of International Automobile Manufacturers

AT&T
AT&T Inc., formerly American Telephone and Telegraph Company

BLOBs
Binary large objects

BOMs
Build of Materials

CAN
Controller area network

CDMA
Code-Division Multiple Access

CIFs
Common Internet File System

CM
Contract manufacturer, responsible for the build of the DAS

CNS
Communications Network Services of Virginia Tech

CO₂
Carbon dioxide

CPRS
Cell Phone Records Study

CPT II
Connor’s Continuous Performance Test II - Version 5

CUBRC
CUBRC, Inc./Calspan – University of Buffalo Research Center

D. C.
District of Columbia

DAS
Data acquisition system

DBQ
Manchester Driver Behavior Questionnaire
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDN</td>
<td>Data Direct Net</td>
</tr>
<tr>
<td>Delta-V</td>
<td>Change in velocity</td>
</tr>
<tr>
<td>DHI</td>
<td>Driving Health® Inventory software</td>
</tr>
<tr>
<td>DLC</td>
<td>Data Link Connector</td>
</tr>
<tr>
<td>DVD</td>
<td>Digital video disc</td>
</tr>
<tr>
<td>E-mail</td>
<td>Electronic mail</td>
</tr>
<tr>
<td>EMI</td>
<td>Electromagnetic interference</td>
</tr>
<tr>
<td>EMS</td>
<td>Emergency Medical Services</td>
</tr>
<tr>
<td>ESC</td>
<td>Electronic stability control</td>
</tr>
<tr>
<td>ETG</td>
<td>Expert Technical Group</td>
</tr>
<tr>
<td>FAQ</td>
<td>Frequently Asked Questions</td>
</tr>
<tr>
<td>FARS</td>
<td>Fatality Analysis Reporting System</td>
</tr>
<tr>
<td>FL</td>
<td>Florida (Tampa Site Contractor)</td>
</tr>
<tr>
<td>GB</td>
<td>Gigabyte</td>
</tr>
<tr>
<td>GES</td>
<td>National Automotive Sampling System General Estimates System</td>
</tr>
<tr>
<td>GPFS</td>
<td>General Parallel File System</td>
</tr>
<tr>
<td>GPRS</td>
<td>General Packet Radio Service</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>GSA</td>
<td>U. S. General Services Administration</td>
</tr>
<tr>
<td>HPC</td>
<td>High Performance Computing</td>
</tr>
<tr>
<td>HSM</td>
<td>Hierarchical storage management</td>
</tr>
<tr>
<td>IBM</td>
<td>International Business Machines Corporation</td>
</tr>
<tr>
<td>ID</td>
<td>Identification (generally referenced with a unique number)</td>
</tr>
<tr>
<td>IFB</td>
<td>Invitation for Bid</td>
</tr>
<tr>
<td>IN</td>
<td>Indiana (Bloomington Site Contractor)</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>In.</td>
<td>Inches</td>
</tr>
<tr>
<td>IQR</td>
<td>Interquartile Range</td>
</tr>
<tr>
<td>IR</td>
<td>Infrared</td>
</tr>
<tr>
<td>IRB</td>
<td>Institutional Review Board</td>
</tr>
<tr>
<td>IV</td>
<td>Initialization vector</td>
</tr>
<tr>
<td>Lb.</td>
<td>Pounds</td>
</tr>
<tr>
<td>LLC</td>
<td>Limited Liability Corporation</td>
</tr>
<tr>
<td>LSF</td>
<td>IBM’s Platform Load Sharing Facility</td>
</tr>
<tr>
<td>M</td>
<td>Million</td>
</tr>
<tr>
<td>M2M</td>
<td>Machine-to-machine (M2M) modem technology</td>
</tr>
<tr>
<td>MB</td>
<td>Megabyte</td>
</tr>
<tr>
<td>Mbps</td>
<td>Megabit per second</td>
</tr>
<tr>
<td>MCS</td>
<td>Mission Control Software</td>
</tr>
<tr>
<td>MD</td>
<td>Maryland</td>
</tr>
<tr>
<td>MPP</td>
<td>Massively parallel processing</td>
</tr>
<tr>
<td>MV</td>
<td>Machine vision</td>
</tr>
<tr>
<td>MVPT</td>
<td>Motor Free Visual Perception Test</td>
</tr>
<tr>
<td>NAS</td>
<td>National Academy of Science</td>
</tr>
<tr>
<td>NAS</td>
<td>Network Attached Storage</td>
</tr>
<tr>
<td>NC</td>
<td>North Carolina (Durham Site Contractor)</td>
</tr>
<tr>
<td>NDS</td>
<td>SHRP 2 Naturalistic Driving Study</td>
</tr>
<tr>
<td>NHTS</td>
<td>National Household Travel Survey</td>
</tr>
<tr>
<td>NIH</td>
<td>National Institutes of Health</td>
</tr>
<tr>
<td>NIMH</td>
<td>National Institute of Mental Health</td>
</tr>
<tr>
<td>NIOSH</td>
<td>National Institute for Occupational Safety and Health</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>NIST</td>
<td>National Institute of Standards and Technology</td>
</tr>
<tr>
<td>NMVCCS</td>
<td>National Motor Vehicle Crash Causation Study</td>
</tr>
<tr>
<td>NY</td>
<td>New York (Erie County Site Contractor)</td>
</tr>
<tr>
<td>OBD-II</td>
<td>On-board Diagnostics</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>OHRP</td>
<td>Office for Human Research Protections</td>
</tr>
<tr>
<td>PA</td>
<td>Pennsylvania (State College Site Contractor)</td>
</tr>
<tr>
<td>PAR</td>
<td>Police Accident Report</td>
</tr>
<tr>
<td>PATA</td>
<td>Parallel AT Attachment (interface standard for hard drive)</td>
</tr>
<tr>
<td>PB</td>
<td>Petabyte</td>
</tr>
<tr>
<td>PCBs</td>
<td>Printed circuit boards</td>
</tr>
<tr>
<td>PDF</td>
<td>Portable Document Format</td>
</tr>
<tr>
<td>PI</td>
<td>Primary Investigator/Principle Investigator</td>
</tr>
<tr>
<td>PID</td>
<td>Parameter Identification</td>
</tr>
<tr>
<td>PII</td>
<td>Personally-Identifying Information</td>
</tr>
<tr>
<td>Psi</td>
<td>Pounds per square inch</td>
</tr>
<tr>
<td>QA</td>
<td>Quality assurance</td>
</tr>
<tr>
<td>RAID</td>
<td>Redundant Array of Independent Disks</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>RFP</td>
<td>Request for Proposals</td>
</tr>
<tr>
<td>RFQ</td>
<td>Request for Qualifications</td>
</tr>
<tr>
<td>RIB</td>
<td>Radar Interface Box</td>
</tr>
<tr>
<td>RMA</td>
<td>Return Merchandise Authorization</td>
</tr>
<tr>
<td>RSA</td>
<td>Rivest, Shamir, Adleman encryption tool</td>
</tr>
<tr>
<td>RT</td>
<td>Request Tracker software</td>
</tr>
</tbody>
</table>
S03  Project S03: Evaluation of Roadway Measurement Systems

S04A  Project S04A: Roadway Information Database Development and Technical Coordination and Quality Assurance of the Mobile Data Collection Project

S04B  Project S04B: Mobile Roadway Data Collection

S05  Project S05: Design of the In-Vehicle Driving Behavior and Crash Risk Study

S06  Project S06: Technical Coordination and Quality Control Study

S07  Project S07: In-Vehicle Driving Behavior Field Study

S08  Project S08: Analysis of the Naturalistic Driving Study Data

S12A  Project S12(A): DAS Procurement

SAS  Statistical Analysis Software®

SATA  Serial AT Attachment (interface standard for hard drive)

SHRP 2  Second Strategic Highway Research Program

SQL  Structured Query Language

SSD  Solid-state drive

SUV  Sport utility vehicle

SWaM  Small, Women and Minority (vendor category)

Sync  Synchronization

TB  Terabyte

TCP/IP  Transmission Control Protocol/Internet Protocol

TPMS  Tire Pressure Monitoring System

TRB  Transportation Research Board

U & T  Usage and Tracking

UFOV®  Useful Field of View®

U.S./USA  United States of America

USB  Universal serial bus

VA  Commonwealth of Virginia

ABBREVIATIONS-5
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>VIN</td>
<td>Vehicle Identification Number</td>
</tr>
<tr>
<td>VT CSR</td>
<td>Virginia Tech Center for Survey Research</td>
</tr>
<tr>
<td>VTTI</td>
<td>Virginia Tech Transportation Institute</td>
</tr>
<tr>
<td>VZW</td>
<td>Verizon Communications, Inc.</td>
</tr>
<tr>
<td>WA</td>
<td>Washington (Seattle Site Contractor)</td>
</tr>
<tr>
<td>WAN</td>
<td>Wide-area network</td>
</tr>
<tr>
<td>WBST</td>
<td>Web-based Screening Tool</td>
</tr>
</tbody>
</table>