Connected Commercial Vehicles—Integrated Truck Project

Driver Clinics, Performance Tests, and Lessons Learned

www.its.dot.gov/index.htm
Final Report —January 31, 2014
FHWA-JPO-13-110

U.S. Department of Transportation
Research and Innovative Technology Administration

Produced by Connected Commercial Vehicles—Integrated Truck Project
ITS Joint Program Office
Research and Innovative Technology Administration
Federal Highway Administration
Federal Motor Carrier Safety Administration
National Highway Traffic Safety Administration
U.S. Department of Transportation

Notice

Cover image provided courtesy of Battelle, 2012.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-JPO-13-110		

4. Title and Subtitle	5. Report Date
Connected Commercial Vehicles—Integrated Truck Project Driver Clinics, Performance Tests, and Lessons Learned Final Report	January 31, 2014
	6. Performing Organization Code 100003838
7. Author(s) Doug Pape, Jason Holdridge, Denny Stephens (Battelle)	**8. Performing Organization Report No.** 100003838-703
9. Performing Organization Name And Address Battelle 505 King Avenue Columbus, OH 43201	**10. Work Unit No. (TRAIS)**
	11. Contract or Grant No. DTFH61-06-D0007/ ORDER T11004/WO BA07-092
12. Sponsoring Agency Name and Address Federal Highway Administration 1200 New Jersey Avenue, S.E. Washington, DC 20590	**13. Type of Report and Period Covered** Task Final Report 9/1/2011-1/31/2014
	14. Sponsoring Agency Code

15. Supplementary Notes

This work was conducted by Battelle as part of the Connected Commercial Vehicles—Integrated Truck Project. The Connected Commercial Vehicle Team is led and managed by Battelle and includes Mercedes-Benz Research & Development North America, Inc. (MBRDNA), DENSO International America, Inc.—North America Research and Development, California Office , the University of Michigan Transportation Institute (UMTRI), Daimler Trucks North America (DTNA), and Meritor WABCO.

16. Abstract

Connected vehicle wireless data communications can enable safety applications that may reduce injuries and fatalities suffered on our roads and highways, as well as enabling reductions in traffic congestion and impacts on the environment. As a critical part of achieving these goals, the USDOT contracted with a Team led by Battelle to integrate and validate connected vehicle on-board equipment (OBE) and safety applications on selected Class 8 commercial vehicles and to support those vehicles in research and testing activities that provide information and data needed to assess their safety benefits and support regulatory decision processes.

Driver Clinics have been conducted as a part of this project to evaluate acceptance of the connected vehicle technology safety applications by drivers who were previously unfamiliar with the technology. A total of 112 professional truck drivers attended the clinic in Ohio or California and drove trucks through maneuvers to demonstrate four safety applications. Participants in the clinic were strongly accepting of the technology, and many offered suggestions for improvement.

Performance Tests recorded data from two commercial vehicles as they drove across the continent. Their purpose was to assess the systems' performance in diverse locations. The equipment performed in mountainous regions and when the two vehicles were hundreds of meters apart. Dropouts and occasional discrepancies in range were observed.

17. Key Words	18. Distribution Statement
Commercial vehicle, connected vehicle, commercial motor vehicle, CMV, dedicated short-range communication, DSRC, V2V	Distribution unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	182	

Acknowledgements

This work was conducted by Battelle as part of the Connected Commercial Vehicles—Integrated Truck Project. The Connected Commercial Vehicle Team is led and managed by Battelle and includes Mercedes-Benz Research & Development North America, Inc. (MBRDNA), DENSO International America, Inc.—North America Research and Development, California Office, the University of Michigan Transportation Institute (UMTRI), Daimler Trucks North America (DTNA), and Meritor WABCO.

Oversight from the United States Department of Transportation was provided by Kate Hartman of the Research and Innovative Technology Administration Intelligent Transportation Systems Joint Program Office, Alrik Svenson of the National Highway Traffic Safety Administration, and Cem Hatipoglu of the Federal Motor Carrier Safety Administration.

Table of Contents

List of Appendices

List of Tables

List of Figures

Executive Summary

Connected vehicle telecommunications for vehicle data can transform vehicle travel in North America, enabling major reductions in injuries and fatalities suffered on our roads and highways, as well as enabling reductions in traffic congestion and effects on the environment. Under this Connected Commercial Vehicle Safety Applications Development Program, the USDOT has contracted with a Team led by Battelle to integrate connected vehicle onboard equipment (OBE) and safety applications on selected Class 8 commercial vehicles and to support those vehicles in research and testing that provide information and data needed to assess their safety benefits and support regulatory decision processes.

This report summarizes the results of Task 7 of the project in which Battelle conducted Driver Clinics and on-road Performance Tests of the applications. The Driver Clinics were conducted to gauge the acceptance of connected vehicle technology by drivers who were previously unfamiliar with it. Driver Clinics focused on obtaining driver feedback on the connected vehicle technology and safety applications in a safe, highly controlled environment.

More than 100 drivers, all holders of a Commercial Driver's License (CDL) with recent professional tractor-semitrailer experience, participated in the clinics. The participants had a wide range of tenure and professional backgrounds. One clinic was held at the Transportation Research Center Inc. in East Liberty, Ohio, and one was at Alameda Point on the San Francisco Bay in California. Participants spent about half an hour driving a new Freightliner tractor with integrated connected commercial vehicle technology. Two remote vehicles driven by professional test drivers executed scenarios that triggered four safety applications in sequence: Intersection Movement Assist (IMA), Forward Collision Warning (FCW), Emergency Electronic Brake Lights (EEBL), and Blind Spot Warning with Lane Change Warning (BSW/LCW). A team member in the tractor with the participant explained each scenario before it was executed and recorded immediate impressions afterward. Following the drive, each participant filled out a questionnaire, and slightly more than half were interviewed individually. The format of the clinic and the questionnaires were adapted from the light vehicle driver clinics so that results could be compared.

Impressions were remarkably positive. Participants readily perceived the benefits of connected commercial vehicle technology. Many offered constructive criticisms. Many drivers emphasized the importance of keeping their eyes out the window. Another frequent caution was that the system needs to be reliable and credible. Frequent, annoying alarms will not be tolerated.

Recommendations from the participants can be used as the basis for further development of connected commercial vehicle safety applications.

The Performance Tests evaluated the ability of the performance of DSRC communications on road in a variety of terrains and highway conditions. Two tractors trucks recorded their own data (or Basic Safety Message—BSM) and the corresponding data from the other tractor on a 39-hour trip from Ohio to California. Although there were gaps in data attributable to software issues, BSMs were transmitted using DSRC for ranges of up to 800 meters. No problems or issues were found with communicating BSMs between tractors pulling 53 foot long box trailers, using dual antennas, one on each side of the cab.

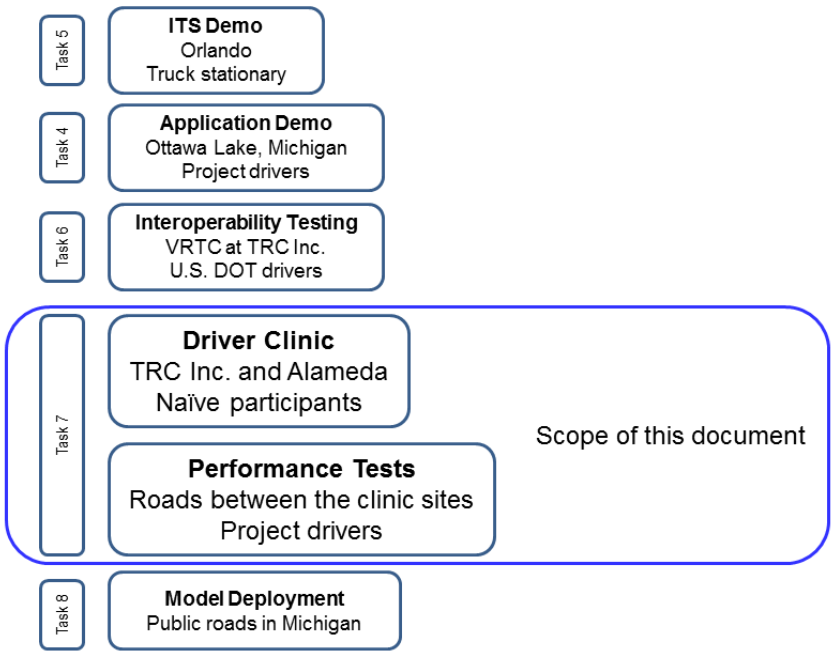
This report also summarizes lessons learned over the course of conducting the clinics. By basing the clinics on the foundation of the light vehicle clinics, discussing plans with USDOT, and applying Battelle's experience, the clinics were conducted according to the written plans. Lessons learned topics include recruiting, organization, maturity of the system and soliciting criticism.

Chapter 1 Introduction

The Driver Clinics were one task within a project where Battelle was a prime contractor for the United States Department of Transportation (USDOT). The purpose of the project was to take technology that has been developed for light passenger vehicles and apply it to commercial motor vehicles, specifically a truck tractor for pulling a semitrailer. Vehicles equipped with this technology broadcast radio signals indicating their position and other information to surrounding vehicles. This information is intended to help drivers avoid crashes. The project has evaluated the technology in a number of ways, two of which are the subject of this report. The Driver Clinics gauged acceptance by one hundred truck drivers in controlled situations on test tracks, and the Performance Tests assessed the ability of the radios to work in a variety of roadways and geographic situations across the continent.

Description of the Overall Project

Connected vehicle telecommunication systems for vehicle data have the potential to transform vehicle travel in North America, enabling major reductions in injuries and fatalities suffered on our roads and highways, as well as enabling reductions in traffic congestion and effects on the environment. As a critical part of achieving these goals, the USDOT wishes to apply the successful experience with connected vehicle technology implementation on light vehicles to commercial vehicles and to demonstrate the performance, interoperability, and safety benefits of the technology in mixed light and commercial vehicle environments. Under this Connected Commercial Vehicle Safety Applications Development Program, the USDOT contracted with a Team led by Battelle to integrate and validate connected vehicle on-board equipment (OBE) and safety applications on selected Class 8 commercial vehicles and to support those vehicles in research and testing activities that provide information and data needed to assess their safety benefits and support regulatory decision processes. The Driver Clinics and Performance Tests are among many tests and demonstrations of the CCV technology during this project. The major tests are shown in Figure 1-1, where the task numbers indicate where the tests fit in the overall project.



Battelle

Figure 1-1. The Driver Clinics and Performance Tests are among several tests of the connected commercial vehicle installation.

The first demonstration to occur was at the ITS World Congress in Orlando, Florida, with light vehicles responding to messages broadcast from a commercial vehicle. The fully functioning installations were demonstrated at the end of Task 4 [1], several weeks before the Driver Clinics began. At the same time that preparations for the Driver Clinics were underway, USDOT staff were conducting Interoperability Testing. The large oval in the figure highlights the testing covered in this document—the Driver Clinics and Performance Tests of Task 7. Following the Driver Clinics and Performance Tests, the equipped tractors were delivered to Ann Arbor, Michigan, for testing in revenue service during the Model Deployment.

Description of the Technologies

The heart of the technology is a radio and computer on a vehicle. It determines the vehicle's location using Global Positioning System (GPS) and broadcasts its location to surrounding vehicles ten times a second. The technology has matured to the point that these functions are performed in a compact, field hardened wireless safety unit (WSU). A special radio protocol called Dedicated Short-Range Communication (DSRC) uses the 5.9 GHz band is used to transmit signals, either from a vehicle to a vehicle (V2V) or between vehicles and the infrastructure (V2I).

The Basic Safety Message (BSM) that is transmitted to surrounding vehicles includes not only the position of the vehicle, but also its speed, heading, size, whether the brake lights are on, and more. Other vehicles in the neighborhood can use this information to determine whether they are on a possible collision course and advise their drivers. A "safety application" is the name of the computer logic on the receiving vehicle that determines whether to inform the driver of a potential hazard (for

example, a vehicle in a blind spot) or to warn the driver of an imminent hazard (for example, of a stopped vehicle ahead).

Description and Purpose of the Driver Clinics

The Driver Clinics invited over 100 truck drivers to a test track where they drove tractors with integrated V2V technology. In a series of carefully rehearsed maneuvers with professional test drivers, the participants experienced four safety applications. Before each scenario, a test conductor in the cab with the participant explained what was going to happen. The participant then drove a simulated near-crash situation with one or two other vehicles, and the OBE issued a warning. There was a short debriefing immediately after each scenario, and participants filled out a longer written questionnaire after leaving the cab. Slightly over half of the participants were invited to stay for an in-depth interview.

The purpose of the clinics was to evaluate acceptance of the connected vehicle technology and safety applications by drivers who were previously unfamiliar with V2V technology. They were asked whether they would like to have the device in their own trucks and whether they found it distracting. Their cautions were documented. The suggestions they had for improvement, including ideas for new applications, were recorded.

Participants' responses in the commercial vehicle Driver Clinics may be compared with those of the light vehicles.

Description and Purpose of the Performance Tests

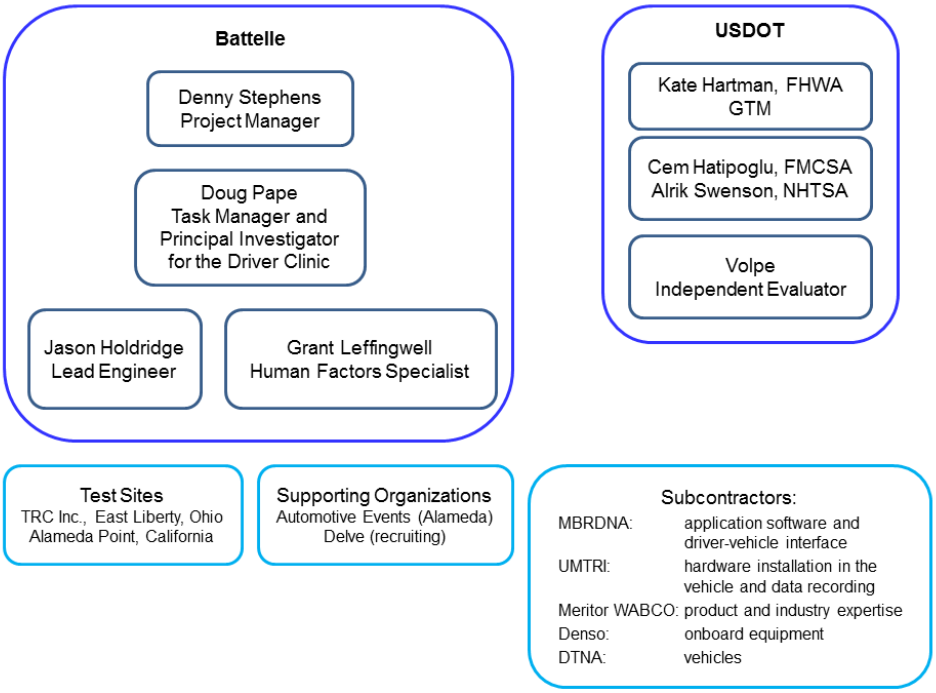
When two tractors equipped with V2V technology were driven from the Ohio clinic site to the California clinic site and on the return trip to Michigan, they were collecting data. Although the message displays to the driver were disabled, BSMs were being transmitted and recorded on both vehicles. This provided the opportunity to test the performance of the equipment in the diverse landscape, road, and traffic conditions across the continent.

Team

The prime contractor for the Connected Commercial Vehicles—Integrated Truck project was Battelle. The project was conducted under the direction of the Intelligent Transportation Systems Joint Program Office with input from other agencies in the USDOT. The independent evaluator, Volpe National Transportation Systems Center, reviewed the test plan for the Driver Clinics as it was being developed, visited both sites during the clinics, and analyzed the data.

Battelle's project manager appointed a team to plan and execute the Driver Clinics. The team was assisted by staff from the two test sites, the Transportation Research Center Inc. (TRC Inc.) in Ohio and Alameda Point in California. Automotive Events handled many of the details in Alameda, and Delve assisted in recruiting and scheduling the participants. All of the other subcontractors on the project supported the Driver Clinics as necessary.

Figure 1-2 is the organization chart of the task.



Battelle

Figure 1-2. The Driver Clinics required coordination between groups within Battelle, subcontractors on the Battelle team, service providers hired for the clinics, and the USDOT.

Subtasks of the Driver Clinics

This document reports the procedure and results for the Driver Clinics and Performance Tests.

The Project Management and Work Plan for this project [2] identified nine subtasks of Task 7, all of which are now complete:

- Subtask 7a. Prepare the Test Plan. A draft version of the test plan was delivered to USDOT on November 15, 2011 and revised according to comments. Further revisions and refinements were made as work progressed. The final version of the test plan is in Appendix B.
- Subtask 7b. Carry Out Logistical Support. Logistical support for conducting the Driver Clinics and Performance Tests was carried out by Battelle, TRC Inc., and Automotive Events.
- Subtask 7c. Purchase Support Equipment. Support equipment was purchased or rented according to the test plan.
- Subtask 7d. Recruit and Prepare Test Subjects. The goal was 100 participants; a total of 112 were qualified and completed the study.

- Subtask 7e. Develop Questionnaires and Focus Group Topics. A set of questionnaires was developed. They were based on questionnaires used at the light vehicle driver clinics and were simplified and adapted to the commercial vehicle clinics. Focus groups were deemed to be unwieldy for the truck driving population, so, with the approval of USDOT, Battelle developed a guide for one-on-one in-depth interviews with selected drivers. All of the data collection instruments are in Appendix C.
- Subtask 7f. Obtain Human Subjects Approval. Battelle's Institutional Review Board (IRB) first approved a draft of the Driver Clinics test plan on December 20, 2011. As plans evolved and changes to the procedures or data collection instruments were made, the IRB reviewed and approved five amendments. No other IRBs were involved. A copy of the final version of the Informed Consent Form (ICF) is in Appendix C-2.
- Subtask 7g. Conduct Driver Clinics. The Ohio clinic was held as six half-day sessions in July 2012, and the California was two consecutive days in August 2012.
- Subtask 7h. Collect and Store Data. Data have been collected and securely stored according to Battelle's established procedures for protecting clients' records. Copies of the completed questionnaires and recordings of the in-depth interviews were forwarded to the Volpe National Transportation Systems Center for analysis.
- Subtask 7i. Analyze and Report Results.

Important Nomenclature

The table on page A-1 defines specialized terms and abbreviations. A few important terms with specific meanings are highlighted here.

Participant—a truck driver whose opinion of the technology was solicited
Host vehicle (HV)—the truck tractor equipped with the technology and in which it is demonstrated
Application—a use of the connected vehicle technology to avoid a certain kind of crash, such as Blind Spot Warning (BSW) or Intersection Movement Assist (IMA)
Scenario—a maneuver involving at least two connected vehicles, intended to trigger an alert from one of the applications.

Over the course of the two clinics, more than 100 *participants* drove drive a *host vehicle* through a series of *scenarios*, each one demonstrating an *application*. A test conductor rode in the passenger seat of the *host vehicle*.

Chapter 2 Methods

This chapter explains how the clinics were organized and run. It describes how the clinics were conducted, the vehicles, the test sites, the recruiting process, and the scenarios. A detailed test plan, attached as Appendix B to this document, was developed several months before the clinics began so that all parties could review it, and new versions were released as plans matured. Safety considerations were reviewed by both Battelle and TRC Inc., and Battelle's Institutional Review Board (IRB) reviewed the use of human subjects.

The nature of the Driver Clinics is best explained from the perspective of the participant who came to the test site, drove a truck, and answered questions, so that is explained first. Subsequent headings present the equipment and procedures in greater detail.

Format of the Clinics

Each participant spent approximately 30 minutes in the driver's seat of a tractor in which connected commercial vehicle technology had been integrated. During that time, the participant drove a sequence of four scenarios, each of which simulated a driving situation that could possibly lead to a crash. The scenarios involved the participant's vehicle and one or two other vehicles, which were driven by experienced test drivers. Participants were accompanied in the cab by a test conductor who had driven the scenarios several times during practice. Observers from the USDOT rode silently with many of the participants.

The list below summarizes the steps at the clinic as they were experienced by the participants. Prior to their arrival, they had been recruited and screened as explained under the *Recruiting* heading. The steps are explained in greater detail in Section 5.4 of the Driver Clinics Test Plan in Appendix B, and a blank of each of the forms is in Appendix C.

1. Greeting and on-site re-screening. Participants were greeted on their arrival and offered refreshments. A team member confirmed that they held a valid CDL-A and asked a series of questions to confirm the participant was eligible.
2. Informed Consent. The participant was asked to read the Informed Consent Form (ICF), and a Battelle staff member discussed the form and asked if there were questions. The participant signed the form.
3. Pre-Drive Questionnaire. This short questionnaire asked basic questions of age and driving experience.
4. Introductory Video. Participants were shown a five-minute video that introduced V2V technology and demonstrated the four applications. The video was an edited version of "Vehicle-To-Vehicle Communication: The Future of Crash Avoidance," which had been shortened and re-arranged to show the four scenarios in the order the participants would experience them. The video was not "Vehicle-To-Vehicle Communication: A New Generation of Driver Assistance and Safety," which was shown to the light vehicle participants.

5. Drive Time. The participants went to the test track in pairs; one drove the white tractor and one drove the red tractor. After familiarization, the test conductor explained the upcoming scenario, the participant drove the scenario, and then the participant parked the truck so the test conductor could ask a few questions of initial impression.
6. Post-Drive Questionnaire. This eight-page document asked a number of questions on V2V in general and on each scenario in particular.
7. In-Depth Interview. Slightly more than half of the participants were invited to stay for a half-hour one-on-one interview with the team's human factors specialist.
8. Cash Payment and Dismissal. Participants were given a $200 cash incentive after they completed the clinic. Those who stayed for the in-depth interview were given an additional $25. Participants who had driven more than 25 miles one way to the clinics were reimbursed for their mileage. A choice of three brands of gas cards was offered at each clinic.

Most participants arrived early for their appointment. Pre-drive activities, including waiting, averaged less than an hour. The driving experience was planned so that it would last 30 minutes. The time that drivers spent on the post-drive questionnaire varied considerably. Participants who did not stay for the interview left about two hours after their arrival at the test site.

Participants were sent away with

- An envelope with their cash incentive
- Gas cards (if applicable)
- A photocopy of the signed ICF (without the participant number)
- A copy of the recruiting brochure (Figure 2-8, given to most participants in Ohio).

Planning for the Clinics

The Driver Clinics were based on the light vehicle clinics, which had been held the previous year. The commercial vehicle Driver Clinics had a much smaller scale, with fewer participants and only two locations. The commercial vehicle scenarios were adapted from those of the light vehicle clinics. As in the light vehicle clinics, participants worked in pairs with one participant briefing for the next scenario while the other was driving it. The pre- and post-drive questionnaires were also adapted from the light vehicle clinics, to facilitate comparison of the results between the two.

The clinic sessions were Tuesday mornings and Thursday afternoons in Ohio, July 10 through July 26, 2012. The time between the sessions allowed for minor adjustments to the process, for documents to be copied, and for word of mouth to spread to improve participation. The clinic California ran all day on Wednesday, August 22, and during the morning and part of the afternoon on Thursday, August 23. The experience gained in Ohio allowed for California sessions to be run more closely. A small waiting list of participants developed in California, so Delve could replace the appointments of those who phoned to cancel.

While original plans for the commercial vehicle clinics included focus groups, they were judged to be impractical for a number of reasons. Professional drivers needed to take time off work to participate, and many had a job that kept them away from the clinic sites and made scheduling a separate visit burdensome. All planning parties agreed that the most practical solution was to invite half of the participants to stay immediately after their driving time for an in-depth interview. The invited participant

sat individually with a member of the team for an open discussion based on the guide in Appendix C-6.

Vehicles

There were four vehicles in the clinics:

- Freightliner Cascadia high-roof sleeper (white), with a 53-foot van semitrailer
- Freightliner Cascadia mid-roof sleeper (red), with a 53-foot van semitrailer in Ohio and a 48-foot van semitrailer in California
- Light vehicle (passenger car) used as the remote vehicle (RV) to trigger safety applications in the tractor
- Small (10-ft-bed) van truck used to block the participant's view of the light vehicle in two of the four scenarios.

Three of the four vehicles for the Ohio clinic are pictured in Figure 2-1 and all four in the California clinic in Figure 2-2. The host vehicles (HVs) driven by the participants were Freightliner Cascadia tractors purchased for this project. A Wireless Safety Unit (WSU) manufactured by subcontractor Denso had been integrated in each tractor as the V2V On-Board Equipment (OBE) and tested as part of prior tasks. The tractors had a Data Acquisition System (DAS) designed and installed by the University of Michigan Transportation Research Institute (UMTRI) for recording dynamic engineering data. Trailers were empty during the clinics.

The remote vehicles were rented from retailers near each site. One remote vehicle was a light vehicle (a passenger car). It was equipped with a vehicle awareness device to broadcast its position and acceleration to trigger the safety applications on the tractors. This vehicle did not have a DAS. The second remote vehicle was a van truck with a nominal bed length of 10 ft and an overall height of 9 ft. Its purpose was to block the participant's view of the first remote vehicle in two of the four scenarios. The blocking truck was not equipped with V2V capability or a DAS.

TRC, Inc.

Figure 2-1. Vehicles at the Ohio clinic: RV, blocking vehicle, and white Cascadia tractor. (The red tractor is not pictured).

Battelle

Figure 2-2. Vehicles at the California clinic: RV, red tractor, blocking vehicle, and white tractor.

Installation of the OBE equipment to perform the safety applications and the DAS to record the performance is described in Vehicle Build and Test Plan [3]. Figure 2-3 is a close-up of the right-side antenna mount on the white tractor. The DSRC antenna is circled. Identical antennas were mounted on the opposite side. The display for the driver was an iPad as shown in Figure 2-13.

Battelle

Figure 2-3. The DSRC antenna on the right side of the tractor is circled.

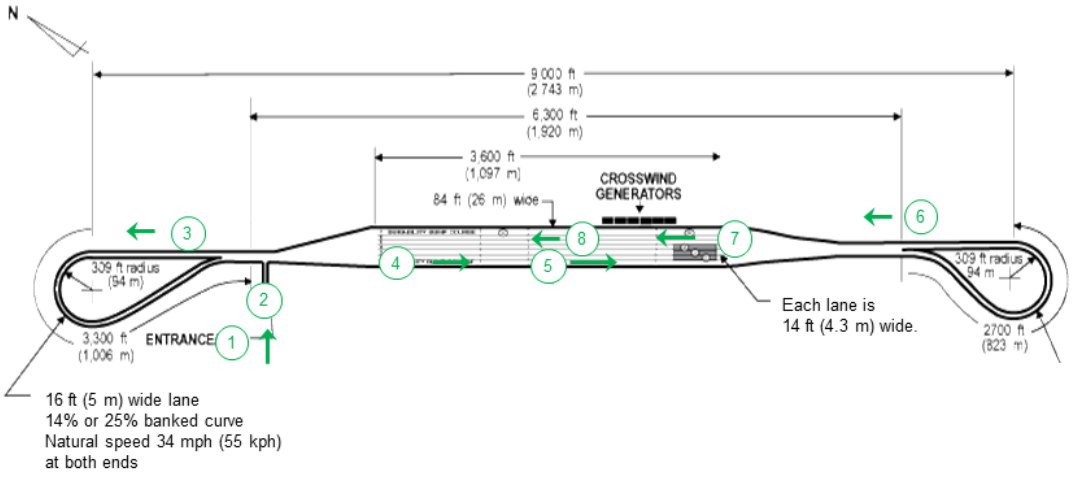
Sites

The clinics were held at the Transportation Research Center Inc. (TRC) in Ohio, and at Alameda Point (the former Alameda Naval Air Station) in California. Both sites have long straight paved tracks that allowed one scenario to be conducted immediately after another, without turning around the vehicle contingent. The Alameda location was also the site of a light vehicle Driver Acceptance Clinic.

Transportation Research Center Inc.

The Transportation Research Center Inc. is approximately one hour northwest of Columbus, Ohio. The 9000-ft Skid Pad shown in Figure 2-4 is commonly used for stopping distance tests. The green circles in the figure indicate the locations of the steps that the participants drove:

1. The participant entered the cab and met the test conductor off the Skid Pad. The participant drove the truck to a temporary stop sign at the entrance to the Skid Pad.
2. The first scenario was IMA at the entrance to the Skid Pad. The RV came from the participant's left.
3. The participant turned left on to the Skid Pad and drove through the north loop. The participant was asked to brake hard on the straight entrance to the loop to get a feel for the brakes.
4. The second scenario was FCW. The two participants' tractors were on separate lanes.
5. The third scenario was EEBL. Both tractors were in the same lane they were for FCW.
6. After the EEBL de-briefing, the trucks turned around in the south loop. The stopped for instructions for the BSW scenario on the exit from the loop.
7. The final scenario, BSW/LCW, was conducted in the opposite direction from FCW and EEBL.
8. The north half of the Skid Pad was available for a repeated scenario if necessary.



Battelle

Figure 2-4. The Ohio clinic had exclusive use of the Skid Pad at TRC Inc.

Figure 2-5 shows the indoor space at TRC Inc. The participants read the informed consent forms and took the written surveys at these tables. One customer office adjacent to this space provided a room to store blank and completed surveys, and a second office was the location of the in-depth interviews.

TRC, Inc.

Figure 2-5. TRC Inc. had indoor space with tables and chairs for the participants to take written surveys and wait for the next step.

Alameda Point (Former Alameda Naval Air Station)

The final and western most light vehicle Driver Acceptance Clinic was at the former Alameda Naval Air Station near Oakland, California, Figure 2-6.

All buildings and utilities had to be brought to the runways. Figure 2-7 shows the buildings and tents installed by Automotive Events. The participants were greeted and took their surveys in a mobile home style trailer. One smaller modular building was the private room for the in-depth interviews, and the other was office space for Battelle and visiting USDOT staff. The buildings were set at the eastern end of Runway 27, and the scenarios were on that runway.

Google

Figure 2-6. The California clinic was at Alameda Point (the former Alameda Naval Air Station). The pavement in the yellow oval was used.

Battelle

Figure 2-7. Automotive Events brought three temporary buildings for the California clinic.

Driver Participants

A total of 112 drivers participated in the clinics, 64 in Ohio and 48 in California. There were 109 male and 3 female participants. One-on-one interviews were held with 61 participants.

The participants were recruited by a variety of means. Experience in nearly every type of professional driving was represented. Some had earned their CDL earlier in the year, and others had been driving trucks for more than 40 years. Most, but not all, of the drivers generally worked in the central Ohio or Bay Area regions where the two clinics were held.

Participants were required to hold a valid CDL-A and have professionally driven a combination vehicle in the past year. They were asked to report themselves in good health and have enough hours of service available for participation. Other qualifications were minimal. A greeter at the clinic verified each CDL-A.

Recruiting

All scheduling was handled by Delve, which is in the business of recruiting participants for studies. All publicity methods ultimately directed prospects to Delve's phone number, where they were screened for eligibility and scheduled if they were interested.

Break room flyers (Figure 2-8) were posted at carriers, shippers, and heavy truck rental locations. These flyers were delivered in person where possible and by e-mail where necessary.

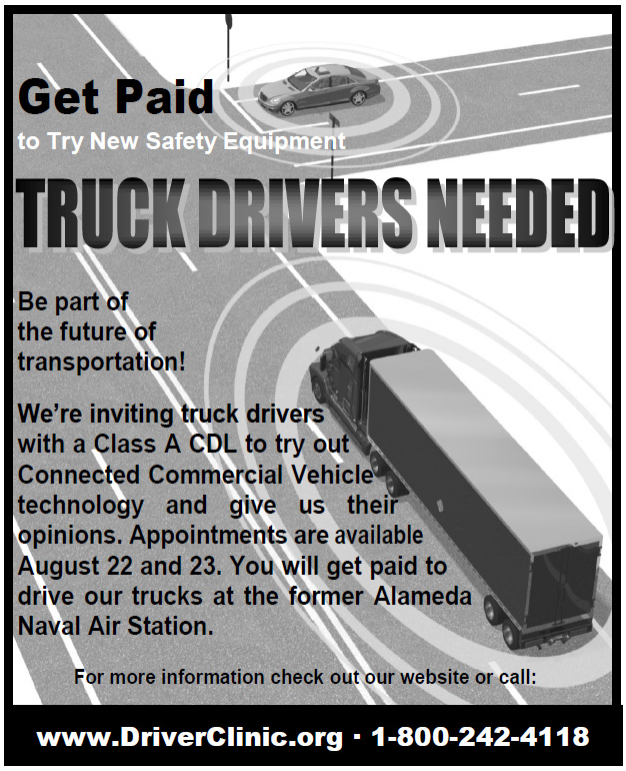
Battelle

Figure 2-8. This flyer was distributed to a number of carriers and other businesses where eligible drivers would be. A similar flyer was made for the California clinic.

The team put up a simple web site, www.DriverClinic.org. The site is described in Appendix E. This was not intended to be a site where prospects would first learn of the clinics; it was a valuable place to direct them for more information. It had descriptions of the technology, videos, and the recruiter's phone number. It also had maps to the clinic sites.

Diverse approaches to recruiting participants were employed. Some worked better than others. Although the team did not keep direct statistics on how participants first learned of the clinic, some sense of what worked could be gained from those participants who volunteered the information and correlations with days appointments were made. Roughly in decreasing order of success, the recruiting approaches were

- Print newspaper advertisement. Surprisingly, after the display advertisement was placed in the print version of the Oakland *Tribune* (Figure 2-9), the phone started to ring.
- Word of mouth. Those in public relations know well that this is often the best publicity. Participants leaving the Ohio clinic were given a copy of the break room flyer and encouraged to invite their friends. Many participants in Ohio said they learned of the clinic through word of mouth, and the method is credited with filling the final three sessions' appointments in Ohio.
- Driver employers (motor carriers) contacted through team members. Members of the Battelle team contacted carriers in the vicinity of the two clinics asking if they could encourage their drivers to participate.
- Personal contacts with motor carriers. Battelle staff phoned or personally visited carriers, warehouses, and other companies that ship or carry by truck. A number of participants are known to have come through this method, but it was expensive and not feasible in California.
- E-mail blasts and electronic newsletters. Trade groups where team members had connections were kind enough to send messages to their members.
- Load boards. A number of web sites allow shippers to post loads, and drivers (typically owner-operators) find work by searching these sites. The team posted a one-day load originating on the days and locations of the clinics, giving Delve's phone number.
- A classified advertisement was placed in several Bay Area newspapers to run for four days, and it was extended for one week. A 30-day online listing on Monster.com was included in the package.
- Cold phone calls to carriers. USDOT provided a list of carriers registered in Alameda and surrounding counties. Starting with those that reported the highest number of tractors, Delve called them to ask whether we could mail a break room flyer. This approach seemed to yield few results.
- Social media fan sites. Announcements were easy to place on Facebook sites for Freightliner and others that would attract drivers. There is no evidence that any participants initially heard of the study this way, and some hosts removed Driver Clinic notices from their sites. The Driver Clinic had its own Facebook page (Appendix F).



Battelle

Figure 2-9. This advertisement ran in the Oakland Tribune on five week days. (Actual size was 3-1/4 x 4 in.)

Table 2-1 shows the success in attracting participants to the clinics. A total of 148 appointment slots were available. Appointments were scheduled for all 56 of the available slots in California. All of the slots for the first half-day session in Ohio were filled. Barely half of the slots on the second and third half-day sessions were filled; word of mouth from early participants helped to recruit participants and fill all of the available slots for the final three Ohio sessions.

Not all who scheduled an appointment appeared at the clinic. The third column of numbers indicates the number of drivers who kept their appointment. All of the participants who appeared at the Ohio clinic were qualified. Two were turned away from the California clinic because they indicated during the re-screening that, despite their CDL-A, they were otherwise unable to drive legally. At both sites, all of the prospective participants who qualified through the on-site re-screening signed the ICF and completed the study. None withdrew from the study. A total of 61 participants were invited to stay for the in-depth interview; all accepted and all completed the interview.

Overall, appointments were scheduled for 90 percent of the available slots, 86 percent of those who made an appointment kept it (a 14 percent attrition rate), and 98 percent of those who arrived at the site were qualified and completed the main part of the study.

Table 2-1. Overall schedule of clinics and participants.

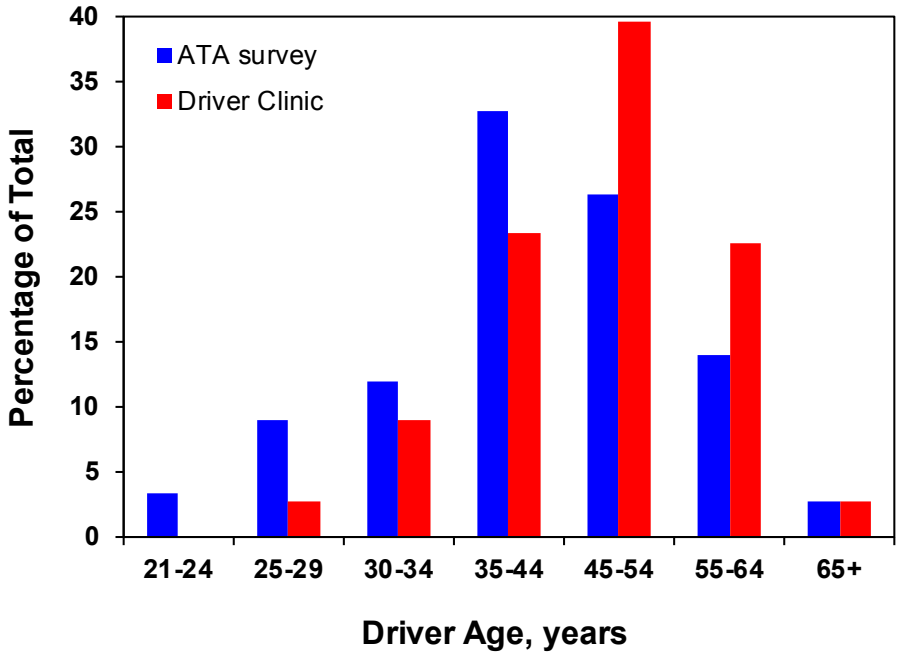
Site	Slots Available	Appointments Made	Drivers Who Appeared	Individuals Qualified	Study Completions	Interviews Conducted
Ohio	92	77	64	64	64	36
California	56	56	50	48	48	25
TOTAL	**148**	**133**	**114**	**112**	**112**	**61**

Battelle

Demographics of the Participants

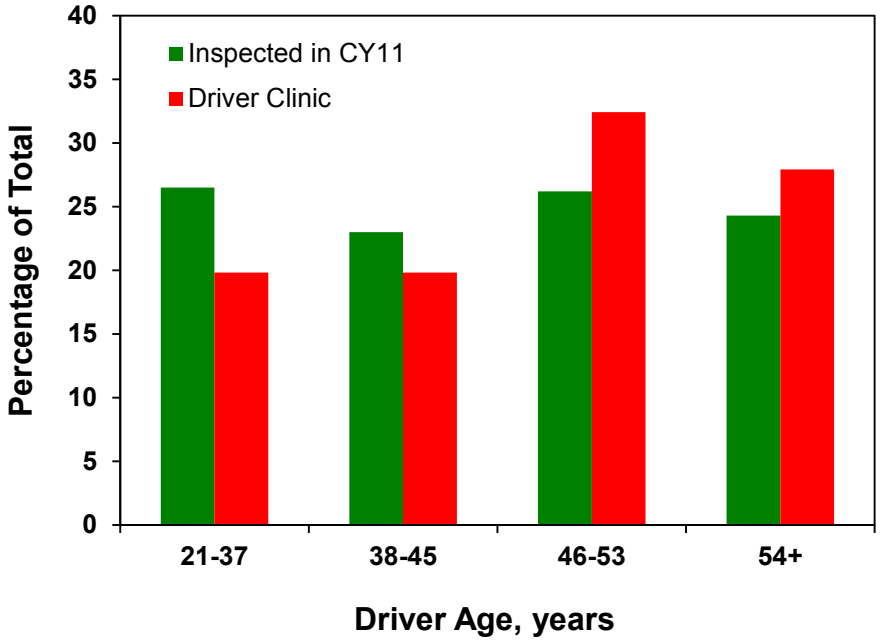
Most participants usually work as an employee driver for a motor carrier, but nearly 20 percent reported working primarily or occasionally as an owner-operator. The ages of participants ranged from 28 to 66 years. The distribution of ages is in Figure 2-10. The figure also shows the age distribution of drivers from a 2005 survey commissioned by the American Trucking Associations. The recruiting process did not control the age of participants, and the age distribution naturally approximated that in the survey. A more recent sampling of driver age was conducted by FMCSA as part of motor carrier inspections in calendar year 2011 [4]. The distribution of clinic participants' ages with that distribution is in Figure 2-11. The match is slightly better, but drivers in their mid forties and older are overrepresented in the clinic participants by this measure as well.

The experience level ranged from recent trainee (two had held their CDL for less than six months) up to corporate training directors. The distribution of number of years that the participants had held their CDLs is shown in Figure 2-12. Sixty percent of the participants had begun driving in their 20s and another 25 percent in their 30s, and a small number earned their CDL after age 50.



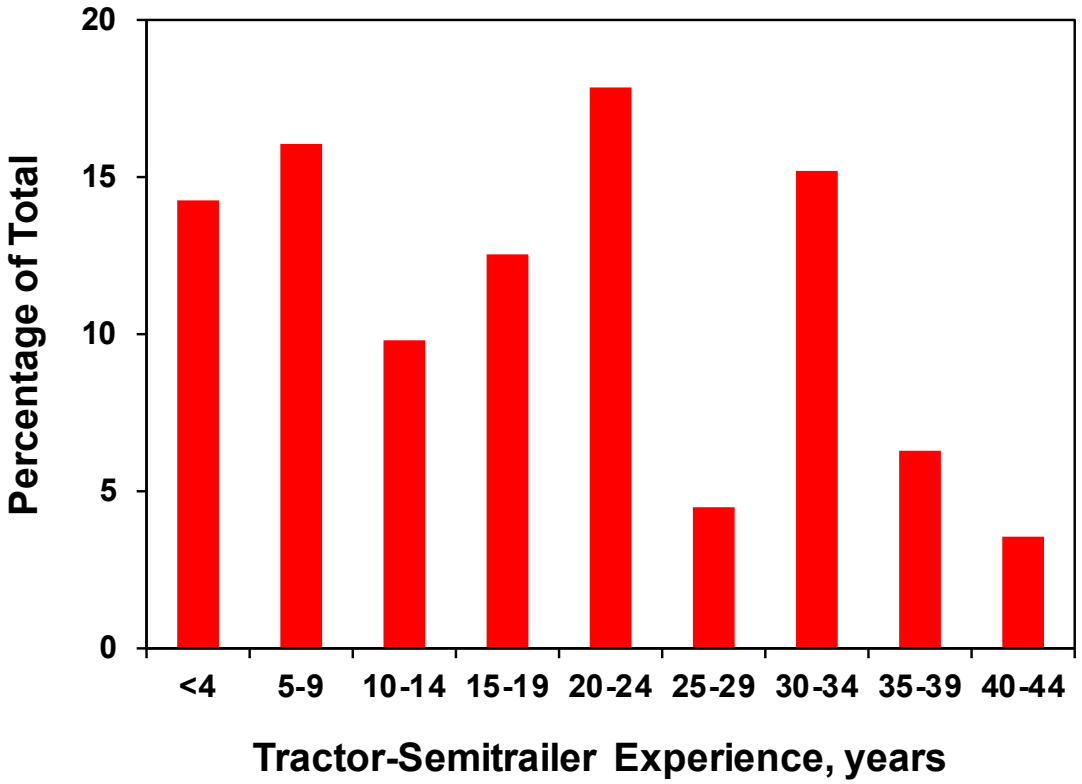
Battelle

Figure 2-10. Distribution of ages of Driver Clinic participants and of respondents to a survey for ATA (Table 2.7 of [5]).



Battelle

Figure 2-11. Distribution of ages of Driver Clinic participants and of drivers subject to motor carrier inspections in 2011 (Slide 9 of [4]).



Battelle

Figure 2-12. Distribution of participants' years of experience driving combination vehicles.

Most participants reported experience in both local and over-the-road service. Three in four participants had experience with straight trucks in addition to combination vehicles. More than 85 percent have driven van semitrailers, 60 percent flatbeds, and 38 percent tankers. One in six had experience driving passengers.

Scenarios

Scenarios were developed so the participants could experience four applications developed for commercial vehicles by MBRNA as part of this project:

- Intersection Movement Assist (IMA)
- Forward Collision Warning (FCW)
- Emergency Electronic Brake Light (EEBL)
- Blind Spot Warning, Lane Change Warning (BSW/LCW)

All of the scenarios are illustrated with both a schematic diagram and a photograph. All are accompanied by images of the messages that were displayed to the driver. The images were displayed on the iPad mounted above the parking brake controls as shown in Figure 2-13. Sounds for the alerts originated in the iPad and were played through the tractor's stereo system.

Battelle

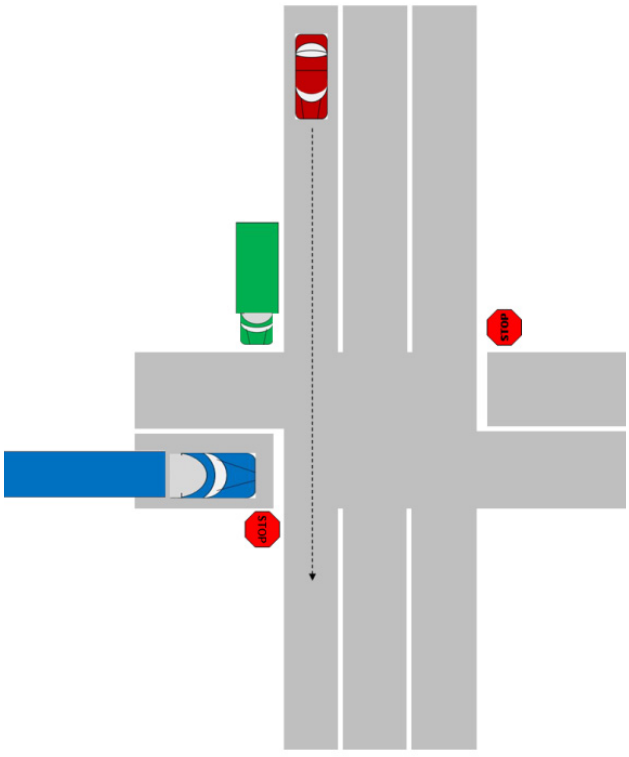
Figure 2-13. Messages for the safety applications were displayed on the iPad to the right of the steering wheel. (The mechanism above the display is a lock.)

The scenarios for the commercial vehicle clinics were near duplicates of those executed during the light vehicle clinics, to permit a close comparison of the two projects. The primary difference is that the host vehicle was a tractor-semitrailer. The second difference is that the blocking vehicle was a van truck rather than a passenger car. The van truck obscured the view of the test participant elevated in a tractor better than a passenger car would have.

The light vehicle clinics mixed the order that participants saw the applications to avoid bias in comparing opinions of one application to another. The commercial vehicle clinics had fewer participants and fewer scenarios, and the vehicles were less maneuverable, so all participants experienced the applications in this order.

IMA: Stopped HV Enters an Intersection with RV Approaching from the Right

The first application experienced by the participants was the Intersection Movement Assist (IMA). The participant drove the HV up to a temporary stop sign that mocked up an intersection. As shown in Figure 2-14 and Figure 2-15, a stationary van truck blocked the participant's view of a light vehicle RV approaching at approximately 25 mph. When the participant released the HV brakes and began slowly moving forward, the application issued a warning. The images that were displayed for the IMA alert are shown in Figure 2-16.

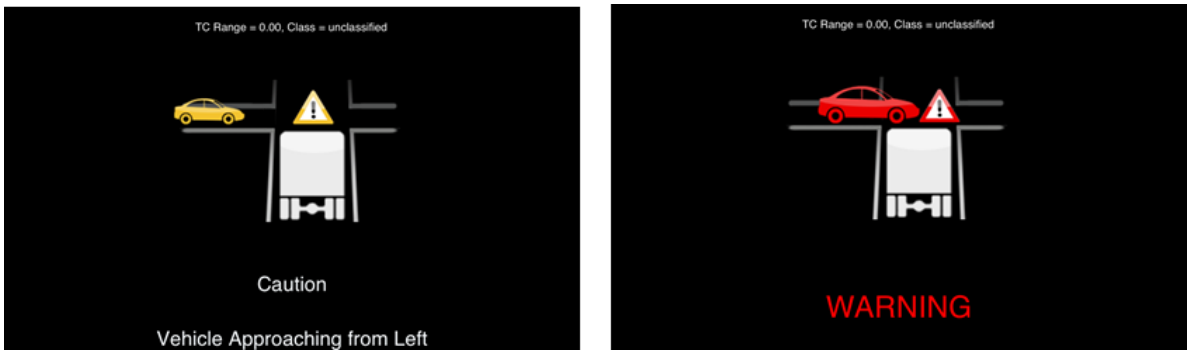


Battelle

Figure 2-14. IMA: An HV rolls into the intersection with cross traffic approaching.

Battelle

Figure 2-15. IMA: The participant in the white tractor is stopped at a stop sign. The participant's view of the approaching red light vehicle was blocked by the stationary yellow truck.

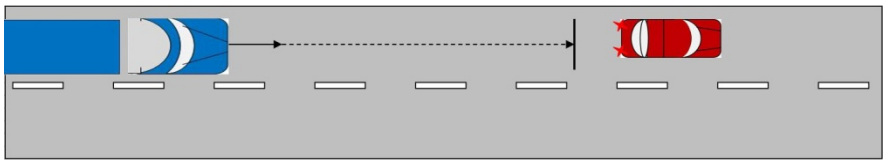


MBRDNA

Figure 2-16. The iPad by the driver displayed the image on the left for a less urgent "inform" level alert and the image on the right for a more urgent "warn" level alert.

FCW: HV Encounters Stopped RV in the Same Lane

The scenario began with the HV traveling in a straight line. Ahead of it in the same lane was a single stationary RV-1. This scenario demonstrated that collision alerts were generated when there is a forward collision threat along the HV path. This scenario is illustrated schematically in Figure 2-17, and Figure 2-18 is a photograph of the scenario at the California clinic. Figure 2-19 shows the two icons shown for the FCW alerts.

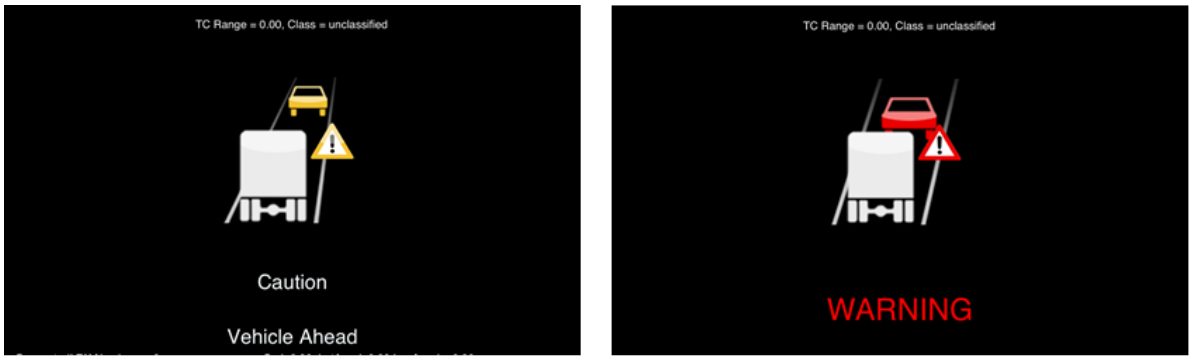


Battelle

Figure 2-17. FCW: The light vehicle is stopped in the same lane as the HV.

Battelle

Figure 2-18. FCW: The red light vehicle has stopped in the path of the white HV.

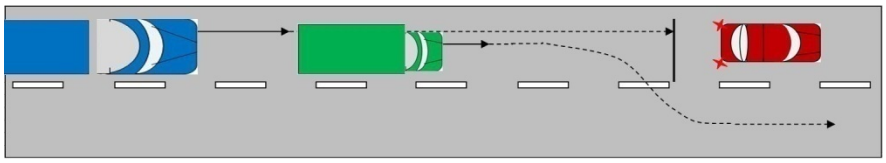


MBRDNA

Figure 2-19. The "inform" level (left) and "warn" level (right) images for the FCW alert.

EEBL: HV Following RV-2, which Changes Lanes to Reveal Stopped RV-1

This scenario also began with the HV traveling on a straight path. Ahead of the HV, in the same lane, was a small truck that blocks its view of a light vehicle also in the same lane. The light vehicle suddenly applied its brakes, and the small truck changed lanes to avoid the stopped car. The paths of the vehicles are shown in schematically Figure 2-20, and Figure 2-21 is a photograph of the light truck making the lane change. The EEBL application had only a "warn" level alert; its display is in Figure 2-22.

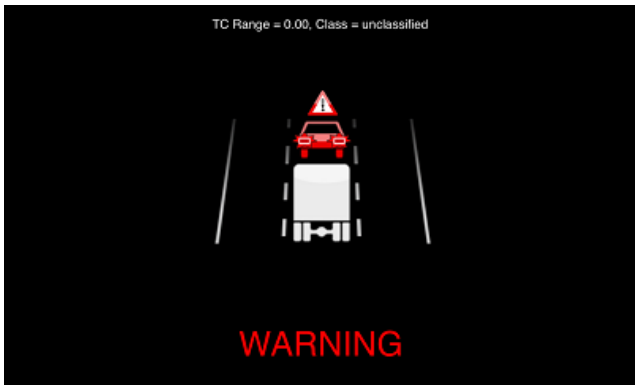


Battelle

Figure 2-20. EEBL: Lane change by the green small truck reveals the stopped light vehicle.

Battelle

Figure 2-21. EEBL: The yellow blocking vehicle is pulling out of the path to reveal the stopped red light vehicle.

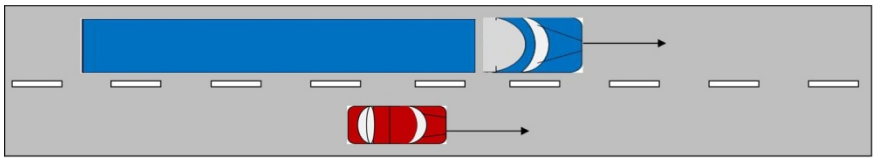


MBRDNA

Figure 2-22. This image was displayed on the iPad when the OBE issued an alert for EEBL.

BSW/LCW: RV in HV's Blind Spot

The BSW application provides an advisory when the RV enters the blind zone on either side of the HV. As shown in Figure 2-23, the RV began to overtake the HV and dwell in its right side blind spot.



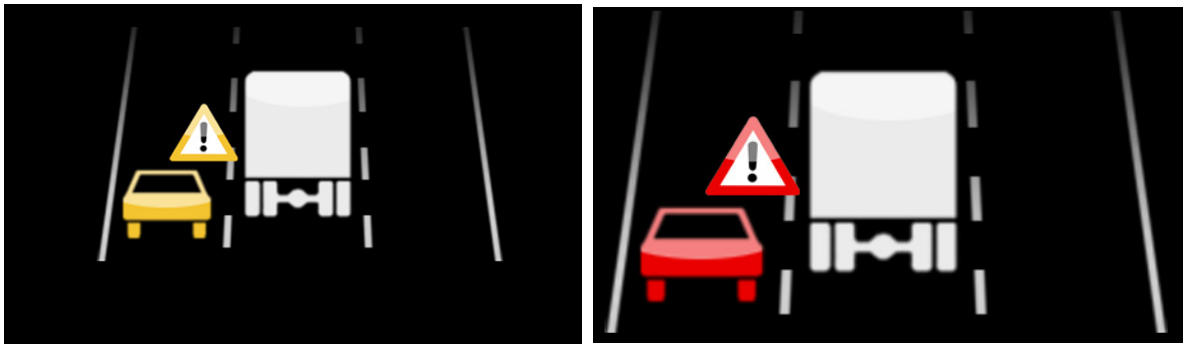
Battelle

Figure 2-23. The red light vehicle is in the HV's blind spot.

The silent BSW inform message switches to an audible LCW warning when the participant begins to signal a lane change toward the RV Figure 2-24 is a photograph of this scenario in progress at the California clinic. The BSW and LCW icons are in Figure 2-25.

Battelle

Figure 2-24. The red light vehicle is in the white HV's blind spot.



MBRDNA

Figure 2-25. The image on the left was displayed, without a sound, when a vehicle was in the participant's blind spot. The image on the right was displayed and a sound was played if the participant activated the turn signal to begin a lane change when a vehicle was in the adjacent lane.

Chapter 3 Findings

The post-drive written questionnaire and in-depth interviews included both limited-response and open questions that invited a free-form response. This section contains a qualitative compilation of the noteworthy remarks made by participants on the questionnaire or during the interview. The independent evaluator performed a quantitative analysis [6] of the questions with fixed responses.

The majority of participants were accepting of the technology. Several cautioned the developers on how to implement the system, and a few suggested new features.

General Compliments

Most participants expressed favorable views of the system. The most common compliments included

- "Must have"
- "At last" or "About time"
- "Better system than I expected. Very impressed."
- "Very, very good thing. No unexpected rear end [crash]."
- "The technology was excellent. The equipment was very good."
- "I like the fact that the driver is still in control, and the truck doesn't try to drive the situation."
- "I would buy this," or "I would want my employer to buy this."
- "[Even considering its flaws], any increase in safety would be worth it."

Cautions

Drivers shared many concerns about the system. The most common concern was that the system required drivers to look at a screen (See Figure 2-13 on page 20). This was written in many questionnaires and heard from almost all of the drivers selected for the interview. While most drivers saw the value of having a visual indication, they generally do not want to rely on a dashboard-located visual indicator to determine what the imminent threat is. Visual displays that bring the driver's eyes inside the cab, particularly at a critical moment, are undesirable. Representative comments were

- "Want eyes out the window."
- "Experienced drivers should use their mirrors and not the BSW,"
- "Audio [warning] more important than visual [warning]."

One driver, who was overall accepting of the technology (writing "It might save someone's life" and "Should have had this technology a long time ago. Very useful.") wrote strongly,

- "Don't like visual warning. When driving, I don't want to take my eyes off the road. This is for all tests!!"

While participants generally agreed that the audio warnings were more useful than their visual counterparts, they expressed many common concerns about the alert tones as well. Most frequently, drivers cautioned that the alert sounds should not be "annoying." Many participants said,

- "If it's annoying, it will be disconnected."

In particular, drivers wondered whether the system would be alerting them constantly in heavy traffic or road construction. In those situations, drivers are typically at their most stressed and focused state, and the idea of an alert beeping constantly was a concern for them. One driver noted a specific concern about the auditory alerts for the BSW warning:

- "When I'm in heavy [slow moving or stopped] traffic and need to change lanes, I will engage my signal to show my intent to change lanes; it's a way of asking permission for drivers to make room. Would this [blind spot warning] alert be going off the entire time?"

Other drivers questioned whether the alert sounds would be drowned out by the noisy environment of the truck cab. Drivers often have a window open to hear roadway noise, as well as many electronics turned on (e.g., radio, CB, police scanners, handsfree headsets for phone).

Some participants were concerned whether the alert sounds would be consistent, or would vary by manufacturer. They expressed anxiety over the possibility they would have to learn new sounds whenever they changed vehicles.

Another common area of caution was an apprehension over whether drivers would become overly reliant on the system. This was especially a concern among the older, more experienced drivers. Many of them felt that younger or novice drivers might rely on the warnings to prevent accidents, instead of developing the skills necessary to prevent accidents through vigilant defensive driving behavior. One driver noted:

- "Overdependence [on a system like this] will cause crashes… When [an alert] doesn't go off, and an accident occurs, who gets blamed? It becomes a liability issue."

A few participants noted that it was difficult to see the screen, due to the glare of the sunlight reflecting from it.

One participant who self-reported colorblindness said that he was not able to distinguish the different colors on the visual indicators. In particular, he was not able to tell which alerts were colored yellow and which were red.

More than one driver noted that the IMA application must work differently for a commercial vehicle than for a light vehicle. A senior driver, who was not selected for the interview, wanted to stay anyway to point out the special needs of a double trailer. It will take many seconds to accelerate and cross a multi-lane highway. Another asked,

- "How does it handle busy 6-8 lane intersections?"

Suggestions

A number of drivers wrote suggestions for modifications to the devices or for entirely new applications.

Most participants who expressed reservations at using the screen suggested that the visual part of the warnings would be more useful if the indications were within their field of view. A driver who wrote, "[IMA] is a good safety feature for blind intersections," wondered,

- "Is it possible to change position of screen?"

Generally, drivers did not like the screen being on the dashboard. As one participant noted:

- "[Make me look] anywhere but down."

These suggestions echoed many others, where drivers wondered if the screen (or the visual warning symbols) could be placed in other areas of the cab. Many asked if it was possible to have a heads-up display (HUD) on the windshield, where the warning could be viewed "at-a-glance," allowing the driver to maintain eyes on the road. Similarly, it was often suggested that the visual indication for the BSW could be on the mirror itself, since drivers would always be looking at the mirror whenever engaging the turn signal.

Drivers also had suggestions for making the sounds and tones more useful. One participant wrote,

- "Want informative sounds, not just beeps,"

…exemplifying a common theme held among the drivers, who wondered whether it would be possible to have intuitive, distinct sounds for each warning. Some suggested a human voice, verbalizing the alerts, would be most helpful. A few participants suggested that the visual and auditory alerts could even be reinforced with tactile methods, such as seat or steering column rattlers.

In general, participants expect that the sensitivity of the system will be adjustable. One representative quote for this suggestion was,

- "Want different sensitivity for city, rural, fog, ice"

Many of the participants noted that the "default" timing of the alerts used during the test would not have been sufficient had they been on wet pavement, fully loaded, or driving in inclement weather. They not only expect for the system to automatically adjust, based on the conditions of the road and vehicle, but also to be manually adjustable as well. Many drivers said they would want to fine-tune the sensitivity themselves when necessary.

There were at least three suggestions for new applications. An enhancement of the BSW application would warn of motorcycles that legally drive between the lanes of stopped traffic on California freeways. Experienced drivers in the Bay Area have developed signals for their Citizens Band (CB) radio to deal with the daily fog. They think that a new V2V application might help in that endeavor. When asked what should be changed about the BSW, a driver observed, “There are many blind spots on all four sides. It would be nice to add a backup feature.”

Chapter 4 Performance Tests

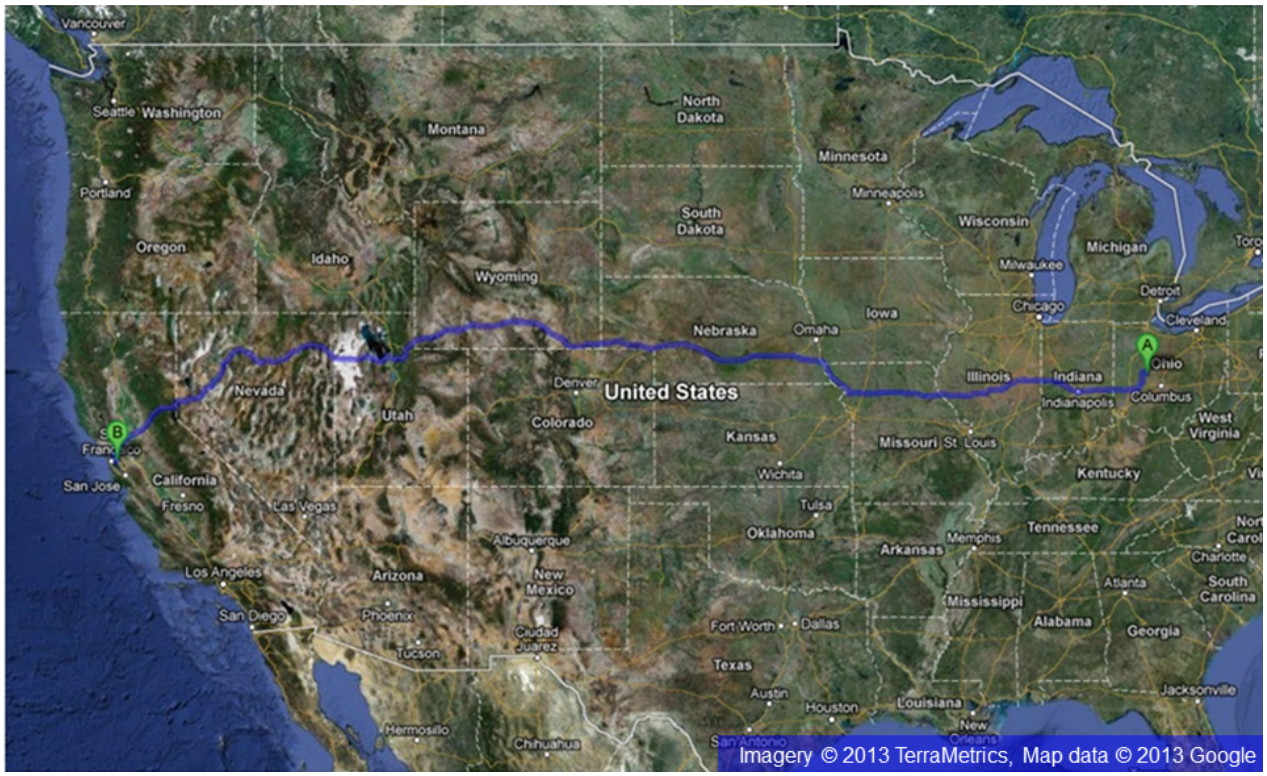
The Performance Tests were intended to evaluate quality of the GPS reception and DSRC communication in a variety of road conditions. Data were collected when the red and white tractors were driven from Ohio to California for the August Driver Clinic. The route included a variety of conditions—urban and rural, two lane to multi-lane, tunnels and bridges, plains and mountains. Data were recorded on the DAS on both tractors in the normal course of driving the trucks, without any intervention required of the drivers. The displays of the applications were disabled during the trips.

The correlation of the data between the two tractors showed excellent performance where DAS records were available. No evidence was found that DSRC performance depended on roadway features or geography. However, gaps in data collected by the DAS prevented evaluating the performance over the entire trip.

Route and Data Recording

The route from TRC Inc. to Alameda is shown in Figure 4-1. It takes US 68 south from Bellefontaine, Ohio, and picks up Interstate 70 west near Springfield, Ohio. In Indianapolis, the route briefly leaves the interstate and is on 38th Street. It departs Indianapolis on Interstate 74 and turns to Interstate 72 west of Champaign, Illinois. The route crosses the Mississippi River near Hannibal, Missouri, and continues across Missouri on US 36. It takes Interstate 29 northwest from St. Joseph, Missouri, and enters Nebraska at Nebraska City. After following a state highway to Lincoln, Nebraska, it picks up Interstate 80, which it follows across Nebraska, Wyoming, Utah, Nevada, and into Oakland, California. It leaves Interstate 980 for surface streets and reaches Alameda Island through a tunnel.

The trucks left TRC Inc. in the afternoon of August 11, 2012 and completed the 2400-mile drive to Alameda, California, in the evening of August 15.



Google

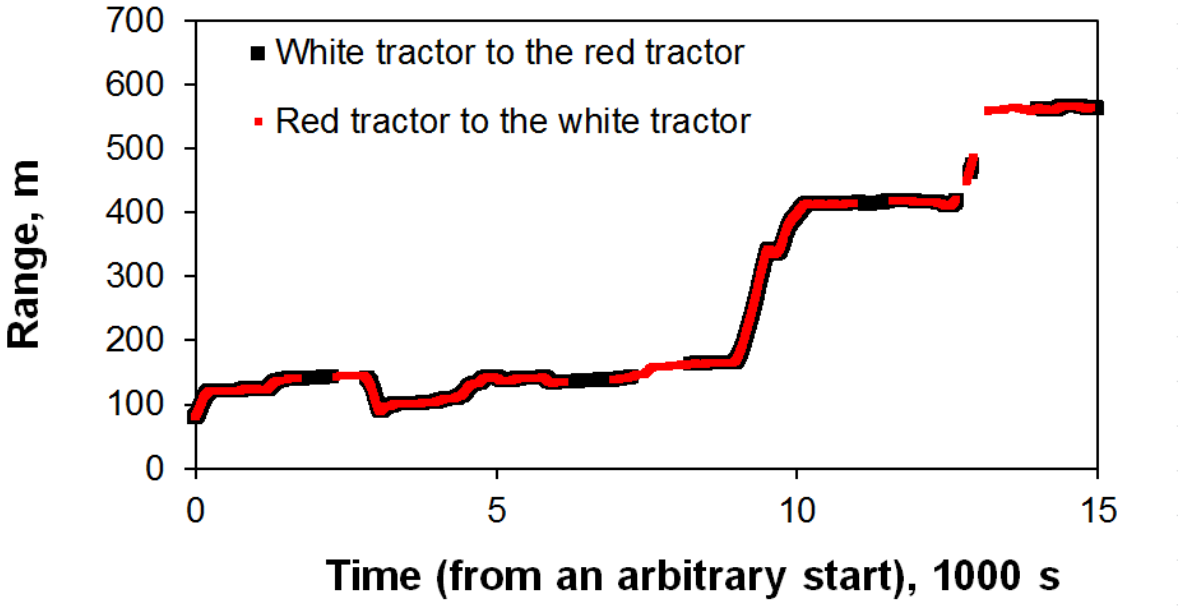
Figure 4-1. The route of the two trucks from TRC Inc. in Ohio to Alameda, California.

The DAS on each tractor recorded its own position from GPS signals independently from the WSU. Each tractor was also recording BSMs from the other tractor, and the range to the other tractor that it calculated from the BSM. Thus, at each moment in time there are three measurements of the range between the two tractors: the range to the red tractor calculated by the white tractor at that moment, the range to white tractor calculated by the red tractor at that moment, and the distance between the two calculated after the trip from DAS GPS data. If all components were functioning properly, those three values would be close. The clocks in the separate tractors were not precisely synchronized, so records were adjusted slightly.

Results

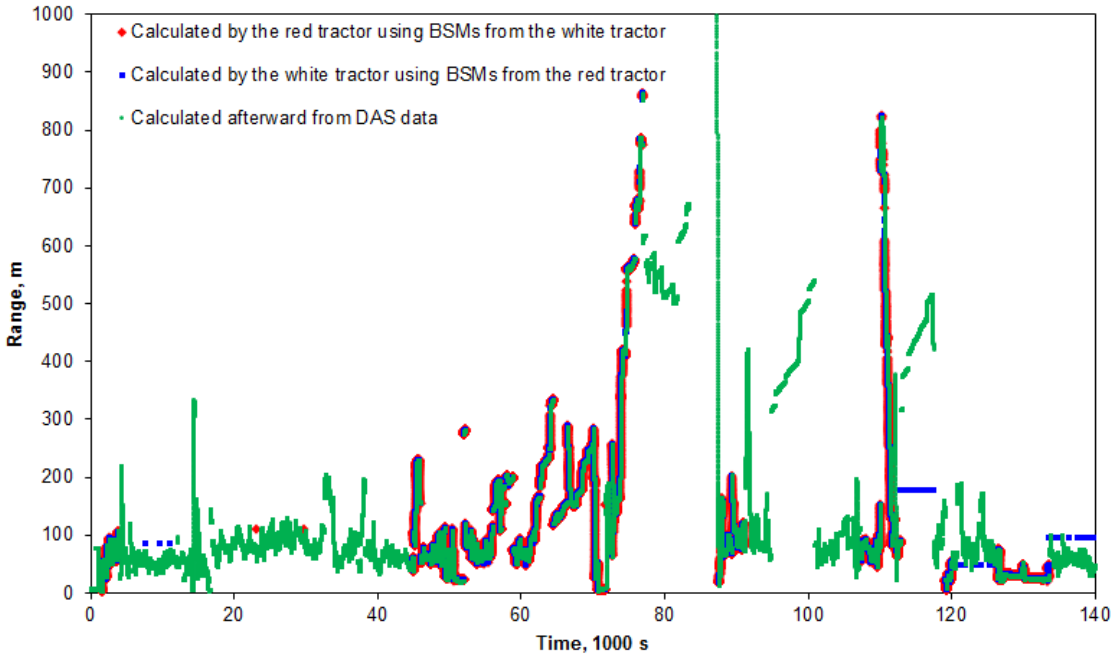
Figure 4-2 is an example of data collected near Laramie, Wyoming, on a mountainous Interstate. The range to the red tractor calculated by the white tractor is represented by the black line, and the range to the white tractor calculated by the red tractor, by the red line. The two agree well, confirming that all equipment was functioning properly for this segment of over five hours. Note that the tractors were hundreds of meters apart during this time.

Figure 4-3 is a compilation of data stored on the DAS of the two tractors for the entire trip from Ohio to California. The horizontal axis is time—the number of seconds after the tractor left TRC, Inc. Only time when the DAS were recording is shown, but instances where a tractor was stopped are included. Two observations can be made from this figure. First, there were long stretches passing through a variety of terrain where valid BSMs were exchanged and recorded. At one point the two vehicles were nearly 1 km apart where valid BSMs were received by both tractors. The second is that there were stretches of the trip when the two tractors were close enough together that they should have been recording each other's BSMs but they were not. As discussed later, the DAS was somehow prevented from properly recording BSMs during these times.



Battelle

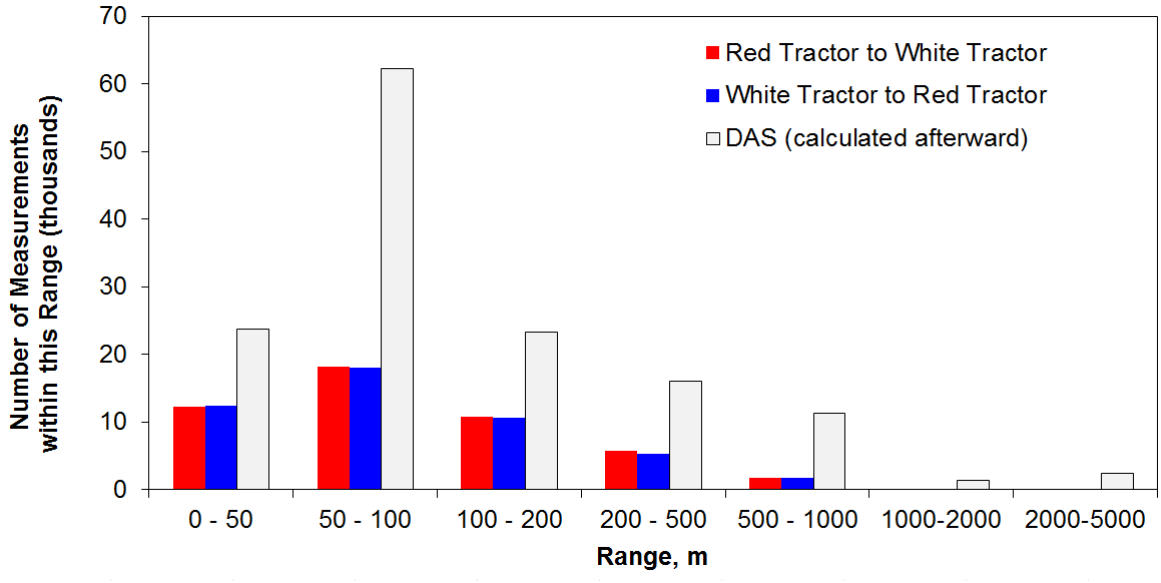
Figure 4-2. The range to the red tractor calculated by the white tractor, and the range to the white tractor calculated by the red tractor, agree well in this four-hour segment.



Battelle

Figure 4-3. The range between the two tractors was measured three ways. The three agreed well at the times when the dots align.

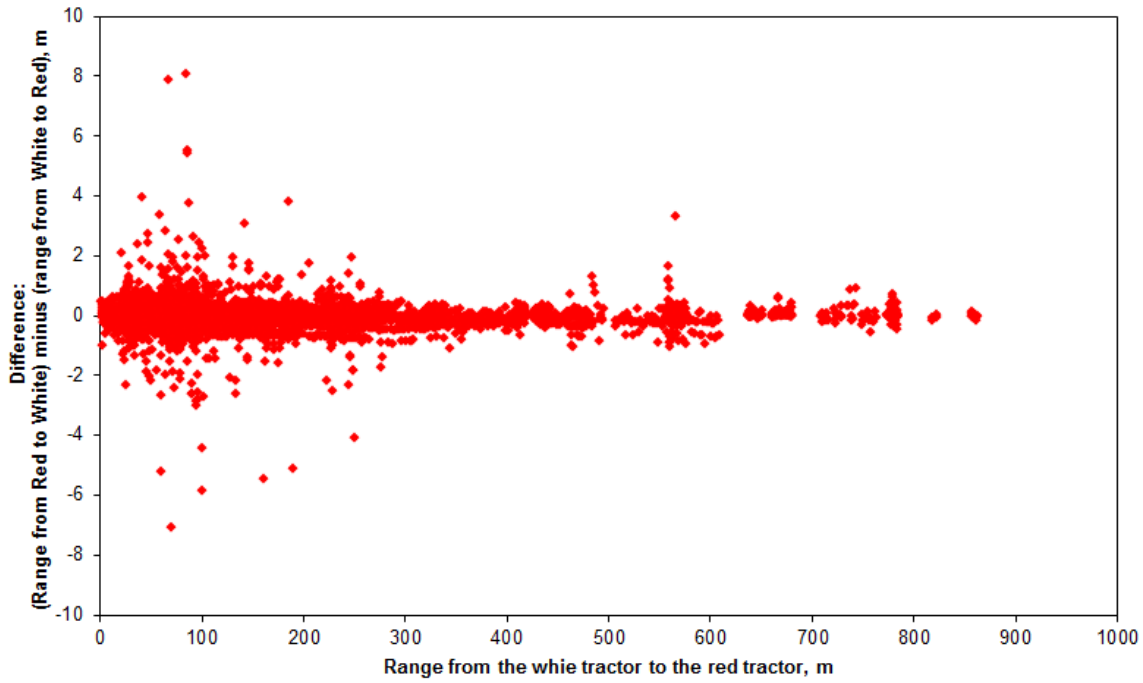
Under some circumstances, the two tractors recorded and processed each other's BSMs when the two were over 800 m apart. Figure 4-4 is a histogram of the range measurements on the drive. The red bars indicate the distribution of ranges that the red tractor calculated to the white tractor using BSMs received from the white tractor. The blue bars indicate the distribution of ranges that the white tractor calculated to the red tractor. For comparison, the gray bars are the distribution of ranges between the two tractors that were calculated using GPS location collected by the DAS, ignoring BSM data. The gray bars are higher than the colored bars because there were instances where the BSMs were not received or not recorded, such as when they were two far apart. The gray bars also show the that the distance between the tractors varied up to nearly 3000 m. No BSMs were received when the tractors were farther than about 850 m apart.



Battelle

Figure 4-4. Histogram of the number of measurements of the range between the two tractors on the drive from Ohio to California.

When both tractors recorded the other's BSMs, the agreement in range was good. Figure 4-5 shows the difference in the ranges between the two tractors, as a function of the range that the white tractor calculated to the red tractor. The clocks in the two were not synchronized, so it is possible that some of the discrepancy is due to the inability to match the two at exactly the same time.



Battelle

Figure 4-5. The discrepancy between the ranges calculated from BSMs was never more than 10 m and usually less than 2 m.

Table 4-1 summarizes the information numerically. Each tractor's DAS was to record its own BSMs and the BSMs it received from the other tractor. The numbers in the first row of the table indicate the fraction of DAS records that include a BSM from the host vehicle, and the second row indicates the fraction that include a BSM from a remote vehicle. Both tractors recorded their own BSMs with greater than 99.9 percent reliability. The red tractor recorded the white tractor's BSMs 51 percent of the trip, and the white tractor recorded the red tractor's BSMs 40 percent of the trip.

Engineers responsible for the WSU programming and for the DAS researched extensively, but were unable to identify a specific reason for some gaps found in BSM records. When the tractors were more than 800 m apart, they could not exchange BSMs, and there were likely other instances where BSMs were not received. In the cases where an identical BSM is recorded in many successive records, a DAS malfunction is likely. Analysis suggested that the DAS was somehow prevented from properly recording BSMs, but the reason for the failure could not be stated with certainty. Upgrades were made subsequently to both the WSU and the DAS prior to full deployment in Model Deployment. No evidence of this behavior was noted in Model Deployment.

Table 4-1. The fraction of the time that each vehicle recorded its own BSMs and the other's BSMs on the drive from Ohio to California.

BSM Origin	DAS		
	Red Tractor	White Tractor	Combined
Host Vehicle	1.00	1.00	1.00
Remote Vehicle	0.51	0.40	0.46

Battelle

Chapter 5 Lessons Learned

Much was learned over the course of conducting the clinics. By basing the clinics on the foundation of the light vehicle clinics, discussing plans with USDOT, and applying Battelle's experience, the clinics were conducted according to the written plans. This section documents how those plans worked out. A few approaches would be taken differently, particularly with respect to recruiting, and they are discussed first.

Recruiting

Perhaps the biggest concern going into this task was whether a full hundred qualified truck drivers could be recruited. They are a small and specific segment of the population. Their schedules are often unpredictable, and home time is precious for over-the-road drivers. The recruiting firm has a large list of names with many hobbies and demographics, but professional truck driver was not one of their attributes.

Conversations with carriers informed the team that drivers earn roughly $25 per hour. The incentive was set to work out to $50 per hour ($200 for a half day's commitment that includes travel time) to entice drivers who may have had to take a whole day off work.

Many kinds of publicity were used. Some proved more effective than others. The web site (Appendix E) served its purpose well of introducing prospects to connected vehicle technology, directing them to the phone number for recruiting, and providing maps to the test sites.

The newspaper display advertisement (Figure 2-9) was surprisingly effective. Any future effort similar to the clinics would certainly include greater use of advertising, in large and community newspapers.

Distributing brochures personally brought in a number of participants. Driving around Columbus to visit terminals and warehouses was time consuming (and not possible in California), but personally speaking with the drivers encountered at these meetings was effective.

Ultimately, enough drivers were recruited. In fact, there was a small waiting list for the California clinic. The shortcoming in recruiting was attracting a representative number of drivers under the age of 30. Had a significantly larger number of prospects responded, they could have been selected by age. The distribution of ages in Figure 2-10 and Figure 2-11 shows a sharp cutoff though. It is more likely that the publicity methods were not reaching younger drivers or that younger drivers had more difficulty putting a fixed date in their schedule. The social media channels were intended to reach younger candidates. Craig's List was an online resource that was not used but has a number of listings for CDL-A. More emphasis could have been placed on driving schools, which might have young recent graduates, and younger participants could have been especially encouraged to invite their younger driving friends.

Organization

The Driver Clinics themselves were conducted as planned.

Staffing levels were adequate. Two Battelle staff members were indoors to explain the informed consent form, administer the pre- and post-drive questionnaires, and dismiss the participants. A third Battelle staff member conducted the in-depth interviews. A TRC Inc. Project Manager greeted the participants, and another TRC Inc. staff member drove the participants between the meeting room and the Skid Pad. Automotive Events had two indoor staff plus one outdoors, who dealt with many cases of tire damage. The indoor and outdoor facilities were adequate at both sites. The timing worked according to plan. The maneuvers were rehearsed so they could be completed in 30 minutes. Counting waiting time, most participants left within about two hours of their arrival, which was as planned.

The practice sessions at TRC Inc. allowed the team of four test drivers to learn the safety applications and develop their roles in performing the clinics. The first meeting was in a conference room, where the drivers saw a video on V2V safety applications, had their human subjects instruction, and began to discuss their roles in the clinics. In the four subsequent half-day practice sessions, the test drivers at first activated the safety applications and then began to coordinate how they would work together in the Driver Clinics, and eventually practiced the timing of the maneuvers including reading the questions for the participants. In the final practice session, other CDL drivers at TRC Inc. played the role of participants, including filling out the pre- and post-drive questionnaires.

Having the practice sessions and first clinic at TRC Inc. its proximity to Battelle and its existing services allowed the procedures to be developed incrementally and thoughtfully. Alameda Point had no infrastructure beyond the pavement itself; all personnel and equipment had to be brought to the site. With the experience of the team in conducting the Ohio clinic and of Automotive Events in establishing facilities, that clinic could be run efficiently in two days following a day of on-site practice.

Wording of the questions for participants, in the written questionnaires and especially in the in-cab protocols, had to be simplified considerably from what was used in the light vehicle clinics.

Maturity of the System

The schedule for the Driver Clinics showed that a successful demonstration of the safety applications in Task 4 of this project was an essential prerequisite for the clinics. The applications were indeed demonstrated before the vehicles came to TRC Inc. for the Driver Clinics. The safety applications were, however, new to commercial vehicles, and needs for enhancement continued to appear through the practice and both clinics. Other members of the team were responsive in providing software and hardware improvements. The schedule for the practice sessions, spread out over three weeks, was valuable for allowing diagnostics and upgrades. The Driver Clinics proceeded according to the plan, and it was important that the plan both require a functional demonstration and recognize that developments would continue.

Soliciting Criticism

When studies with prospective users are a part of the product development process, the ideal approach to identify needs for improvement is frequently observed errors, such as failures to interpret user interface. The highly controlled environment of the Driver Clinics, where no particular reaction to the alerts was expected, was intended to assess acceptance of the system more than to solicit suggestions. Indeed, the results were that most participants liked the system. In addition, *Suggestions* showed that a number had constructive criticisms or suggestions for improvements. A few volunteered this information, but there could have been the formal question, "Under what circumstances would you turn it off?"

Although the blog postings are not known for sure to have brought in participants, they did generate responses. Inherent disadvantages of online chat forums are that they can produce overly negative comments and the true identity of writers is not known. They could be a means of compiling a list of concerns and they would provide a means to hear from drivers too disinterested to attend a clinic. More realistic conversations with confirmed truck drivers could be had at a booth at a trucking show or in a rest stop.

Chapter 6 Conclusions

The purpose of the Driver Clinics for the Connected Commercial Vehicle Safety Applications Project was to obtain driver feedback on connected vehicle technology and safety applications and to assess their acceptance of the applications.

More than 100 professional truck drivers attended one of two Driver Clinics and drove a combination tractor with integrated connected commercial vehicle equipment in a series of maneuvers with cooperative vehicles. The drivers experienced four safety applications: Intersection Movement Assist (IMA), Forward Collision Warning (FCW), Emergency Electronic Brake Lights (EEBL), and Blind Spot Warning with Lane Change Warning (BSW/LCW). The scenarios were carefully planned and none of the vehicles was ever in danger of a crash.

Participants in the clinics uniformly embraced the technology. They saw its value and appreciated the benefits of all four safety applications. They would like to have V2V technology in their own trucks.

The clinics did produce suggestions for improvement and cautions for deployment. A common theme was a request for the DVI to provide the information quickly and clearly, without taking the driver's eyes off the road. The warnings must not be a distraction. The reliability must be high—if the warnings come when an experienced driver knows they are not justified, the system will be ignored or possibly removed. A commercial vehicle, especially a tractor with a double trailer, takes much longer to cross a road than does a light vehicle, so the IMA application needs to be adjusted accordingly. Participants in the California clinic recommended adjustments or even a new application for fog, and a variation on the BSW application for motorcycles that drive between the lanes of stopped freeway traffic.

The performance of the integrated installations was tested in a variety of terrains when the two tractors were driven from Ohio to California. Missing data records prevented verification of performance in several of the planned locations. Communication between the two tractors was shown to work well in a variety of terrains.

Chapter 7 References

[1] Bogard, S. (UMTRI) and Peredo, G., (MBRDNA) (2013) "Applications Performance and Functional Test Report for Connected Commercial Vehicle Integrated Truck (CCV-IT)." (Report from the University of Michigan Transportation Research Institute to Battelle for ITS JPO) Battelle document 10003838-404. Contract No. DTFH61-06-D0007/ORDER T11004/WO BA07-092.

[2] Battelle Memorial Institute. (June 16, 2011) "Connected Commercial Vehicle (CCV) Safety Applications Development Project: Project Management and Work Plan." (Report from Battelle to ITS JPO) Battelle document 10003838-1. Contract No. DTFH61-06-D0007/ORDER T11004/WO BA07-092.

[3] LeBlanc, D., Bogard, S., and Gilbert, M. (January 12, 2012) "Connected Commercial Vehicle—Integrated Truck Project: Vehicle Build and Build Test Plan Final Technical Report." (Report from the University of Michigan Transportation Research Institute to Battelle for ITS JPO) Battelle document 10003838-202. Contract No. DTFH61-06-D-0007, Task Order No. BA07-095.

[4] Hatipoglu, C. (January 2013) "Calendar Year 2011 Roadside Inspections." Presentation at the TRB 92nd Annual Meeting. Available online at http://www.fmcsa.dot.gov/facts-research/research-technology/report/TRB-2013-Hatipoglu-Roadside-Inspections-508.pdf

[5] Global Insight, Inc. (May 2005) "The U.S. Truck Driver Shortage: Analysis and Forecasts." Report to the American Trucking Associations.

[6] Stevens, S. (November 2012) "Analysis of the Heavy Truck Driver Acceptance Clinic Subjective Data." Volpe National Transportation Systems Center, HS7AA1 – Project Memorandum. Report to ITS Joint Program Office.

APPENDIX A. Glossary of Terms and Abbreviations

Application	a use of the connected vehicle technology to avoid a certain kind of crash, such as Blind Spot Warning (BSW) or IMA (Intersection Movement Assist)
ASD	Aftermarket Safety Device. Not as well integrated with a vehicle as an OBE, but with greater capability than a Vehicle Awareness Device.
BSM	Basic Safety Message. The package of information about a vehicle's position and status that is broadcast to surrounding vehicles by the OBE, ASD, or Vehicle Awareness Device.
BSW / LCW	Blind Spot Warning / Lane Change Warning. A safety application.
CAMP	Crash Avoidance Metrics Partnership. Originally was GM and Ford; now includes Mercedes-Benz, Toyota, Honda, Volkswagen, Nissan, and Hyundai-Kia.
CAN	Controller Area Network. Just about all cars and trucks have one nowadays. Lots of parts of the vehicle broadcast their status and receive their instructions from the bus.
CCV	Connected Commercial Vehicles (the name of this project)
CDL	Commercial Driver's License. The participants drove a combination unit vehicle, so they were required to show a Class A CDL.
CSW	Curve Speed Warning. An application developed by MBRDNA for commercial vehicles.
DAC	Driver Acceptance Clinic
DAS	Data Acquisition System. Records data for the engineers to examine after the experiment.
GRD	Geometric Road Description
DNPW	Do Not Pass Warning. A safety application not used in the clinics.
USDOT	United States Department of Transportation
Driver	Any person driving any vehicle in the project. The driver of the Host Vehicle during the scenarios of the clinics is referred to as the *participant*.
DSRC	Dedicated Short-Range Communication. Think of it as Wi-Fi for the road.
DTNA	Daimler Trucks North America
DVI	Driver-Vehicle Interface. A lighted symbol on the dash, possibly a beep, and maybe a seat vibration
EEBL	Emergency Electronic Brake Light. A safety application.
FCW	Forward Collision Warning
FHWA	Federal Highway Administration (part of USDOT)

HIA	"Here I Am." Old name for a Vehicle Awareness Device (which see)
HV	Host Vehicle. The vehicle in which the participant drives
IMA	Intersection Movement Assist. A safety application. (Called "busy intersection" when speaking to the participants.)
ICF	Informed Consent Form
IDI	In-Depth Interview
IRB	Institutional Review Board
ITS JPO	Intelligent Transportation Systems Joint Program Office
LTAP / OD	Left Turn Across Path / Opposite Direction. A safety application not used in the clinics.
MBRDNA	Mercedes Benz Research and Development North America
MD	Model Deployment. A parallel but separate project
NHTSA	National Highway Traffic Safety Administration (part of USDOT)
OBE	On-Board Equipment. A device on the vehicle that supports the Connectivity
OEM	Original Equipment Manufacturer. Usually this term refers one of the car manufacturers, but it could be a manufacturer of other things.
Participant	This term is reserved for the driver of the Host Vehicle who is participating in the study.
RITA	Research and Innovative Technology Administration (part of USDOT)
RSD	Retrofit Safety Device. A device with functionality similar to an OBE that is installed in a vehicle as an aftermarket retrofit. May have slightly less integration than an OBE but is better integrated with the vehicle and has more capability than a Vehicle Awareness Device.
RSE	Road Side Equipment. A device on the stationary infrastructure for Connectivity
RV	Remove Vehicle. A vehicle in a scenario other than the HV. In the clinics, RV-1 is a sedan and RV-2 is a small truck.
Scenario	An arrangement of vehicles and a plan for their motion intended to demonstrate an application.
SP	Safety Pilot. A parallel but separate project
TRC Inc.	Transportation Research Center Inc.
UMTRI	University of Michigan Transportation Research Institute
Vehicle Awareness Device	(not to be shortened) A device in a vehicle that broadcasts announcing its position to neighboring vehicles. The BSM from a Vehicle Awareness Device contains only location information, no information about the vehicle condition. An OBE does include vehicle status in the BSM.

VRTC	Vehicle Research and Test Center. A laboratory of NHTSA on the grounds of TRC Inc.
VSC-A	Vehicle Safety Communications – Applications
VSC3	Vehicle Safety Communications 3 (Consortium)
V2V	Vehicle-to-vehicle (communication)
V2I	Vehicle-to-infrastructure (communication)
WSU	Wireless Safety Unit.

APPENDIX B.

Driver Clinics Test and Safety Plan

The Driver Clinics Test Plan was first delivered to the U.S. DOT in draft form in November 2011. The document was modified in response to comments, and other changes were made as plans evolved. Significant updates were reviewed by Battelle's IRB. A new version was in effect for the Ohio clinic. This appendix is the expanded version that was in effect for the California clinic.

The document refers to its own appendixes, which are not present because the same material is present in this final task report.

Connected Commercial Vehicle Integrated Truck Project

Driver Clinics Test and Safety Plan
Ohio Clinic

July 2, 2012

U.S. Department of Transportation

Federal Highway Administration
Federal Motor Carrier Safety Administration
National Highway Traffic Safety Administration
Research and Innovative Technology Administration

Produced by Connected Commercial Vehicle Integrated Truck Project
ITS Joint Program Office
Research and Innovative Technology Administration
U.S. Department of Transportation

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
Connected Commercial Vehicle integrated Truck Project Driver Clinics Test and Safety Plan Ohio Clinic	July 2, 2012
	6. Performing Organization Code 100003838
7. Author(s) Douglas Pape, Rosalee Meyer, Battelle	**8. Performing Organization Report No.**
9. Performing Organization Name And Address Battelle 505 King Avenue Columbus, OH 43201	**10. Work Unit No. (TRAIS)**
	11. Contract or Grant No. DTFH61-06-D0007/ ORDER T11004/WO BA07-092
12. Sponsoring Agency Name and Address Federal Highway Administration 1200 New Jersey Avenue, S.E. Washington, DC 20590	**13. Type of Report and Period Covered** Driver Clinics Test and Safety Plan 9/1/2011-9/30-2013
	14. Sponsoring Agency Code

15. Supplementary Notes

The Connected Commercial Vehicle Team is led and managed by Battelle and includes Mercedes-Benz Research and Development North America, Inc. (MBRDNA), DENSO International North America Research Laboratory (NARL), the University of Michigan Transportation Institute (UMTRI), Daimler Trucks North America (DTNA), and Meritor WABCO.

16. Abstract

Connected vehicle wireless data communications can enable safety applications that may reduce injuries and fatalities suffered on our roads and highways, as well as enabling reductions in traffic congestion and impacts on the environment. As a critical part of achieving these goals, the U.S. DOT contracted with a Team led by Battelle to integrate and validate connected vehicle on-board equipment (OBE) and safety applications on selected Class 8 commercial vehicles and to support those vehicles in research and testing activities that provide information and data needed to assess their safety benefits and support regulatory decision processes. Driver Clinics are being conducted as a part of this project to evaluate acceptance of the connected vehicle technology and safety applications by drivers who are previously unfamiliar with the technology.

This document contains the plans for preparing for an executing the Driver Clinics and Performance Tests for the Connected Commercial Vehicles Integrated Truck project. The Driver Clinics and Performance Tests are Task 7 of that project.

These plans will be reviewed by all stakeholders, including the U.S. DOT, Battelle's human subjects Institutional Review Board (IRB), and a safety committee. Following these reviews, the plan will guide the execution of the task.

17. Key Words	18. Distribution Statement
Commercial vehicle, connected vehicle, dedicated short-range communication	(Remove; Insert Information Here or leave blank)

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
		71	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

RECORD OF REVISIONS

Version	Sections Affected	Description of Changes	Date	Approval
0.3	All	Approved by Battelle's IRB	Dec 12, 2011	
1.0	Various	Revised to respond to comments from U.S. DOT on Dec 9	Jan 18, 2012	
2.0	3.4.3 5.3.4	revised incentive, half-day schedule at TRC Inc,	June 1, 2012	
2.1	Fig 3-3 Appendix A Appendix B	The figure now says we have exclusive use of the Skid Pad. A new sketch in Appendix A-1 shows the order and locations of the scenarios. In-vehicle documents all in one booklet.	July 2, 2012	

TABLE OF CONTENTS

List of Appendices

TABLE OF CONTENTS (CONTINUED)

Page

List of Tables

List of Figures

GLOSSARY OF TERMS AND ABBREVIATIONS

Term	Meaning
Application	a use of the connected vehicle technology to avoid a certain kind of crash, such as Blind Spot Warning (BSW) or IMA (Intersection Movement Assist)
ASD	Aftermarket Safety Device. Not as well integrated with a vehicle as an OBE, but with greater capability than a Vehicle Awareness Device.
BSM	Basic Safety Message. The package of information about a vehicle's position and status that is broadcast to surrounding vehicles by the OBE, ASD, or Vehicle Awareness Device.
BSW / LCW	Blind Spot Warning / Lane Change Warning. A safety application.
CAMP	Crash Avoidance Metrics Partnership. Originally was GM and Ford; now includes eight manufacturers.
CAN	Controller Area Network. Just about all cars and trucks have one nowadays. Lots of parts of the vehicle broadcast their status and receive their instructions from the bus.
CCV	Connected Commercial Vehicles (the name of this project)
CDL	Commercial Driver's License. The participants will be driving a combination unit vehicle, so they will need a Class A CDL.
CSW	Curve Speed Warning. An application developed by MBRDNA for commercial vehicles.
DAC	Driver Acceptance Clinic
DAS	Data Acquisition System. Records data for the engineers to examine after the experiment.
GRD	Geometric Road Description
DNPW	Do Not Pass Warning. A safety application not used in the clinics.
DOT	See U.S. DOT
Driver	Any person driving any vehicle in the project. The driver of the Host Vehicle during the scenarios of the clinics is referred to as the *participant*.
DSRC	Dedicated Short-Range Communication. Think of it as wi-fi for the road.
DTNA	Daimler Trucks North America (Think Freightliner.)
DVI	Driver-Vehicle Interface. A lighted symbol on the dash, possibly a beep, and maybe a seat vibration
EEBL	Emergency Electronic Brake Light. A safety application.
FCW	Forward Collision Warning
FHWA	Federal Highway Administration (part of U.S. DOT)
HIA	"Here I Am." Old name for a Vehicle Awareness Device (which see)
HV	Host Vehicle. The vehicle in which the participant drives
IMA	Intersection Movement Assist. A safety application. (Called "busy intersection" when speaking to the participants.)
ICF	Informed Consent Form
IDI	In-Depth Interview
IRB	Institutional Review Board

Term	Meaning
ITS JPO	Intelligent Transportation Systems Joint Program Office (part of RITA)
LTAP / OD	Left Turn Across Path / Opposite Direction. A safety application not used in the clinics.
MBRDNA	Mercedes Benz Research and Development North America
MD	Model Deployment. A parallel but separate project
NHTSA	National Highway Traffic Safety Administration (part of U.S. DOT)
OBE	On-Board Equipment. A device on the vehicle that supports the Connectivity
OEM	Original Equipment Manufacturer. Usually somebody using this term is talking about one of the car manufacturers, but it could be a manufacturer of other things, instead.
Participant	This term is reserved for the driver of the Host Vehicle who is participating in the study.
RITA	Research and Innovative Technology Administration (part of U.S. DOT)
RSD	Retrofit Safety Device. A device with functionality similar to an OBE that is installed in a vehicle as an aftermarket retrofit. May have slightly less integration than an OBE but is better integrated with the vehicle and has more capability than a Vehicle Awareness Device.
RSE	Road Side Equipment. A device on the stationary infrastructure for Connectivity
RV	Remove Vehicle. A vehicle in a scenario other than the HV. In the clinics, RV-1 is a sedan and RV-2 is a small truck.
Scenario	An arrangement of vehicles and a plan for their motion intended to demonstrate an application.
SP	Safety Pilot. A parallel but separate project
TRC Inc.	Transportation Research Center Inc.
UMTRI	University of Michigan Transportation Research Institute
U.S. DOT	United States Department of Transportation
Vehicle Awareness Device	(not to be shortened) A device in a vehicle that broadcasts announcing its position to neighboring vehicles. The BSM from a Vehicle Awareness Device contains only location information, no information about the vehicle condition. An OBE does include vehicle status in the BSM.
VRTC	Vehicle Research and Test Center. A laboratory of NHTSA on the grounds of TRC Inc.
VSC-A	Vehicle Safety Communications - Applications
VSC3	Vehicle Safety Communications 3 (Consortium)
V2V	Vehicle-to-vehicle (communication)
V2I	Vehicle-to-infrastructure (communication)

1.0 INTRODUCTION

The driver clinics described in this test plan are one task within a project where Battelle is a prime contractor for the United States Department of Transportation (U.S. DOT). The purpose of the project is to take technology that has been developed for light passenger vehicles and apply it to a commercial vehicle, specifically a tractor for pulling a semitrailer. Vehicles equipped with this technology broadcast radio signals indicating their position and other information to surrounding vehicles. This information is intended to help drivers avoid crashes. The overall project will evaluate the technology in a number of ways, including these driver clinics, which will gauge its acceptance by truck drivers.

Two clinics at different sites are planned. During each clinic, at least thirty participants will drive trucks equipped with the Connected Commercial Vehicle technology. After driving several scenarios to demonstrate the technology over the course of half an hour, the participants will be asked their opinions.

The clinic at TRC Inc. in Ohio will be first. It is scheduled for three days and is expected to solicit the opinions of 72 truck driver participants. The second clinic, at the former Alameda Naval Air Station in California, will be two days for approximately 36 participants. Adjustments will be made to the recruiting and scheduling practices so that the total number of participants will be at least 100.

1.1 Description of the Overall Project

A contractor team led by Battelle is conducting Connected Commercial Vehicle (CCV) Safety Applications Development Project for the U.S. DOT. Task 7 in that project is the Driver Clinics, which are accompanied by Performance Tests.

The Draft Project Management and Work Plan for this project [8] observes that connected vehicle telecommunication system for vehicle data can transform vehicle travel in North America, enabling major reductions in injuries and fatalities suffered on our roads and highways, as well as enabling reductions in traffic congestion and impacts on the environment. As a critical part of achieving these goals, the U.S. DOT wishes to apply the successful experience with connected vehicle technology implementation on light vehicles to commercial vehicles and to demonstrate the performance, interoperability, and safety benefits of the technology in mixed light and commercial vehicle environments. Under this Connected Commercial Vehicle Safety Applications Development Program, the U.S. DOT has contracted with a Team led by Battelle to integrate and validate connected vehicle on-board equipment (OBE) and safety applications on selected Class 8 commercial vehicles and to support those vehicles in research and testing activities that provide information and data needed to assess their safety benefits and support regulatory decision processes. The Driver Clinics and Performance Tests are among many tests and demonstrations of the CCV technology during this project. The major tests are shown in Figure 1-1, where the task numbers indicate where the tests fit in the overall project.

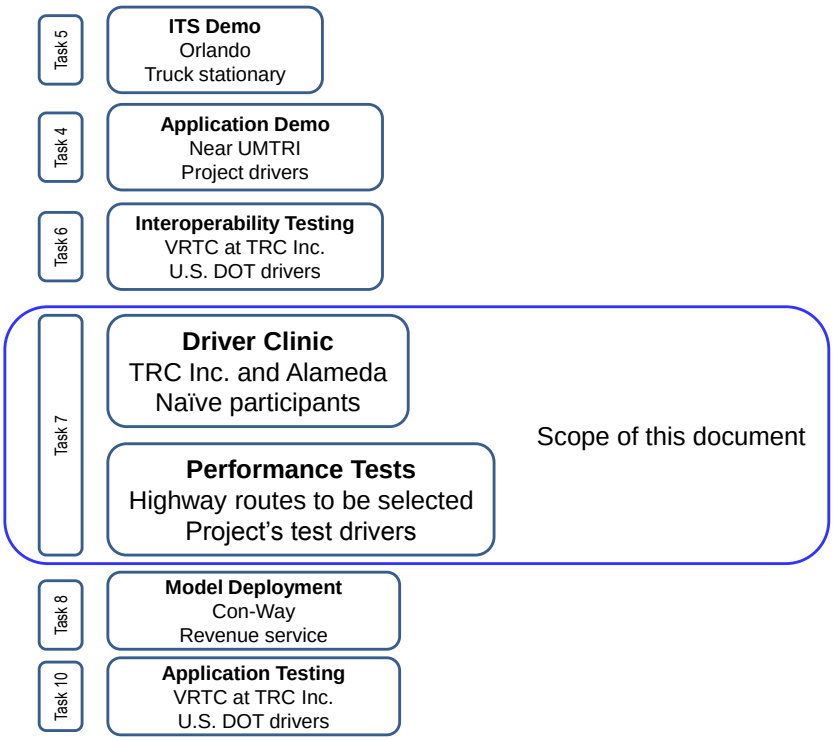


Figure 1-1. The Driver Clinics and Performance Tests are among several tests of the connected commercial vehicle installation.

The first demonstration to occur was at the ITS World Congress in Orlando, Florida, with light vehicles responding to messages broadcast from a commercial vehicle. The fully functioning installations are to be demonstrated at the end of Task 4, an important prerequisite to the Driver Clinics and Performance Tests. The vehicles will be made available for Interoperability Testing to be performed by the U.S. DOT. The large oval in the figure highlights the testing covered in this document. Following the Driver Clinics and Performance Tests will be testing in revenue service during a Model Deployment and subsequent objective Application Testing by the U.S. DOT.

1.2 Description of the Technologies

The connected vehicle telecommunication system is to enable major reductions in injuries and fatalities suffered on our roads, as well as enabling reductions in traffic congestion and detriments to the environment. To achieve these goals the U.S. DOT wishes to apply the successful experience with connected vehicle technology implementation on light vehicles to commercial vehicles.

The heart of the technology is a radio and computer on a vehicle. It determines its location using Global Positioning System (GPS) and broadcasts its location to surrounding vehicles ten times a second. The technology has matured to the point that these functions are performed in a compact, hardened wireless safety unit. A special radio band and protocol called Dedicated

Short-Range Communication (DSRC) are used to transmit signals, either from a vehicle to a vehicle (V2V) or between vehicles and the infrastructure (V2I).

The Basic Safety Message (BSM) that is transmitted to surrounding vehicles includes not only the position of the vehicle, but also its speed, heading, size, and certain other information such as whether the brake lights are on. Other vehicles in the neighborhood can use this information to determine whether they are on a possible collision course and advise their drivers. A "safety application" is the name of the computer logic on the receiving vehicle that determines whether to inform the driver of the presence of other vehicles (for example, in their blind spot) or to warn their drivers (for example, of a stopped vehicle ahead).

1.3 Description and Purpose of the Driver Clinics

The purpose of the Driver Clinics is to evaluate acceptance of the connected vehicle technology and safety applications by drivers who are previously unfamiliar with the technology.

1.4 Description and Purpose of the Performance Tests

In parallel with the Driver Clinics, the team will conduct Performance Tests. The purpose of the Performance Tests is to assess how well the connected vehicle technology performs in environments on the road. The vehicles will be available for testing on the drive from the Ohio clinic to the Alameda clinic.

1.5 Scope of this Document

This document contains the plans for preparing for an executing the Driver Clinics and Performance Tests for the Connected Commercial Vehicles project. The Driver Clinics and Performance Tests are Task 7 of that project.

These plans will be reviewed by all stakeholders, including the U.S. DOT, Battelle's human subjects Institutional Review Board (IRB), and a safety committee. Following these reviews, the plan will guide the execution of the task.

This document will serve as the guiding plan for completion of the Driver Clinics so that they support the overall goals of the CCV Safety Applications Development Project. This document is subordinate to the Draft Project Management and Work Plan for this project [8]. That document will be updated periodically throughout the duration of the project to reflect significant changes in plans, schedule, or budget. The present document will be updated frequently as plans for the clinics develop. As it approaches formal approval by the Institutional Review Board and the safety team (Section 2.3), version control and change management will be implemented.

The Draft Project Management and Work Plan for this project [8] identifies nine subtasks of Task 7.

Subtask 7a. Prepare the Test Plan. This document is that test plan.

Subtask 7b. Carry Out Logistical Support. This document, particularly Section 3.2 identifies logistical support that is needed. Section 5.2 is the plan for providing that support.

Subtask 7c. Purchase Support Equipment. Section 5.2 identifies the support equipment that will be purchased or rented.

Subtask 7d. Recruit and Prepare Test Subjects. Section 3.4 contains the qualifications for the test subjects and the screening and recruiting approach. Test subjects will be prepared according to the steps outlined in Sections 5.2.

Subtask 7e. Develop Questionnaires and Focus Group Topics. Drafts of all of the human subjects data collection instruments have been prepared. The various questionnaires are described in Section 4.1, and the instruments themselves are in Appendix B.

Subtask 7f. Obtain Human Subjects Approval. Description of the IRB process is in Section 2.3.2 Protections for the IRB to review are in Section 7.1.

Subtask 7g. Conduct Driver Clinics. The steps for conducting the clinics themselves are in Sections 5.3 and 0.

Subtask 7h. Collect and Store Data. The steps for collecting and storing the data are in Section 5.2. The data's quality will be assessed according to the procedure in Chapter 8.0.

Subtask 7i. Analyze and Report Results. The analysis methods are in Chapter 8.0, and the draft outline of the Task Report is in Chapter 9.0.

1.6 Important Nomenclature

The table after the Table of Contents defines specialized terms and abbreviations. A few important terms with specific meanings are highlighted here.

Participant—a truck driver whose opinion about the technology we are soliciting. Also called a subject
Host vehicle (HV)—the truck equipped with the technology and in which it is demonstrated
Application—a use of the connected vehicle technology to avoid a certain kind of crash, such as Blind Spot Warning (BSW) or Intersection Movement Assist (IMA)
Scenario—a series of maneuvers involving at least two connected vehicles, intended to trigger a message from one of the applications.

Over the course of the two clinics, at least 100 *participants* will drive a *host vehicle* through a series of *scenarios*, each one demonstrating an *application*. A test conductor will ride in the passenger seat of the *host vehicle*.

2.0 TASK MANAGEMENT

This task is of sufficient scope that it needs to be managed as a separate activity, under the direction of the Project Manager of the Connected Commercial Vehicle Safety Applications Project.

2.1 Deliverables and Schedule

The Draft Project Management and Work Plan [8] identifies four deliverables for this task. They are listed in Table 2-1.

Table 2-1. List of deliverables for the driver clinics task.

Deliverable	Tentative Date
Driver Clinics Test Plan and Procedures	October 31, 2011
Certification of IRB Review and Approval	December 31, 2011
Driver Clinics Lessons Learned Document	January 31, 2013
Driver Clinics and Performance Test Results and Report	January 31, 2013

Note: The dates listed here are those in Appendix D of the Work Plan and are one day before the dates listed in Table 5 of the Work Plan. They depend on other activities in the Integrated Truck and Safety Pilot projects.

Figure 2-1 has the schedule for this task. A key prerequisite for conducting the clinics is the demonstration of applications on an integrated truck platform in Task 4, which is scheduled for April 2012. The applications must be functioning properly for the clinics to be conducted, and the tractors must have completed their testing to be available to the clinics.

The sixth and final light vehicle Driver Acceptance Clinic is January 18 to 21, 2012, in Alameda, California [10]. Because that is the recommended site of the west coast commercial vehicle driver clinic, that would be the best possible opportunity for the staff for the commercial vehicle driver clinic to inspect the site, discuss the preparations for the clinic, and experience the procedures of a driver clinic.

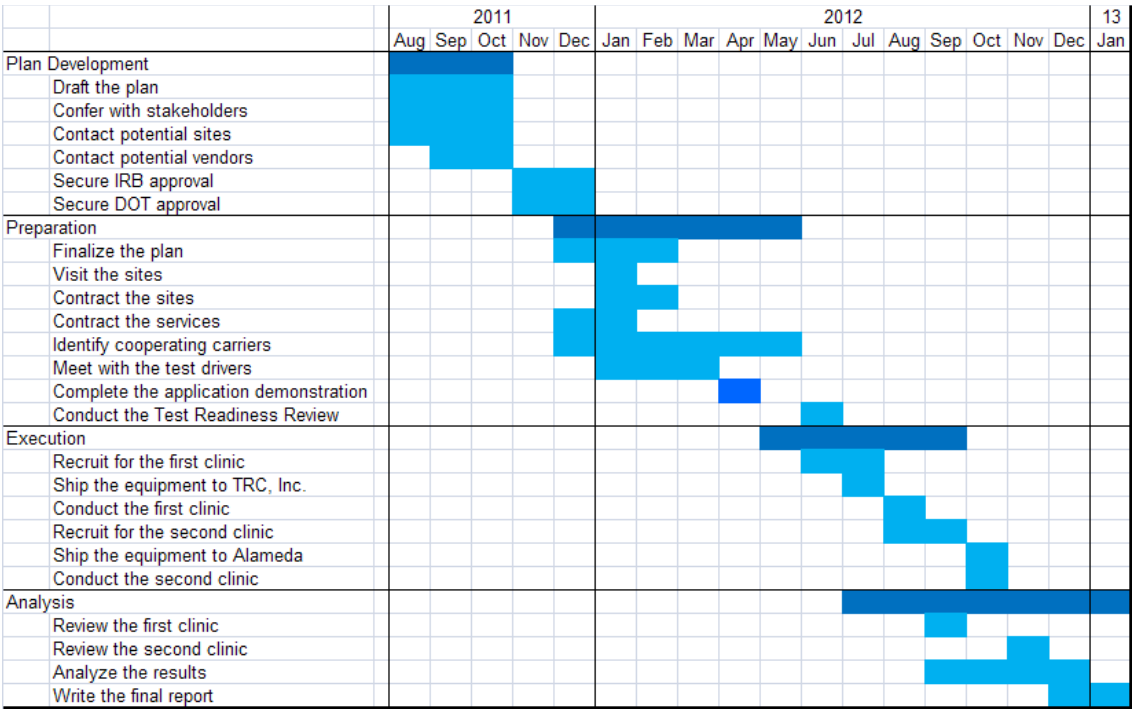


Figure 2-1. Schedule for the Driver Clinics task.

2.2 Organizational Structure, Management, and Staffing

Battelle has primary responsibility for planning and executing the driver clinics. Battelle and it subcontractors are the team conducting the entire Connected Commercial Vehicles project. The subcontractors are

- Mercedes Benz Research and Development North America (MBRDNA)
- Daimler Trucks North America (DTNA) Advanced Research NAFTA
- University of Michigan Transportation Research Institute (UMTRI)
- DENSO INTERNATIONAL North America Research Laboratory (NARL)
- Meritor WABCO

UMTRI will support the clinics by providing a remote vehicle. UMTRI will outfit the vehicle with an Aftermarket Safety Device (ASD) to be provided by U.S. DOT. UMTRI will be responsible for the operation of the DAS in each vehicle during the clinics and securing the data from them.

Battelle will hire service providers to assist with the clinics. Automotive Events supported the light vehicle Driver Acceptance Clinics and will have a similar though more limited role in the commercial vehicle Driver Clinics. Automotive Events will provide temporary equipment and non-technical personnel at the Alameda clinic and will transport the vehicles between clinic sites. Delve, a recruiting firm for consumer opinions, will be responsible for screening and scheduling participants.

Professional test drivers hired from TRC Inc. will ride with the participants in the host vehicles as test conductors. Two additional TRC Inc. professional test drivers will drive the remote vehicles that are moving during the scenarios.

At least three Battelle staff will be on site during each of the clinics. Doug Pape is the clinics task manager. Jason Holdridge is the lead engineer for the task, and Dr. Rosalee Meyer is the human factors lead.

The organization chart is in Figure 2-2.

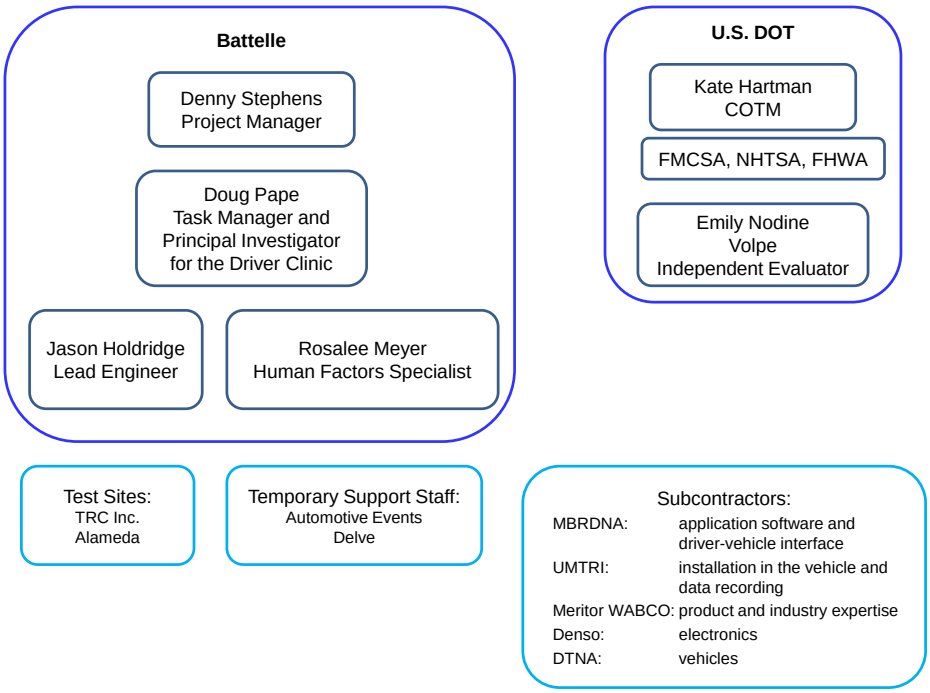


Figure 2-2. The driver clinics will require coordination between groups within Battelle, subcontractors on the Battelle team, service providers hired for the clinics, and the U.S. DOT.

2.3 Approvals that Must Be Secured

A number of stakeholders will review this test plan from diverse perspectives. All stakeholders will have the opportunity to review this test plan in its mature form. Battelle's internal Institutional Review Board and Battelle's safety team will formally review the plan as a whole and particularly Section 7.0 for considerations under their respective purview.

2.3.1 U.S. DOT

The United States Department of Transportation is the client for this work. The results from the Driver Clinic task and from the project as a whole must support the broader objectives of the U.S. DOT. The U.S. DOT Government Technical Manager is with the ITS Joint Program Office. Data must be collected in a way that supports the analysis by the project's independent evaluator, the Volpe National Transportation Systems Center.

2.3.2 IRB

Battelle's Human Subjects Institutional Review Board (IRB) has a legal and ethical obligation to ensure that the interests of the driver subjects in the clinics are properly protected. Before initiation of the study, the protocol, recruiting materials, informed consent form, and any written materials that will be made available to participants will be submitted to the Manager of the Battelle Institutional Review Board, for review and approval. The Principal Investigator will ensure IRB compliance and provide a copy of the written IRB approval of the protocol and related materials to U.S. DOT prior to initiation of the study. Recruiting of individual drivers will not begin until approval has been obtained. Protocol changes will be submitted to the Battelle IRB as a protocol amendment. Written documentation of IRB approval is required before the amendment can be implemented.

2.3.3 Team

Members of the contractor team will have the opportunity to comment on the plan. Members' interests will correspond mainly to their respective contributions to the project.

2.3.4 Safety

The protection of human safety is paramount in all experiments. Moving vehicles present the possibility of injury if maneuvers are poorly planned or carelessly executed. Battelle's Systems Development Product Line has an established procedure for hazard analysis and safety. Line management, safety officers, project personnel, and independent reviewers will review the plans and meet to critically review the protections.

2.3.5 Test Sites

The host sites will expect the safety of the participants and their own personnel. They will be concerned that the clinics not modify or damage their physical facilities. The logistics of preparing for and conducting the clinics should not interfere with other ongoing activities.

Part of the initial discussions with the test sites will be to learn their concerns and develop ways to meet them. The host sites will have the opportunity to review the mature test plan and request changes.

2.4 Management Risks

The Draft Project Management and Work Plan for this project [8] lists a number of project-level management risks that could affect this task. Table 2-2 identifies risks that are unique to the Driver Clinics and the Performance Tests.

A number of the project-level risks, including slow delivery of the tractors and trailers, and challenges in first-time integration of OBEs in commercial motor vehicles, will affect the ability of this task to begin its experimental work on time. A key milestone is the Application Demonstration in Task 4, which indicates that the modified vehicles are ready for subsequent testing tasks. This plan is being developed on the assumption that the Application Demonstration will be completed on schedule in April 2012.

Table 2-2. Summary of Technical and Programmatic Risks.

Item	Potential Risk	Description	Mitigating Strategies & Controls	Status
1	Inability to recruit a sufficient number of participants	Cannot achieve the desired number of participants.	• Participants will be recruited through a variety of means, including through carriers to identify individual employees. • The incentive will be slightly above the usual hourly rate for truck drivers.	Initial contact with a small number of carriers has been made.
2	Participants fail to arrive on schedule for their turn.	Cannot achieve the desired number of participants.	• Participants will receive a "reminder call" on the day before their appointment. • Adjustments can be made to recruiting and scheduling.	
3	Slippage in delivery of trailers due to high competitive demand	Schedule compression	• Project management is monitoring the situation. • If necessary, trailers can be rented for a short term.	Trailers are awaiting administrative actions.
4	Delay in receiving certified ASDs and RSEs	Schedule compression	• Project management is monitoring the situation. • Clinic preparation can be scheduled among testing days for application demo or interoperability testing.	
5	Weather significantly delays the clinics	The clinics can continue in light rain but not heavy rain.	• Flexible scheduling at TRC Inc., will allow a rain day if necessary.	John Thorne of Automotive Events has told us that average monthly rain in Alameda in late summer is a fraction of an inch.
6	In-vehicle time cannot be reduced to permit a sufficient throughput rate	Cannot achieve the number of participants or have to pay for more days of track and staff time.	• Professional test drivers will practice the routine before the clinic and develop efficiencies. • Scenarios will be eliminated if necessary.	Further discussion when the service providers are under contract.
7	Test sites cannot be booked at times consistent with the project's schedule		• Sites with flexible scheduling have been selected. • Sites will be booked well in advance.	Alameda is lightly used. TRC Inc. can be booked in single days interspersed with other activities.

Item	Potential Risk	Description	Mitigating Strategies & Controls	Status
8	Harm to a participant	Breach of confidentiality or other violation of protocol	• Participants will be identified only by first name and code number during the driving and interviews • Records containing identifiable information will be kept secure. • All staff working with the participants will be trained in IRB practices.	Protections are being planned and reviewed.
9	Equipment failure delays testing.	The OBE will have been installed in the host vehicles for only a matter of months at the time of the clinics.	• Having two host vehicles on site will allow one to continue running. • Technicians from MBRDNA will be on call to troubleshoot the equipment.	
10	Vehicle crash	A tractor crashes during testing, driver clinic, or transport. This would cause property damage, project delay, and possible personal injury.	• Only qualified drivers will operate the trucks. • Test and Clinic plans will include a hazard analysis, and safety practices will be followed. • The project manager will work with Battelle's risk officer to mitigate the financial consequences.	Safety measures are being planned and reviewed.

3.0 ELEMENTS OF PLANNING

This chapter presents the components of the clinics and their preparation.

Figure 3-1. Red, white, and blue Cascadia Tractors for this project.

3.1 Vehicles

The host vehicle to be driven by the participants during the Driver Clinics will be a Freightliner Cascadia tractor with a high-roof sleeper body (the white tractor in Figure 3-1) or a mid-roof sleeper (the red tractor). The tractor will pull a 53-foot-long van semitrailer, which will be empty during the clinics. These vehicles were purchased specifically for this project. Wireless safety units manufactured by subcontractor Denso will have been integrated in the tractors. The tractor will have a Data Acquisition System (DAS) for recording dynamic engineering data.

One remote vehicle, a Honda Accord provided by UMTRI, will be equipped with an ASD to broadcast its position and at least enough vehicle status information for EEBL. This vehicle will also have a DAS.

A second remote vehicle will be a van truck with a bed length of approximately 10 ft and an overall height of 9 ft. The purpose of this vehicle will be to block the participant's view of the first remote vehicle in some of the scenarios. This van truck will not be equipped with V2V capability or DAS, and it will be rented from a local retailer for the clinics.

The clinics anticipate having two tractor-semitrailer combinations available. The participant in one tractor will be parked, debriefing the previous scenario and preparing for the next scenario, while the participant in the other tractor is driving a scenario. Only one remote light vehicle and one remote small truck are required.

The fleet of vehicles as depicted in illustrations is in Figure 3-2. The host vehicle (HV) is the tractor-semitrailer driven by the participant. The first remote vehicle (RV-1) is shown in the figures as an equipped passenger car colored red. Its applications are not necessarily active. A third vehicle (RV-2) is a 10-foot-bed single-unit van truck. It is occasionally used to block the participant from seeing the first remote vehicle. The blocking vehicle in the light vehicle clinics

was a passenger car, but a participant in the cab of the host vehicle will easily see over the passenger car.

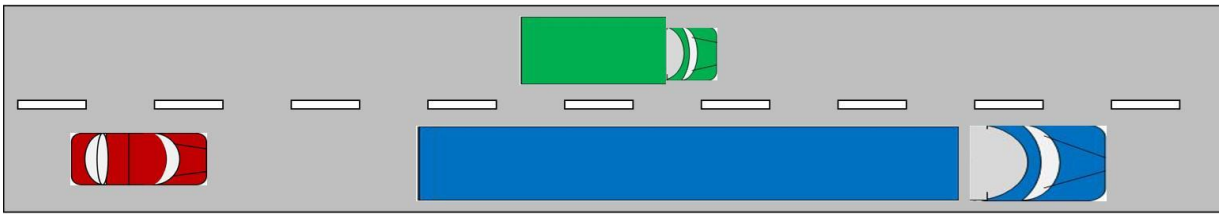


Figure 3-2. The scenarios will have the participant driving the host vehicle (blue) and interacting with a passenger car (red). Occasionally a van truck (green) will block a sight line.

3.2 Sites

Battelle recommends that the two clinics be held at the Transportation Research Center Inc. (TRC) in Ohio, and at the former Alameda Naval Air Station in California. Both sites have long straight paved tracks that will allow one scenario to be conducted immediately after another, without turning around the vehicle contingent. This will minimize the time that the driver participants are in the host vehicles and allow the greatest throughput rate. The Alameda location is also the site of a light vehicle Driver Acceptance Clinic, so much of the preparation for conducting a clinic there can benefit the commercial vehicle clinics. TRC Inc. will provide drivers for the host and remote vehicles. Because they are already on site at the clinic location, the preparation days and even the clinic days need not be consecutive, allowing greater flexibility in scheduling.

Table 3-1 summarizes the schedule of sites and participants for the Driver Clinics task. Details of the recruiting and scheduling are in Sections 5.2.2 and 5.3.4.

Table 3-1. Overall schedule of clinics and participants.

Site	Number of Clinic Days	Number of Participants per Day	Total Number of Participants	Comments
TRC Inc.	3	24	72	Half-day sessions on six non-consecutive calendar days
Alameda	1-1/2	24	36	The second day will end early for packing.
TOTAL	**4-1/2**	**--**	**108**	**Clinics will be adjusted to achieve at least 100 total participants.**

Automotive Events will be hired to provide support services for the clinics. The facilities and staff of the TRC Inc. will be sufficient for most of the services needed in Ohio; the role of Automotive Events will be greater at Alameda, which has little in the way of buildings and staff. Drivers who are veterans of the light vehicle Driver Acceptance Clinics will be hired through Automotive Events to aid in the detailed planning, though not the actual execution, to provide continuity between the light and commercial vehicle clinics.

Criteria for selecting the two sites were:

- Geographic diversity (one generally in the eastern part of the U.S. and one in the west)
- Ability to accommodate the applications (which requires about a mile straight, an intersection mockup, and preferably a loop)
- Convenience for planning
- Schedule accommodation. The two sites were selected in late fall 2011, with the clinics themselves in the late summer of 2012.

3.2.1 Transportation Research Center Inc.

The Transportation Research Center Inc. is approximately one hour northwest of Columbus, Ohio. It is on U.S. Highway 33, a limited-access highway. The 9000-ft skid pad shown in Figure 3-3 is commonly used for stopping distance tests. The turn-arounds at the ends will allow host vehicles to enter the track at the test speed. The entrance to the skid pad is at a right angle to the traffic direction, allowing the busy intersection scenario. TRC Inc. will provide office space and support staff for the clinics.

The proximity of TRC Inc. to Battelle and its staff CDL-A holders will permit the utmost flexibility in scheduling the preparation and clinic days. The host vehicles will already be on site for the interoperability testing by VRTC. The clinic days will not be consecutive. Intervening days will allow TRC Inc. to accommodate its other customers and will allow the clinic team to make minor adjustments to procedures or the recruiting approach.

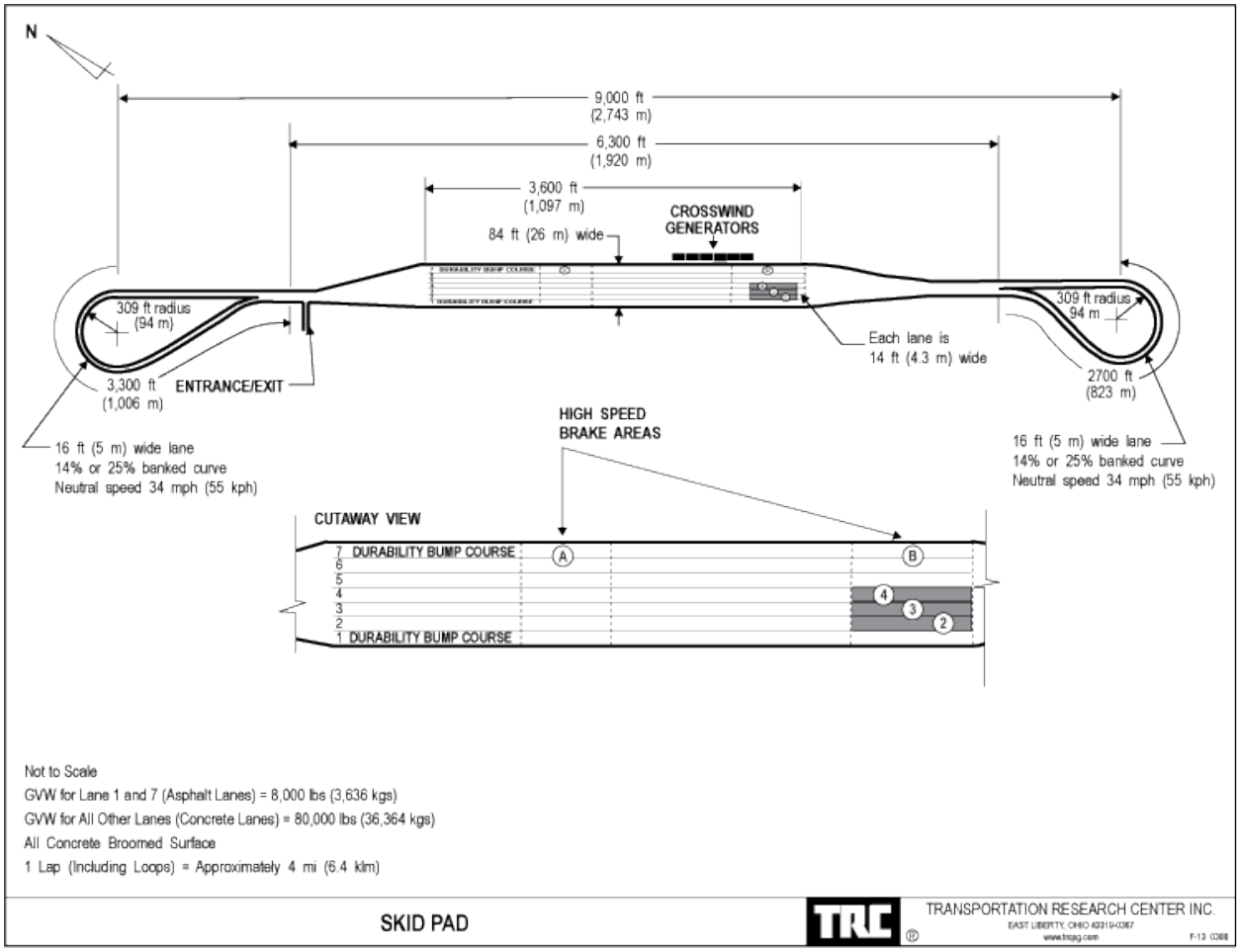


Figure 3-3. The Ohio clinic will have exclusive use of the Skid Pad at TRC Inc.

3.2.2 Former Alameda Naval Air Station

The final and westernmost light vehicle Driver Acceptance Clinic will be at the former Alameda Naval Air Station near Oakland, California, Figure 3-4. The runway at the airport provides a wide, open space for running the scenarios, and its length provides adequate room for sequentially conducting scenarios. The site is in a large population center where many truckers can be found. Because all of the clinic staff will have traveled to the site for the clinic, the one preparation and two test days will all be consecutive.

TRC Inc. can supply radios for the test conductors, private offices for the clinic staff, and a copy machine, catering arrangements, and other materials for conducting the clinics. All of this equipment will have to be brought to Alameda. Both sites will require a small amount of additional signage for the participants.

Figure 3-4. The California clinic will be at the former Alameda Naval Air Station.

3.3 Scenarios

MBRNA is developing the following applications for commercial vehicles:

- Forward Collision Warning (FCW)
- Blind Spot Warning/Lane Change Warning (BSW/LCW)
- Intersection Movement Assist (IMA)
- Emergency Electronic Brake Light (EEBL).

Each of these applications will be demonstrated to the participant through one or more scenarios illustrated below. The sequencing of the scenarios will be worked out with the test drivers when they are under subcontract. To provide a greater driver throughput at the Alameda clinic, one or more of the scenarios may be omitted.

Most of the scenarios for the commercial vehicle clinics will be near duplicates of those executed during the light vehicle clinics, to permit a close comparison of the two projects. The primary difference is that the host vehicle is a tractor-semitrailer. The second difference is that the blocking vehicle will be a van truck rather than a passenger car. The van truck will obscure the

view of the test participant better than would a passenger car. The speeds in most cases are identical to those in the light vehicle clinics; the distances have been adjusted for the greater stopping distance of the commercial vehicle and the corresponding timing differences in the applications.

A fifth application, the Curve Speed Warning, is unique to commercial vehicles. The application depends on Roadside Equipment (RSE) to broadcast the location and posted speed of the curve. If an RSE is available in time to complete testing of the application, the application will be considered for the clinics.

3.3.1 EEBL: HV Approaches Decelerating RV with an Obstructing Vehicle

In this scenario the EEBL system will issue a warning when the brakes of a RV-1 within its forward path and direction of travel have been applied in an abrupt manner, and the line of sight to the braking vehicle is blocked by a RV-2 (i.e., the small truck). This scenario demonstrates the EEBL performance in the presence of obstructing vehicles or adverse weather conditions. An illustration of this scenario is shown in Figure 3-5.

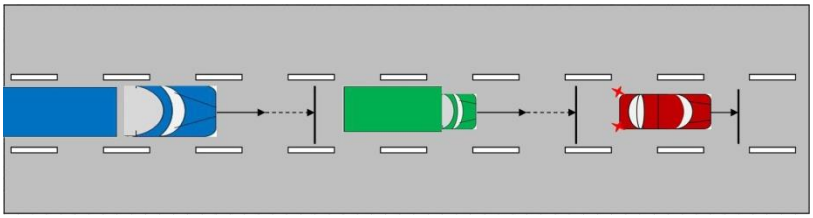


Figure 3-5. EEBL: RV-1 in the same lane as the host vehicle, with a blocking vehicle RV-2.

3.3.2 FCW: HV Encounters Stopped RV in the Same Lane

The scenario begins with the HV traveling on the road. Ahead of it in the same lane is a single stationary RV-1. This scenario demonstrates that countermeasure's collision alerts are generated when there is a FCW threat along the HV path. An illustration of this scenario is shown in Figure 3-6.

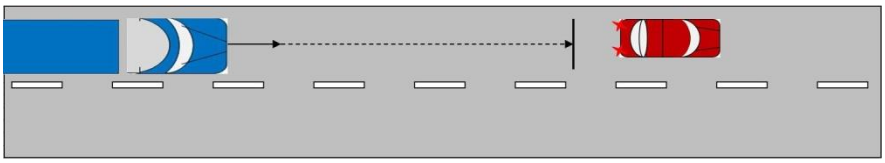


Figure 3-6. FCW: RV-1 stopped in the same lane as the HV.

3.3.3 FCW: HV Following RV-2, which Changes Lanes to Reveal Stopped RV-1

This scenario begins with the HV traveling on a straight road in the left lane. Ahead of the HV, in the same lane, is a single RV-2 traveling at the same speed as the HV. The HV is following RV-2 at a small but safe distance. Far ahead of the RV-2 is another vehicle, RV-1, stopped in the lane. RV-2 changes lanes to avoid the stopped RV-1. During this scenario, the HV maintains a constant speed until the alert is triggered. The participant brakes, and the HV comes to a complete stop before a collision with RV-1. An illustration of this scenario is shown in Figure 3-7.

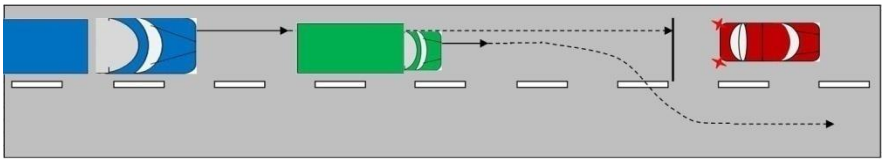


Figure 3-7. FCW: Lane change by RV-2 reveals stopped RV-1.

3.3.4 BSW/LCW: RV in HV's Blind Zone

The BSW application provides an advisory when the RV enters the blind zone on either side of the HV. As shown in Figure 3-8, the RV will begin to overtake the HV and dwell in its right side blind spot.

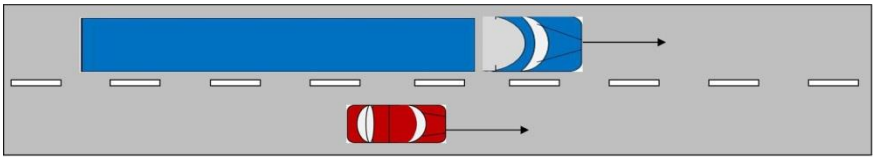


Figure 3-8. RV-1 in the blind spot.

3.3.5 BSW/LCW: HV Attempts a Lane Change, with RV in its Blind Zone

The LCW application provides a warning when the HV is signaling to turn or change lanes and an RV is currently occupying, or will soon be occupying, the blind zone on the corresponding side of the HV. An illustration of this scenario is shown in Figure 3-9.

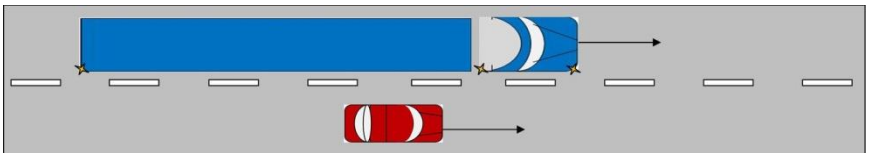


Figure 3-9. Lane change attempt with RV-1 in blind zone.

3.3.6 IMA: Stopped HV Enters an Intersection with RV Approaching from the Right

The objective of this scenario is to demonstrate that an alert will be given when the HV is stopped at the intersection and then starts slowly moving forward when an RV approaches the intersection. As shown in Figure 3-10, the HV is stopped and the RV is approaching the intersection at a constant speed. When the HV releases the brake and begins slowly moving forward, the application will issue a warning.

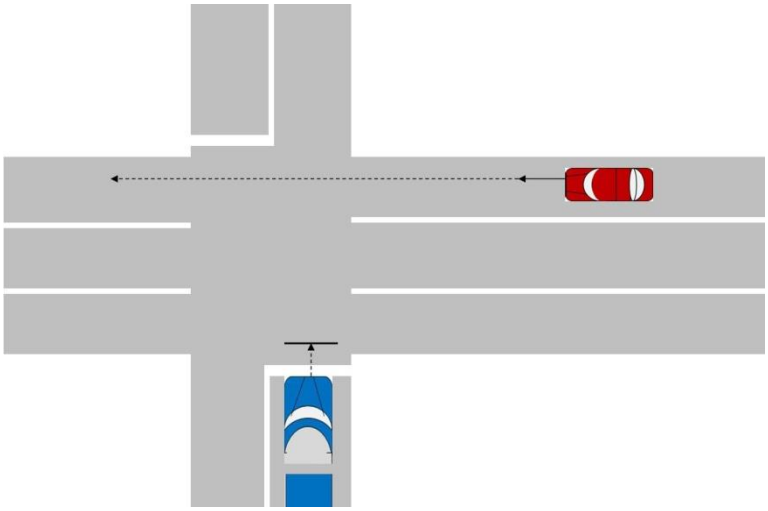


Figure 3-10. Stopped HV rolls into intersection with cross traffic RV-1 approaching.

3.3.7 CSW: HV Approaches a Curve at a Speed Substantially Higher than Marked

This scenario demonstrates an application that is unique to commercial vehicles. Entering a curve too fast can be hazardous to any vehicle, but a vehicle with a high center of gravity is susceptible to rollover, which can be especially severe. As shown in Figure 3-11, the HV will drive on a straight segment and approach a curve at the end of the skid pad at TRC Inc. or is laid out in cones at Alameda. The safe speed for the curve will be 35 mph and the HV will approach at 35 mph, but the RSE will indicate a recommended speed of 25 mph.

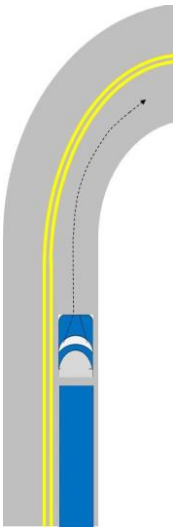


Figure 3-11. HV approaches a curve at a speed higher than indicated by the RSE.

3.4 Driver Participants

The primary qualification for participants is to be licensed to drive a tractor semitrailer combination. Drivers will be recruited through carriers and various means of advertising.

3.4.1 Qualifications for Participants

Male and Female participants will be eligible for the study if they meet all of the following criteria:

1. Participant is an adult (at least 21 years of age) with a valid Class A Commercial Driver License (CDL-A).
2. Participant currently drives a tractor trailer
3. CDL is not suspended or revoked, and driver is not out of service.
4. Participation in the study would not violate Hours of Service regulations if it were on a public highway.

5. Participant, if an employee driver, has made scheduling arrangements for work following the "on duty" time at the clinic.
6. Participant has not had more than two moving violations in the past three years.
7. Participant has not caused an injury crash in the past three years.
8. Participant is not taking medicines or other substances that may interfere with driving.
9. Participant is in reasonably good health, as evidenced by valid CDL-A and as affirmed by the participant.
10. Participant is willing to participate in an in-vehicle evaluation and in-depth interview with a total time commitment of approximately two hours.
11. Participant and immediate family members are not employed in the design, engineering, or testing of technologies for automotive or trucking applications. Participant and immediate family members are not an employee of the prime contractor, a subcontractor, or one of the service providers hired for the clinics.
12. Able to speak, read, and adequately comprehend English.
13. Willing and able to give written informed consent.

Greeters at the clinic will ask to see the participant's CDL to confirm that it is valid and verify the driver's age. The greeter will write the participant's date of birth on the informed consent form to document that the CDL was checked. Information for all other eligibility criteria will be self reported by the participant.

The recruiting process will attempt to bring participants with an age distribution approximating that of the truck drivers in the United States, which is indicated in Table 3-2. Both Ohio [5] and California [4] permit applicants for a CDL-A to be as young as 18 years. Federal Motor Carrier Safety Regulations [2] require that drivers in interstate service be at least 21 years of age. Because this project is for the United States Department of Transportation, FMCSA rules will apply, and the minimum age for participation will be 21 years.

Table 3-2. Age distribution of truck drivers in the truck transportation industry. From Table 2.7 of [6]

Age Category	Percentage of Truck Drivers
21-24	3.4%
25-29	9.0%
30-34	12.0%
35-44	32.8%
45-54	26.3%
55-64	13.9%
65+	2.8%

Drivers will be asked other demographic information (e.g., type of employment, years of experience, types of routes driven) when they arrive at the clinic, but there will be no attempt to establish diversity in a category other than age. The age distribution will be an approximation; eligible drivers will not be dismissed based solely on age, if an age category has sufficient numbers of recruits.

3.4.2 Recruitment Approach

Truck drivers are a small fraction of the population with unique scheduling constraints, and cannot be recruited through means for finding subjects for evaluating consumer items.

Initial advertising and publicity will be handled by many methods and media. The recruiting process will begin with personal contacts to carriers that operate near one of the clinic locations. Company or terminal management will be asked to spread the word of the clinics to their drivers and adjust work schedules as necessary. Potential participants will also be contacted directly through social media web sites that attract professional drivers. Notional recruitment literature is in Appendix 0.

All recruitment methods will direct interested persons to contact Delve (by phone or by web site). From this point, all prospective participants will go through the same steps. The screener will explain the purpose and nature of the study, using the screening questionnaire described in Section 4.1.2. Individuals who are still interested will be asked to affirm that they meet the basic requirements of the study (i.e., that they have a valid CDL-A and are in reasonably good health). Individuals who have affirmed their qualification and understanding will be allowed to schedule a time slot at the clinic.

Potential participants will advised that will be that they will be compensated for their time at the clinic. They will be reminded that FMCSA Hours of Service (HOS) rules require that the time at the clinic be logged as "on duty." [3] (Approximately one hour will be "on duty—driving.") The "on duty" time will prevent a day that may otherwise have been a day off from counting toward the 34-hour restart, and it will affect the participant's ability to schedule work in the upcoming week.

3.4.3 Incentive Payments

During the recruitment process, potential subjects will be offered a payment as an incentive to participate in the study. Table 3-3 lists the payments that will be given to subjects for various levels of participation.

Subjects who complete the drive and post-drive questionnaire will receive $200. Subjects who complete the drive, post-drive questionnaire, and in-depth interview will receive $125. The $25 incremental incentive is offered for the in-depth interview to encourage participants who have completed the driving portion to remain at the study for another approximately half hour.

Subjects appearing at the clinic site who do not have a valid Class A CDL will not be permitted to participate and will not receive payment.

Potential subjects who choose not to sign the informed consent document will not be paid. Potential subjects who do not appear for their appointment will not be paid, but they will not be penalized in any way: their employer will not be notified of their non-appearance, nor will they be barred from future studies. Late arriving participants will be paid according to the normal schedule if they can be accommodated; if not, they may receive the minimum payment at the discretion of the Principal Investigator.

In addition to the incentive payments, eligible participants who have driven a long distance to reach the clinic will be given a gas card to compensate for their travel expenses. A card with a value of $25 will be given for approximately every 25 miles of one-way distance between the participant's origin and the test site.

Table 3-3. Schedule of incentive payments.

Condition	Payment
Subject fails to appear at the test site.	$0
Subject appears at the test site but does not meet objective selection criteria, e.g., does not have a valid CDL-A.	$0
Subject chooses not to sign the ICF	$0 (up to $50 at the discretion of the principal investigator)
Subject begins the pre-drive questionnaire and elects to withdraw before completing the driving portion.	up to $200, at the discretion of the principal investigator
Subject completes the driving portion and post-drive questionnaire but is not selected for an in-depth interview or elects to withdraw before the in-depth interview.	$200
Subject completes the entire study, including the in-depth interview.	$125
Subject signs the ICF but cannot complete the study because of equipment failure, bad weather, or other reason beyond the subject's control.	$200

Note: The gas cards for travel are in addition to these incentive payments.

This page intentionally left blank.

4.0 DATA COLLECTION

Two categories of information will be collected for the driver clinics. The first set will be qualitative, subjective data about the driver's impressions about the system, and the second will be performance data collected from the DASs on the host and cooperative vehicles.

4.1 Instruments for Human Data Collection

Participants will provide information at several instances before, during, and after they drive the host vehicle. This section outlines the purpose and content of the data collection instruments and other materials seen by participants. The materials are in Appendix B. Battelle's Institutional Review Board will review the content of all materials seen by participants, the methods of using them, and the procedures for protecting the data they yield, as discussed in Section 7.1.

The data collection instruments are heavily based on the instruments for the light vehicle clinics, with modifications for commercial vehicles. Table 4-1 lists the data collection materials and participant identifiers for each. Records in which participants can be identified (either by full name or face) will be available only to DOT and Battelle research staff. Records in which participants are identified by code numbers will be available to all staff working on the project. The code number with be the study location (OH or CA) followed by a unique number.

Table 4-1. Participant Data Collection and Document List

Documents	When	How Participants are Identified
Promotional Recruiting Documents	recruiting	(no data recorded)
Screening Questionnaire	recruiting	full name
Re-Screening Checklist	at the clinic	(no data recorded)
Informed Consent Form and Self-Certification	at the clinic	full name and code number
Pre-Drive Questionnaire	at the clinic	code number
In-Vehicle Protocols	at the clinic	(no data recorded)
In-Vehicle Debrief Questionnaire	at the clinic	code number
In-Vehicle Video Recording	at the clinic	code number, first name, face, and voice
Post-Drive Questionnaire	at the clinic	code number
In-Depth Interview	at the clinic	code number
Audio Recording of the Interview	at the clinic	code number, first name and voice
Cash Receipt	at the clinic	full name

4.1.1 Promotional Recruiting Documents

Terminal managers may invite us to put a notice on a bulletin board in the driver lounge. When we first contact terminal managers or potential participants, we will provide them brochures to explain the study. Online advertising, postings, and a Facebook page will reach other contacts. The purpose of these documents is to present information to potential participants and not to record information about them. Promotional documents are in Appendix B-1.

4.1.2 Screening Questionnaire

The purpose of the screening questionnaire is to determine whether applicants are qualified and interested to participate in the driver clinic. Initial contact with the applicants is likely to be through a telephone call or web site. Their name, age, answers to screening questions, and contact information for sending the map and reminder message will be recorded. The screening questionnaire is in Appendix B-2.

4.1.3 Informed Consent Form (ICF) and Self-certification

The greeter will re-screen participants, to verify that they meet the entry criteria. Self-certification consists of the following: The greeter will repeat the complete screening questionnaire and write the participant's date of birth on the ICF to document possession of a valid CDL. Participants will, with their signature, self-certify on the ICF that they are at least 21 years of age, have a valid Class A Commercial Drivers License (CDL-A), and have not had more than two moving violations or caused an injury crash in the past three years. They will also certify that they will log their participation time as "on duty" and understand the effect of participation on their work schedule. The complete list of qualifications listed in Section 3.4.1.

The purpose of the ICF is to describe to potential participants the purpose, risks, and benefits of being in the study. The ICF is in Appendix B-3

4.1.4 Pre-Drive Questionnaire

The pre-drive questionnaire will collect descriptive data and assess current attitudes towards the system and currently deployed safety technologies. The greeter will administer the pre-drive questionnaire before the orientation brief, in which the system will be briefly described. The survey will include questions about driver demographics (age, gender), current vehicle and work experience, (years experience, vocation, types of routes driven), and equipment experience (types of vehicles, in-vehicle electronic and advanced safety system operation, other in-cab electronics). The pre-drive questionnaire is in Appendix B-4.

4.1.5 In-Vehicle Protocols, Debrief Questionnaires, and Video Recordings

Test conductors will follow the in-vehicle protocols for each application. The in-vehicle debrief questionnaires are in Appendix B-5. No participant data will be collected on the protocols.

The in-vehicle debrief questionnaires collect participants' immediate impression of the application, comprehension of the warning, and efficacy of the application. Participants will also be asked how useful they feel the application would be in the real world. Responses will be measured on a 7-point Likert scale (example: Strongly agree – Strongly disagree). The in-

vehicle debrief questionnaires are in Appendix B-5. The test conductor, a CDL-A holder, will enter participant responses on the questionnaires.

The DAS will be recording video and audio in the cab in addition to the engineering data.

4.1.6 Post-Drive Questionnaire

All participants will complete a questionnaire following their in-vehicle session. The post-drive questionnaire will ask participants about their opinions of the applications after the in-vehicle session. Participants will be asked to rank order the applications from most to least useful. Responses will be measured on a 7-point Likert scale. The post-drive questionnaire is in Appendix B-6.

4.1.7 Post-Drive In-Depth Interview and Audio Recording

The interviewer will conduct a follow-up interview with a portion of the participants. The objective of the in-depth-interview is to collect qualitative narratives to add depth to in-vehicle questionnaire data. The interviews will extend the findings of the post-drive questionnaire to discuss drivers' attitudes to the applications, real world examples in which each application may or may not have been useful, and desirability and efficacy of the applications. The concluding interview may delve deeper into the follow-up questions. During the interview, questions regarding frequency and severity of "real world" scenarios will also be asked. Responses will be captured as free text and will be attached to the post-drive questionnaire. The interview will be audio recorded. The guide for the interviews is in Appendix B-7.

4.1.8 Cash Receipt

Participants will be paid in cash according to the schedule in Table 3-3. The information on the receipt will be the amount paid, the participant's printed name, the participant's signature, and the date. The receipt is in Appendix B-8.

4.2 Engineering Data

The host vehicle and the passenger car remote vehicle will both be equipped with a DAS. The DAS records acceleration, position, and information on the truck's performance and status from the truck's J1939 bus. The DAS in the host vehicles will be the same that will be used for the ensuing model deployment study. UMTRI and the independent evaluator are currently finalizing specifications for the DAS. Planned categories of data include:

- In-vehicle (speed, accelerations, turn signal…)
- Subject sehicle GPS (location, heading…)
- Lane tracking sensor (boundary type, offset…)
- Forward radar (range, range rate…)
- OBE DVI (alert type, alert level…)
- OBE remote vehicles (location, state…)
- OBE general and video.

The participant's face and voice will be recorded when the participant is in the tractor cab. Two cameras will provide views outside the cab: one in the windshield looking forward and one on the right side mirror directed at the truck's blind spot.

Data from the DAS is stored in a database. The database is a format that can be used by the independent evaluator. The clinic team will confirm at least daily that the DAS is working properly by spot checking the data, and data will be backed up at least daily.

5.0 PROCEDURE FOR THE CLINICS

This section has the steps of actually conducting the clinics. The first two subsections have the steps to be completed in the months before the team arrives at the clinic site. The third subsection has the steps the team will carry out at the site. The final section lists the sequence of the clinic as it will appear to the participants.

5.1 Common Preparatory Activities

In the early months of 2012 there will be many detailed arrangements to make to prepare for the clinics. Contracts need to be established with the host sites and service providers. Driver needs to get acquainted, thresholds need to be de-tuned, timing needs to be practiced. In-cab instructions and questionnaires need to be trialed.

5.1.1 Personnel Assignments

The staff needed to execute a clinic are listed in Table 5-1. Staff from TRC Inc. will handle most of the support jobs there. The team will need to provide more of its own support at Alameda. In the weeks prior to each clinic, individuals will be assigned to these jobs. The host site may require that other staff be present as well; these arrangements will be made.

At least three Battelle staff will be at every clinic. The Principal Investigator will oversee the clinic and ensure that it is conducted according to the protocol. The primary duty of the Human Factors Specialist will be to conduct the in-depth interviews.

The Greeter will be the primary point of contact for the participants during the times when they are not in driving or in the interview. The Program Coordinator will greet the participants as they arrive, take their information, and keep them comfortable when they are waiting for their turn to drive or be interviewed. The Greeter will usually be responsible for giving the pre- and post-drive questionnaires to the participants. The Human Factors Specialist or Lead Engineer may assist with the questionnaires when a number of simultaneously arriving participants keep the Greeter busy.

The Informed Consent process will be given by a Battelle staff member, usually the Principal Investigator.

Most in-depth interviews will have two staff members present. One of them will be the Human Factors Specialist, and the other will usually be a Battelle staff member.

Four professional test drivers will be needed to execute the scenarios. Two will be in the two host vehicles with the participants, and two will drive remote vehicles. All four drivers will have a CDL-A and will be able to serve in any of the four capacities.

TRC Inc. staff will fill a number of minor roles. Automotive Events will provide a Producer to fulfill these roles in Alameda.

Table 5-1. Staff who need to be on site during the clinics.

Role	Duties	Organization
Principal Investigator	• Ensure that the clinic is conducted according to the protocol • Explain the ICF to participants • Support the Human Factors lead in the in-depth interviews	Battelle
Lead Engineer	Support the Principal Investigator in all duties.	Battelle
Human Factors Specialist	• Lead the in-depth interview • Interact with IRB, address human subjects issues	Battelle
Producer	Ensure that all support equipment and services are in order.	Automotive Events in California
Greeter	• Greet the participants as they arrive • Screen participants • Administer pre- and post-drive questionnaires • Keep them comfortable as they transition from one stage to the next	TRC Inc. in Ohio Automotive Events in California
Test Conductor in the first host vehicle	• Ride with the participant • Explain the scenarios to the participant • Record the participant's immediate impression of the scenarios • Control traffic on the test track	TRC Inc.
Test Conductor in the second host vehicle		TRC Inc.
Professional Test Driver #3	Drive the sedan remote vehicle	TRC Inc.
Professional Test Driver #4	Drive the single-unit truck remote vehicle	TRC Inc.
Shuttle Driver	Transport the participants from the guard house to the offices and from the offices to the Skid Pad	TRC Inc. (not needed at Alameda)

Battelle will provide an exhibit booth or posters to introduce the participants to connected vehicle technology. The materials will be based on the Outreach efforts of Task 11. There will be reading material and a computer with Internet connection to help the participants relax as they wait their turn for driving. DOT may wish to provide further safety literature for the participants to read or take home.

5.2 Per-Site Preparatory Activities

A set of preparatory steps will need to be completed twice, once for each site. They are listed here.

5.2.1 Pre-Clinic Visit

Clinic staff will visit each site months before the clinic to inspect the facilities, choose locations for support equipment, and plan the scenario routes. TRC Inc. is near to Battelle and will likely be visited several times by Battelle staff; at least one visit will include an Automotive Events support person and the lead test driver. The visit to the Alameda site will be near the time of the light vehicle clinic there, January 18 to 21, 2012, and the subsequent 100-car study.

Driving-related decisions to make during the visit or with information gathered from the visit include

- Two-lane zones, curved path or track if available
- Turn-around locations.
- Site-specific radio calls, egress points, RV-2 parking
- Greeting and holding area for waiting participants
- Safe zone for observers

The entire team will develop a list of support equipment during the visit. Delivering and maintaining the equipment will primarily be the responsibility of Automotive Events. Support supplies may include

- Tents, tables, chairs
- A camper to serve as an indoor office and interview room
- Catering—snacks for the participants, lunch for the test personnel
- Temporary chalk, cones, rope, signs
- Secure storage of shipping materials and completed surveys
- Copy machine for ICF

The skid pad at TRC Inc. has a natural intersection-like entrance and turn-around at each end, which are well suited for the IMA and CSW scenarios respectively. Test personnel will inspect the pavement at Alameda to determine whether these two scenarios can be mocked up with cones.

During the visit, the team will coordinate with the site staff for severe weather plans, emergency plans (including first responders and the route to the nearest hospital), temporary staff, overnight security, and radios.

5.2.2 Recruiting

The process of recruiting participants includes outreach, identifying individuals, and screening potential participants.

Battelle will begin to contact carriers in the regions of the clinics well in advance of the clinics themselves. Communication channels for reaching drivers will be established and potential

participants will be advised of the upcoming clinics in advance. Actual recruiting and scheduling appointments will begin three to four weeks before each clinic.

Potential participants will be recruited, screened, and scheduled according to process in Section 3.4.2.

Table 3-1 in Section 3.2 listed the overall schedule for the clinics. The tables in Section 5.3.4. show how 28 participants can be accommodated in a full day or 14 participants in a half day. The light vehicle clinics scheduled nine participants for every group of eight slots, and the number who appeared was usually eight. If the commercial vehicle clinic experiences the same no-show rate, then 24 participants can be expected for the 28 slots scheduled daily. If the number of actual participants at the first clinic is substantially less than planned, then an extra day or possibly two should be added to the Ohio clinic. The ability to spread the non-consecutive clinic days over two or more weeks at TRC Inc. allows the flexibility to adjust recruiting and scheduling. If the no-show rate is too high, then a greater excess of participants can be recruited, with the possibility of working through lunch if turnout is high. An extra day at TRC Inc. can be added if necessary. Adding days to the California clinic is more expensive because all the staff have traveled to the site; the number of available slots can be increased by having participants drive a smaller number of scenarios. Part of the afternoon for the final day at Alameda will be for packing the equipment.

5.3 On-Site Activities

This is the work of the clinic staff during the clinic and in the days immediately before and after.

5.3.1 Ship the Equipment

The two host vehicles and the sedan remote vehicle will already be on site at TRC Inc. before the clinic begins because of the testing by VRTC. The remote single-unit truck will be rented and driven to TRC Inc. in time for the on-site preparation. Most of the support equipment and office supplies will already be at TRC Inc. Automotive Events will rent campers to serve as offices at Alameda and will bring portable office equipment and other support supplies. Food will be ordered. Battelle will bring copies of the printed materials for the week.

Automotive Events will drive the two host vehicles to California for the second clinic, with the remote sedan and various support supplies in one of the trailers. A remote single-unit truck will be rented near the site. Automotive Events will ship or order other support equipment as needed. Battelle will bring copies of the printed materials for the week.

5.3.2 Lay Out the Site

TRC Inc. will conduct a safety briefing for all clinic personnel before any of the outdoor work begins. Protocols for taking the participants will be developed during the early days of work, and a second safety briefing will be in order when all of the procedures are established.

The test drivers will place cones or temporary markers on the test track. Non-driving staff will arrange the office area for a suitable suite of spaces for greeting, administering written questionnaires, interviewing, and waiting.

Personnel assignments and duties will be confirmed.

5.3.3 Practice the Scenarios

Project personnel will drive the scenarios several times at each site before the participants appear. There are two reasons for this. The functionality of the connected commercial vehicle equipment must be verified at the clinic site, and the choreography of the scenarios must be arranged. At TRC Inc. this may be done over a period of two or three non-consecutive days. The same routine will be adapted to Alameda in the day immediately prior to the clinic.

The system functional test is a series of maneuvers, some of which may be the clinic scenarios, to verify the functionality of the system according to a pre-arranged sequence of tests.

The test personnel will drive each of the scenarios several times as though they were conducting them with participants. They will confirm that the radio signals are clear and sufficient, that the vehicles can be positioned, and that the course has adequate room to execute the scenarios with proper safety margins. Most importantly, they will confirm that a naïve participant reacting to the signals can stop the host vehicle without endangering personnel or property.

The test conductors will work to improve the safety, precision, and efficiency of the scenarios. They will do so by practicing their procedures and selecting the order the scenarios. One or more scenarios may occasionally be dropped from the list if a clinic becomes behind schedule. Candidates for omission are the EEBL and one of the forward collision scenarios because of their similarity. If practicing shows that a scenarios needs to be dropped more than occasionally, Battelle will consult with U.S. DOT and other team members.

5.3.4 Execute the Clinic

The morning and afternoon schedules for half-day clinics are in Table 5-2 and Table 5-3.The full-day schedule will be as in Table 5-4. The greeter, shuttle driver, and principal investigator will arrive at the site at 7:00 for the full-day and morning clinics to greet the first participants, who will be instructed to arrive before 7:30. While the first participants are reading the ICFs and pre-drive questionnaires, the test conductors will be checking the vehicles and equipment for proper operation. Two participants will be scheduled in every time slot because two CCV-equipped host vehicles will be available. The first pair of participants should be on the track by 8:30. Then a cycle will be established with participants in three stages at once: two taking the pre-drive questionnaire, two driving, and two in post-drive activities. The full-day schedule has a break for lunch, and the cycle is established again in the afternoon. The last pair of participants leaves the track at 5:00, and there is no interview of the final drivers so the clinic staff are finished at 5:30. The afternoon schedule is paced identically to the morning schedule, starting later.

TRC Inc. drivers are required to have a 15-min break after 2-1/2 hours of continuous driving, and they are allowed 45 min for lunch. The schedule provides a full hour for lunch in case the morning is slightly behind schedule. TRC Inc. will have extra test drivers trained in the clinic procedures in case the host vehicles need to keep running through lunch to maintain the schedule.

Table 5-2. Daily schedule for the morning clinics.

Hour	Participants to Arrive	Test Conductors	Interviewer
7:30	Pair 1		
8:00	Pair 2	pre-trip inspection	
8:30	Pair 3	Drive with Pair 1	
9:00	Pair 4	Drive with Pair 2	
9:30		Drive with Pair 3	In-depth Interview 1
10:00	Pair 5	Drive with Pair 4	In-depth Interview 2
10:30	Pair 6	break	In-depth Interview 3
10:45		Drive with Pair 5	
11:00	Pair 7		In-depth Interview 4
11:15		Drive with Pair 6	
11:30			(break)
11:45		Drive with Pair 7	In-depth Interview 5
12:00			
12:15	The greeter administers the final questionnaire.	The day is completed.	In-depth Interview 6
12:45	The greeter's day is completed.		The day is completed.

Table 5-3. Daily schedule for the afternoon clinics.

Hour	Participants to Arrive	Test Conductors	Interviewer
12:00	Pair 1		
12:30	Pair 2	pre-trip inspection	
1:00	Pair 3	Drive with Pair 1	
1:30	Pair 4	Drive with Pair 2	
2:00		Drive with Pair 3	In-depth Interview 1
2:30	Pair 5	Drive with Pair 4	In-depth Interview 2
3:00	Pair 6	break	In-depth Interview 3
3:15		Drive with Pair 5	
3:30	Pair 7		In-depth Interview 4
3:45		Drive with Pair 6	
4:00			(break)
4:15		Drive with Pair 7	In-depth Interview 5
4:30			
4:45	The greeter administers the final questionnaire.	The day is completed.	In-depth Interview 6
5:15	The greeter's day is completed.		The day is completed.

Table 5-4. Daily schedule for the full-day clinics.

Hour	Participants to Arrive	Test Conductors	Interviewer
7:30	Pair 1		
8:00	Pair 2	pre-trip inspection	
8:30	Pair 3	Drive with Pair 1	
9:00	Pair 4	Drive with Pair 2	
9:30		Drive with Pair 3	In-depth Interview 1
10:00	Pair 5	Drive with Pair 4	In-depth Interview 2
10:30	Pair 6	break	In-depth Interview 3
10:45		Drive with Pair 5	
11:00			In-depth Interview 4
11:15	(Greeter's lunch break)	Drive with Pair 6	
11:30	(Greeter's lunch break)		(break)
11:45		lunch	In-depth Interview 5
12:00	Pair 7 (arrive early if you want lunch)		
12:15			In-depth Interview 6
12:30	Pair 8 (arrive early if you want lunch)	(contingency)	
12:45		Drive with Pair 7	lunch
1:00	Pair 9		lunch
1:15		Drive with Pair 8	
1:30	Pair 10		
1:45		Drive with Pair 9	In-depth Interview 7
2:00	Pair 11		
2:15		Drive with Pair 10	In-depth Interview 8
2:30	Pair 12		
2:45		break	In-depth Interview 9
3:00	Pair 13	Drive with Pair 11	In-depth Interview 10
3:30	Pair 14	Drive with Pair 12	(break)
4:00	(The greeter's day is completed.)	Drive with Pair 13	In-depth Interview 11
4:30		Drive with Pair 14	In-depth Interview 12
5:00		The day is completed.	Administer the final questionnaire.
5:30			The day is completed.

These are tentative schedules. They will be adjusted in consultation with the test drivers after they are hired and have had an opportunity to practice the scenarios. The schedule shows the participants arriving in pairs. The length of the drive for most participants to TRC Inc. means they will arrive sporadically through the day. The greeter will attempt to bring the participants through their turn in the cab in the order they arrive at the testing office. TRC Inc. has an area where participants can sit, read, watch TV, and eat snacks while they wait for their turn.

5.3.5 Pack the Equipment

After the Ohio clinic, the supplies and the remote sedan will be loaded in the back of one of the trailers, and the two host vehicles will be driven to Alameda. Following the Alameda clinic, all equipment will be returned to Ann Arbor, Michigan, for the model deployment. Small supplies will be transported from Ann Arbor to Automotive Events headquarters in Cleveland, Ohio.

5.3.6 Write lessons learned

Following both clinics, all staff from all institutions that participated in the clinic will write notes on what went well and what can be improved in future similar works. Battelle will compile these notes and write a Lessons Learned document. The document written after the first clinic will be especially important in improving the efficiency of the second clinic. The document will be updated following the second clinic and included in the final report.

5.4 What the Participants Will Experience

This section repeats what has been said, from the perspective of the participant.

TRC Inc. is northwest of Columbus, and Alameda is in a metropolitan area. Most participants will have driven at least half an hour to reach the clinic, and some, especially in Ohio, may have driven two or more. Participants beginning or ending their session near a meal time will be offered a meal.

Table 5-5 lists the estimated time a participant will be in each of the steps of the clinic.

Table 5-5. Estimated time for a participant to complete each step of the clinic.

Step	Estimated Time (minutes)
Greeting, re-screen, informed consent	20
Pre-drive questionnaire	10
Wait for driving	10
Driving	30
Post-drive questionnaire	15
Payment and dismissal	5
TOTAL	**90**

Note: Participants selected for an in-depth interview will spend an additional 30 minutes.

The driving time itself is close to 60 min for the light vehicle clinics. The scenarios for the commercial vehicle clinics will be mocked up during the application testing, to estimate the actual time for the commercial vehicle scenarios.

The limiting factor for throughput rate is the time each driver is in the host vehicle. The pre- and post-drive questionnaires can also consume time if participants do not read quickly. Table 5-4 shows that keeping the time in the host vehicle to 30 minutes is essential to maintaining the

necessary daily throughput. Table 5-5 shows that the same limit is important to getting individual participants through the clinic in less than two hours.

Most participants can be expected to wait for their turn to drive, but they should be able to take their post-drive questionnaire and leave promptly after their drive time. Participants who are not selected for an interview should be able to leave the clinic site within one and a half to two hours of their arrival.

The post-drive in-depth interview will add approximately 30 min to a participant's time.

5.4.1 Greeting, Re-Screen, Informed Consent, Pre-Drive Questionnaire

Upon arrival at the test site potential participants will be met by a greeter. (At TRC Inc. the participants will first be met at the guardhouse. They will be instructed to park their vehicle, and a TRC Inc. driver will come to escort them to the clinic office, where they will meet the greeter.) The greeter will re-screen participants using the same set of questions used at recruiting to verify that the criteria for participation are met. The greeter will ask to see the participant's CDL and record the participant's date of birth on the ICF. Individuals who do not meet the screening criteria will be dismissed. Those who do meet the criteria will receive a copy of the informed consent to read.

After the participant has had an opportunity to read the informed consent, a Battelle staff member, normally the principal investigator or human factors specialist, will review the document with the participant and give the participant an opportunity to ask questions. The consent form also includes a certification that the participant understands that time at the clinic is to be logged as "on duty." After the participant has signed the consent form, the participant will complete the pre-drive questionnaire in Appendix B-4.

5.4.2 Driving Time

The test conductor will escort the participant to the host vehicle. After driving to the station, the test conductor will orient the participant to the track, describe the safety procedures, and remind the participant to follow instructions. Participants will have an opportunity to familiarize themselves and adjust the equipment in the cab (seat, steering wheel, mirrors). The test conductor will call the participant's attention to the location of the DVI. When the participant is comfortable, the test conductor will ask the participant to drive a short distance to become accustomed to the vehicle.

Participants will then complete a series of scenarios to demonstrate each application. The procedure for each application will roughly be as follows:

- The test conductor will describe the situation in which the application is relevant. For example, the test conductor will tell the participant that BSW alerts drivers when a vehicle is in an adjacent lane in the blind spot.
- The test conductor will then provide an orientation of the scenario and tell the participant what to expect, using a diagram.
- The test conductor will then ask the participant to execute the scenario. After checking that the GPS and vehicle information are operational and communicating to the remote

vehicles that the scenario is about to begin, the test conductor will tell the participant to begin.

- The test conductor will provide guidance to the participant according to the test protocols. For example, the test conductor will tell the participant when to activate the turn signal in the BSW/LCW scenario, and the test conductor may need to have the participant stop if the DVI does not activate properly.
- After the all the scenarios are run for an application, the test conductor will administer the in-vehicle debrief.

A participant will be permitted to repeat a scenario if it was not executed according to the plan on account of a miscue or equipment malfunction.

The protocols and in-vehicle debrief questionnaires are in Appendix B-5.

5.4.3 Post-Drive Questionnaire

After participants complete the driving time, they will be escorted to a private, quiet area and introduced to the interviewer or greeter. The participant will self-complete the post-drive questionnaire. After completing the post-drive questionnaire, participants not invited to the in-depth-interview will be dismissed. The post-drive questionnaire is in Appendix B-6.

5.4.4 In-depth Interview

Approximately half of the participants will be selected for an in-depth interview. Selection will be approximately every-other-participant, and will be based on available schedule slots. After completing the post-drive interview, the interviewer will skim the pre-test questionnaire, in-vehicle debriefs, and post-test questionnaire for relevant discussion topics. For example, if a participant rated many of the warnings issued by the safety features confusing, the interview may delve deeper into the cause of the confusion. Otherwise, the interviewer may engage the participant in a discussion about which applications are most useful, and why, and whether the participant had been in any near-miss incidents in which the application would have been helpful. A notional discussion guide in Appendix B-7.

5.4.5 Dismissal (payment and receipt of ICF copy)

The interviewer or greeter will give the participant an opportunity to ask last questions about the clinic participation and give a copy of the signed informed consent. Participants will be paid cash on site, and they will sign a receipt for the cash, which is in Appendix B-8.

6.0 PROCEDURE FOR THE PERFORMANCE TESTS

(The plan for the Performance Tests will be developed following completion of the Application Performance & Functional Test Plan & Procedures. The Performance Tests are expected to be conducted on the drive from Ohio to California.)

This page intentionally left blank.

7.0 PROTECTION ANALYSIS

This chapter discusses two types of protection that must be afforded the personnel in the driver clinics. First are the protections for the human subjects participating in the study. The second section of this chapter addresses the safety of both the human subjects and the staff performing the clinics. A third section deals with the hazards of the Performance Tests.

7.1 Human Subjects

This section describes the processes and protections in place to protect individual's rights as participants. The documents that participants will see or on which information about them will be recorded are listed in Table 4-1 in Section 4.1.

7.1.1 Informed Consent

Informed consent will be obtained from participants prior to data collection. Participants will receive an Informed Consent Form (ICF) and will be given time and opportunity to inquire about the details of the study and decide whether to participate. The greeter and PI will explain that the participant is completely free to refuse participation in the study or to withdraw from the study at any time and for any reason. All other requirements necessary for the protection of the human rights of the participant will also be explained. Participants may ask as many questions as they like before deciding whether to participate in the study. The participants will sign and date the ICF and will be provided a copy at the conclusion of their study time. The informed consent will be the most recent version approved by the Battelle IRB. It is in Appendix B-3.

7.1.2 Recruiting and Screening

Recruiting will be conducted in accordance with the processes in Section 5.2.2. Initial outreach will be by Battelle staff, and screening will be by Delve. Promotional outreach materials are in Appendix B-1, and the script for screening potential participants is in Appendix B-2. Criteria for participation in the study are listed in Section 3.4. Documentation of participants' fulfillment of the entry criteria will be completed by the recruiter on the participant screeners in Appendix B-2. The greeter at the test site will confirm participant eligibility by reviewing the screening questions with the participant immediately prior to requesting informed consent. The screening criteria have two purposes—to ensure data is collected from the desired representative population and to limit driving to qualified operators of the equipment.

7.1.3 Data Protection and Confidentiality

Hard copies of completed surveys and questionnaires will be locked. Electronic copies of transcribed and entered data will be secure and accessible only to the study team. Participants' full names and study code will not be on the same form or document, with the sole exception of one copy of the ICF, which will be kept in a separate and secure location by the clinic's human factors leader. Participants will be identified on other paper instruments only by a code number. Participants' voices and faces will be recognizable from the video recording in the cab and the audio recording of the interview, and these recordings will be available only to Battelle and UMTRI staff working on the study.

7.1.4 Participant Withdrawal or Termination

An individual is free to choose whether or not to participate in this study. Participants are free to withdraw from the study at any time without any penalty or loss of benefits.

Participants may be terminated from the study at any time for the following reasons:

1. Failure of the participant to sign the ICF
2. Failure of the participant to make adequate scheduling accommodations to participate in the study
3. Discovery that the participant has provided false information during the screening process
4. Early departure of the participant during the study
5. Intentional or continued unsafe behavior through failure to follow instructions, creating a hazard for either the participant or the investigators, after being warned by the test conductor.

If a participant begins the study but does not complete it, the reason for withdrawal or termination will be recorded in the appropriate box at the bottom of the participant's pre-drive questionnaire. If a participant elects not to sign the ICF, then no record of the individual's arrival will be kept, unless a minimal payment is made, in which case only the cash receipt will be kept.

7.1.5 Unforeseen Events

An unforeseen event is an event that is unforeseen or unexpected and has the potential to adversely affect a human subject or the conduct of a human subjects study. Unforeseen events will be reported to the IRB via a telephone call to the IRB manager and follow-up email. Reportable events may include incidents that could be categorized as: (1) adverse events; (2) unanticipated problems; or (3) non-conformances.

An adverse event is an event or incident not previously known or not anticipated to result from:

- The interactions or interventions used in the study
- The collection of privately identifiable information under the research;
- An underlying disease, disorder or condition of a human subject, or,
- Other circumstances unrelated to the research or any underlying disease, disorder or condition of the subject.

An unanticipated problem is an event that is not expected given the nature of the research procedures and the subject population being studied, and suggests that the research places subjects or others at a greater risk of harm or discomfort related to the research than was previously known or recognized.

A non-conformance is an aspect of the research study that has not been performed in accordance with applicable laws and regulations, ethical standards, Battelle policies, IRB requirements, or contractual obligations.

The following events will be reported to the IRB if they occur:

- Unforeseen events (within one (1) hour of discovery). If, during the course of the research study, there are any unforeseen events, the task manager will notify the IRB manager within one (1) hour of discovery, then follow IRB instructions.
- Protocol violations that
  - Placed a human subject at risk, or
  - Were caused by the action or inaction of a researcher
- New or changed risks to human subjects, including new findings
- Failure to follow regulations or IRB requirements
- Unresolved complaint by a human subject
- Audit, inspection, or inquiry by a federal agency
- Breach of confidentiality
- Change to the protocol, taken without prior IRB review, to eliminate an apparent immediate hazard to a human subject

7.2 Safety of the Driver Clinics

This section discusses the procedures that will be followed to reduce the risk of injury associated with the hazards present while the Driver Clinics are conducted. The Battelle Safe Work Practices Handbook [12] addresses most hazards typically present in experimental work. For hazards associated with individual projects, Battelle's Systems Development Product Line has a procedure, Safety Planning [11].

The procedure calls for hazards to be identified and their severity to be assessed, according to Figure 7-1. Tasks with extreme or very high ratings are not to be attempted, and tasks with high or moderate ratings require risk reduction measures. This section lists the hazards associated with conducting the driver clinics and where necessary states the risk reduction measures that are to be implemented.

Maximum Consequence with higher than negligible probability					
Likelihood of Occurrence	**Minor** (first aid)	**Moderate** (medical treatment)	**Serious** (lost time)	**Major** (fatality)	**Catastrophic** (multiple fatalities)
Almost Certain	**H**	**H**	**VH**	**E**	**E**
Likely	**M**	**H**	**H**	**VH**	**E**
Possible	**L**	**M**	**H**	**H**	**VH**
Unlikely	**L**	**L**	**M**	**H**	**H**
Rare	**VL**	**L**	**L**	**M**	**H**

Figure 7-1. Table for categorizing the consequences of safety hazards (from [11]).

This hazard analysis was developed with references to the risk assessment for the light vehicle clinics. The general approach to handling the risks is similar for both sets of clinics. The greater stopping distance, larger mass, and blind spots of a tractor-semitrailer combination presents hazards unique to the commercial vehicle clinics, and they are addressed accordingly. Two significant differences are worth noting here:

- There will be greater radio communication to ensure that area around the truck is clear before it moves.
- When the truck is approaching a stopped vehicle, the stopped vehicle will be unoccupied to prevent injuries in the case of a crash.

7.2.1 Responsibilities and Authorities

The clinics will involve staff from Battelle, other members of the contractor team, on-site service providers, and the government, in addition to the participants. Battelle's clinic manager is responsible for the safe planning of the clinics and will be on site responsible for their safe execution. Staff from Battelle, other members of the contractor team, and others hired specifically for the clinics have the responsibility to provide a safe environment for the observers and the participants.

Any person present at the clinics has the authority to raise a safety objection, and work will be suspended until the objection is resolved.

The participant will be driving the host vehicle during the scenarios and will have responsibility for its safe operation while driving. Part of the instructions will be to tell the participant to question any unclear directions. If the participant believes any requested action is unsafe, the participant may refuse to drive a scenario. The participant may leave the study at any time. If a

participant chooses to leave the study while in the driver's seat, then a test conductor will escort the participant off the course, either by walking or by driving the host vehicle back to the starting point.

The test conductor in the active host vehicle controls movement of vehicles on the test track by two-way radio messages. Two host vehicles may be on the track at one time, but one will be designated the active host vehicle, and authority will be transferred by clear radio communication between the two.

7.2.2 Hazard Analysis

Significant hazards that are unique to the driver clinics are listed here. Their likelihood and possible consequences are discussed, and risk reduction measures are explained.

7.2.2.1 Crash into a Cooperative Vehicle

The truck driver can see in front better than in behind the truck, so whenever possible other vehicles will be in front of the host vehicle when positioning for the next scenario. The passenger car will turn around first, the more maneuverable light van with the more cognizant driver second, and the host vehicle last.

Electronic warnings in the scenarios will be timed to allow sufficient distance for the truck to brake without striking another vehicle. Stopping distances will be tested thoroughly and cautiously before the participants drive the scenarios. The participant will be aware of the locations of other vehicles, even those that are momentarily hidden during the scenarios. Even with these precautions, the truck's crashing into the rear of the passenger car is a possibility. To limit possible damage to property and not personnel, the passenger car will not be occupied during scenarios where the truck must brake to avoid striking it. Radio communication between the professional test drivers will ensure that the car is unoccupied and personnel are clear of the course before the vehicle begins moving. Before the scenario, the participant will be instructed, should a collision become inevitable, to drive straight and hit the car rather than to suddenly steer out of the way. A sudden steering can cause a rollover, which can injure the truck's occupants.

7.2.2.2 Poor Participant Performance

The scenarios will be designed so that they do not require special driving skills, other than operating a tractor-semitrailer combination. Screening personnel will verify that participants hold a Class A Commercial Driver's License, which is the legal authority to operate such a vehicle, and participants will be asked to affirm that they have experience driving such a vehicle. Before they agree to participate and again when they are in the cab, participants will be told that the clinic is intended to be an exercise in safe driving and not to test the limits of the driver's skill or the vehicle's capability.

After explaining each scenario and before beginning it, the test conductor riding with the participant will ensure the participant understands what is expected. Should the participant not follow the test protocol, the test conductor will correct the participant's miscues through a verbal clarification. The scenario will be restarted. Should the participant fail to follow the protocol a second time, the test conductor will ask the participant to bring the vehicle to a complete stop in a safe location and set the parking brake. The test conductor will again readdress the proper

protocol. The participant will be warned that further failure to adhere to the proper protocol will result in expulsion from the clinic. The scenario will be restarted. Should a third violation of protocol occur, it will be the last. The test conductor will ask the participant to bring the vehicle to a complete stop in a safe location, set the parking brake, and turn off the engine. The test conductor will take the keys from the participant. Both participant and driver will exit the vehicle and the test conductor will then take the driver's seat and transport the participant back to the staging area. The participant will be deemed to have withdrawn from the study.

The test conductor riding with the participant has the authority to declare that a participant has withdrawn from the study at any time the test conductor notices grossly unsafe driving behavior or suspects that the participant does not have the skills to continue in the clinic.

These procedural safeguards make the likelihood of a crash due to poor participant performance to be unlikely. The risk rating is Low.

7.2.2.3 Equipment Failure

Test personnel are the first to drive every day to ensure the equipment is operating properly. That includes a pre-trip inspection of the host vehicle and remote vehicles. Equipment will have been tested thoroughly at previous locations. The test conductor in the host vehicle will be attentive to signs of OBE degradation or malfunction. The new vehicles will be in top mechanical condition before the clinics. With the daily inspections, the likelihood of a vehicle failure is rare. A failure of the OBE, a new piece of equipment, during the clinic is likely. With the test conductor watching the OBE and the situation, a crash resulting from an OBE failure will be unlikely.

7.2.2.4 Collision with a Fixed Object

Both sites have wide margins. Test personnel drive ahead of time to confirm the route is adequate. The likelihood is rare and the risk rating is Low.

7.2.2.5 Struck Pedestrian

A person standing on the pavement who is struck by a moving vehicle may suffer a lost time injury or a fatality. All persons who might walk in the course will wear high-visibility vests. Each scenario will have a designated number of test conductors and will have checklists and radio signals to clear the area around the host vehicle before it moves to begin a scenario and before it moves to position for the next scenario. Each site will have a clearly marked area where observers without wearing a visibility vest may watch the clinic. The procedures will make the likelihood of striking a pedestrian rare, so the risk rating is low.

7.2.2.6 Equipment Fire

The host vehicle will carry no cargo. The special electronics in the vehicles will have been operated before the clinics, so its likelihood of starting a fire is rare. The host vehicle will carry a fire extinguisher in accordance with the Federal Motor Carrie Safety Regulations [1]. Occupants will be instructed to abandon the vehicle for all but the smallest fires. The risk rating for injury due to fire is Low.

7.2.2.7 Regular Outdoor Hazards of Sunshine and Weather

Personnel will be cognizant of the possibility of sunburn and bug bites. The threat of lightning will suspend operations. The clinic can continue in light rain as long as visibility and pavement friction are adequate. The clinic task manager, the test conductors in the host vehicles, and the participant have the authority to suspend testing if any one of them judges the weather to be unacceptable. The risk rating is Low.

7.2.2.8 Moving Heavy Objects

Staff will follow good ergonomic principles when moving heavy equipment and will ask for help or use a cart when necessary. A strained back or pinched finger might require medical treatment, but the occurrence is unlikely if procedures are followed. The risk rating is Low.

7.3 Safety of the Performance Tests

The Performance Tests will be on public highways that are shared with traffic not involved in the tests. The paramount concern in the Performance Tests will be to avoid increasing the risk to other vehicles above what is normal on the public roads.

Precautions from the light vehicle clinics will be in place if they are applicable and appropriate.

The hazard analysis will be completed while the test plan is being developed.

This page intentionally left blank.

8.0 ANALYSIS METHODS

The purpose of the Driver Clinics for the Connected Commercial Vehicle Safety Applications Project is to obtain driver feedback on and acceptance of the connected vehicle technology and safety applications. Data will be analyzed to codify common themes among participants' opinions and seek notable suggestions for improvement.

8.1 Questionnaires and Interviews

We will analyze the questionnaire and interview data for patterns in participants' opinions of the overall V2V system and its component applications. A critical product of the Driver Clinics will be the subjective reactions of the drivers to the connected vehicle safety applications, including the DVI (the visual and auditory alerts and warnings). These reactions not only reflect their acceptance of the technologies, but may also include recommendations for improving them as connected vehicle technology moves forward. This subjective information is necessary to gauge driver acceptance of the overall system, as well as specific technologies and their implementation.

We will compute a set of data variables that will characterize driver responses and reactions to the connected vehicle technology as a whole, individual connected vehicle safety technologies, specific design elements, and recommendations for improvement. These variables will include descriptive statistics such as a mean and variance measures that will indicate driver behaviors and acceptance relative to various aspects of the system.

To the extent possible, participant responses will be analyzed by demographic variables to identify patterns of responses that vary by age, driving experience, and familiarity with other safety equipment.

8.1.1 Questionnaires

The data analyses will consist primarily of descriptive statistics, augmented by figures and tables highlighting key data. No formal hypothesis testing will be incorporated into this study. We anticipate that the data will be analyzed as follows:

Demographic and driving experience data will be summarized in tables using basic descriptive statistics (primarily counts, ranges, and means).

Results from the in-vehicle debrief questionnaire will be summarized by application and will integrate findings from the open-ended questions and in-depth interviews.

Responses to the Likert Scale questions will be transcribed to an MSExcel spreadsheet. For each question, a response profile will be generated. The profile will show the number or percentage of responses for each rating.

Responses to open-ended questions (e.g., "What is your immediate impression of this safety feature? Do you have concerns or suggestions or other comments?") will be analyzed using a

qualitative content analysis. Responses will be recorded, transcribed to an MSExcel spreadsheet or MSWord as appropriate, and reviewed for overall patterns and repetitive themes.

8.1.2 In-depth Interview

For the IDIs (conducted in lieu of focus groups), we will conduct content analyses of the raw data of the sessions, including words, phrases, sentences, and nonverbal responses of the focus group participants. Project staff will examine all data (tapes, notes, post-session summaries) for patterns and themes that emerge from the data. Individual comments regarded as especially insightful will be highlighted, as well as instances of difficulty or confusion across multiple participants.

At this time, we anticipate that the data analyses will consist primarily of descriptive statistics, augmented by figures and tables highlighting key data.

We anticipate that the following will be reported for the interview analysis:

- Overall discussion topics (e.g., usefulness of each application, usability of DVI)
- Common themes in each topic (e.g., "useful in urban settings"; "I didn't see the warning")
- Frequency counts of common themes within each topic

8.2 Engineering Data

Analysis of the engineering data will be subordinate to analysis of the subjective data. The data may be checked on to confirm statements from participants. Participants may relate subjectively that, for example, they thought a vehicle was closing rapidly or that a boundary of safe operation had been crossed. Engineering data can be analyzed to quantify the conditions when a level of discomfort appears.

Although the OBE will have been tested before the clinics begin, it will still be in its early months of operation. Checks on the consistency of behavior made be made with the clinic data, and the team may be interested in observing how the applications perform as the several participants drive them in slightly different manners. To improve participants' safety, the warning thresholds will likely have been "de-tuned" so that warnings are given sooner than they would in true installation, as they were in the light vehicle clinics. Engineering tests of the applications' parameters are in other tasks and the primary data from the clinics is drivers' evaluations.

8.3 Subjective Observations

Test conductors riding with the participants will record their subjective observations of participants on the In-Vehicle debrief form for each scenario, in the *Notes of interest specific to this scenario* section. These comments will be included in the content analysis of the in-vehicle debrief questionnaires for each application.

9.0 REPORT

The Final Report for the Driver Clinics will summarize the methods and the findings. A draft outline of the report is in Table 9-1. If the report for the light vehicle Driver Acceptance Clinics is available, the Final Report will compare the commercial vehicle findings with those of the light vehicle clinics.

The report's introduction will put the clinics in the context of the DOT's greater goal of accelerating the deployment of connected vehicle technology.

The descriptions of the scenarios will appear with expanded descriptions suitable for explaining them to the report reading audience. The steps in preparing for the clinics will be briefly summarized, and the procedures of the clinics themselves will be in somewhat greater detail. Observations may be made on what went well in performing the clinics or how they could be run more smoothly.

The instruments that the participants read and heard will be in appendixes to the report, in the same form as they were used in the clinics.

Table 9-1. Draft outline of the final report.

Executive Summary
1. Introduction
   - 1.1. Background of connected vehicle technology
   - 1.2. Other portions of this contract
   - 1.3. Purpose of the clinics
2. Methods
   - 2.1. Clinic sites
   - 2.2. Demographics of the participants
   - 2.3. Descriptions of the applications and scenarios
3. Findings
   - 3.1. General acceptance of the V2V technology as a whole
   - 3.2. Rankings of scenarios and applications
   - 3.3. Opinions of the Driver Vehicle Interface
4. Conclusions

References
Appendixes

This page intentionally left blank.

10.0 REFERENCES

This test plan refers to a number of other documents, which are listed in this section. The documents are grouped by how readily available they are. The first group is publications and federal regulations, which are generally available. Other documents are specific to the light vehicle clinics or to this project and have limited distribution.

Links to the documents are provided where possible. Links to the publications in 10.1 are available to all. While links to other documents are on Battelle's internal information server and are available only to Battelle staff, the documents themselves (except the Battelle-specific documents in 10.4) are available to DOT staff through other means.

10.1 Publications

[1] "Fire Extinguisher" Federal Motor Carrier Safety Regulations. Subpart H—Emergency Equipment, Emergency Equipment on All Power Units. 49 CFR 393.95 (a)

[2] "General Qualifications of Drivers." Federal Motor Carrier Safety Regulations. Part 391 Qualifications of Drivers and Longer Combination Vehicle (LCV) Driver Instructors, Subpart B—Qualification and Disqualification of Drivers. 49 CFR 391.11(b)(1).

[3] "On duty time." Federal Motor Carrier Safety Regulations. Part 395 Hours of Service of Drivers, §2, Definitions. 49 CFR 395.2. (See also http://www.fmcsa.dot.gov/rules-regulations/truck/driver/hos/hos-faqs.asp)

[4] California Commercial Driver Handbook. 2010-2011. http://dmv.ca.gov/pubs/comlhdbk/comlhdbk.pdf

[5] "Ohio Bureau of Motor Vehicles Commercial Driver License (CDL)" web site. Ohio Department of Public Safety. October 2011. http://bmv.ohio.gov/cdl.stm

[6] Global Insight, Inc. The U.S. Truck Driver Shortage: Analysis and Forecasts. May 2005. Available online at http://www.truckline.com/StateIndustry/Documents/ATADriverShortageStudy05.pdf

10.2 Project Specific Documents

[7] Volume I. Technical and Management Proposal" V2V Commercial Vehicle Safety Applications Development. January 28, 2011. http://websps31.battelle.org/convehsafety/home/Shared%20Documents/Project%20Management%20Documents/Final%20Proposal/opp100724_tech_volume_CRIT1-3_20110328.pdf

[8] "Project Management and Work Plan." Connected Commercial Vehicle (CCV) Safety Applications Development Project. Battelle Memorial Institute. Contract No. DTFH61-06-D-0007, Task Order No. BA07-095. June 16, 2011. http://websps31.battelle.org/convehsafety/home/Shared%20Documents/Deliverables%20-

%20Drafts%20and%20Comments/Task%201.%20%20Work%20Plan%20and%20Project%20Management/Draft%20Project%20Management%20and%20Work%20Plan%20110620/PN100003838_CCV_Safety_Apps_PMP_Draft1-1-20110620.pdf

10.3 CAMP and U.S. DOT Internal Documents

[9] "V2V-SP Risk Management Plan" Vehicle-to-Vehicle Safety System and Vehicle Build for Safety Pilot (V2V-SP). May 17, 2011. (CAMP and DOT internal document) http://websps31.battelle.org/convehsafety/home/Shared%20Documents/References%20and%20Resources/06CAMP%20Driver%20Clinic%20Reference%20Material/V2V-SP%20Risk%20Management%20Plan%20May%2017,%202011.pdf

[10] "Driver Acceptance Clinics Plan" Vehicle-to-Vehicle Safety System and Vehicle Build for Safety Pilot (V2V-SP). August 5, 2011. (CAMP and DOT internal document) http://websps31.battelle.org/convehsafety/home/Shared%20Documents/References%20and%20Resources/06CAMP%20Driver%20Clinic%20Reference%20Material/DAC_Plan_FINAL_08182011.pdf

10.4 Battelle Internal Documents

[11] "Safety Planning" Systems Development Quality Management System Operating Procedure. Issue 1.1. 2008. (Battelle internal document)

[12] Battelle. "Safe Work Practices Handbook." November 2009. (Battelle internal document) http://infosource.battelle.org/sites/1620/Safe%20Work%20Practices%20Handbook/Forms/AllItems.aspx

APPENDIX C.

Human Subjects Data Collection Instruments

The documents in this appendix are the materials that were in use for the California clinic. Originals of all documents, except those in Appendix C-1, are securely stored by Battelle's Records Management Office.

C-1. Screening and Informational Materials

The first four documents were used before the participants arrived at the clinics. The Phone Screening Questionnaire was used by the staff at Delve when a candidate phoned to make an appointment. The Phone Questions and Answers were prepared by Battelle and were available to Delve; they were usually not needed. The Confirmation Letter was sent by Delve to each participant who made an appointment.

The Re-Screening Checklist was on site at the clinics. These questions were asked of the participants as they arrived.

Telephone Screening Questionnaire

Driver Clinic in Alameda, California, August 2012

Truck Drivers

Demographics Desired
Adult (>21) professional drivers with a Class A Commercial Driver's License (CDL).

Schedule Desired:
As on page 4.

Thank you for your interest in the Truck Safety project.

My name is _____**,** and I am a researcher with Delve. As you know, we are in the process of recruiting professional drivers to participate in a research study, to be held at the former Alameda Naval Air Station. It is an opportunity where you would be driving a test vehicle, equipped with state-of-the-art communication technology, and providing your opinions on crash avoidance safety applications.

- ☐ For about 2 hours of your time, you would be paid $200 for completing the driving study. Some drivers may be invited to participate in an interview; if invited you will stay an extra half hour would be paid an additional $25.

Because we are offering to pay you, your time at the site has to be logged as "on duty" and will figure in your hours of service. You cannot use the day as a day off for your 34-hour restart. Are you interested in proceeding? (IF YES, CONTINUE; IF NO, THANK AND END)

We are looking for specific qualifications, so I have to ask you a few questions to see if you qualify first.

1. Do you have a Class A CDL and Have you professionally driven a tractor with a semitrailer in the past year?

   ☐ Yes (CONTINUE)
   ☐ No (THANK AND END)

2. Do you or any members of your household work for any of the following fields or types of companies:

   IF YES TO ANY, THANK AND END

   - ❑ Design, engineering, or development of automotive- or truck-related technologies?
   - ❑ An auto or truck manufacturer?
   - ❑ Battelle, Transportation Research Center Inc., or Automotive Events?

3. Have you ever participated in a research study involving driving or testing a vehicle? (IF YES, BRIEFLY DESCRIBE)

   ☐ Yes (DESCRIBE:_____)
   CONTINUE, AND CHECK WITH CLIENT
   ☐ No (CONTINUE)

4. Are you currently taking any substances or medications on a regular basis that would impair your ability to drive (e.g., causes drowsiness or dizziness)?

   ☐ Yes (THANK AND END)
   ☐ No (CONTINUE)

5. Are you in reasonably good health?

   ☐ Yes (CONTINUE)
   ☐ No (THANK AND END)

6. Is your CDL currently under suspension or revocation?

   ☐ Yes (THANK AND END)
   ☐ No (CONTINUE)

7. How many moving violations have you had in the past 3 years (e.g., , speeding, failure to yield, following too closely.)

   ☐ None (CONTINUE)
   ☐ 1 to 2 (CONTINUE)
   ☐ 3 or more (THANK AND END)

8. In how many highway accidents have you been the cause of in the past 3 years?

   ☐ None (CONTINUE)
   ☐ 1 to 2
   Was it an accident that resulted in an injury for anyone involved?
      ☐ Yes (THANK AND END)
      ☐ No (CONTINUE)
   ☐ 3 or more (THANK AND END)

9. Are you available on any ONE of these days: Wednesday, August 22 or Thursday, August 23? The driving time must be logged and is part of your “hours of service.” Consider this a work commitment when you schedule your time.

   ☐ Yes (CONTINUE)
   ☐ Maybe or Don’t Know (ASK THE PARTICIPANT TO CHECK THE SCHEDULE AND CALL BACK)
   ☐ No (THANK AND END)

10. Are you at least 21 years old?

If the age is below 20, THANK AND END
If the age is 20, “Will your birthday be before August 22?”

   ☐ Yes (CONTINUE)
   ☐ No (THANK AND END)

END SCRIPT (TO BE USED WHEN PARTICIPANT IS TERMINATED FOR ANY REASON): Thank you so much for taking the time to answer our questions. Unfortunately, we have filled that particular quota for the study. Have a great day.

GO TO INVITATION.

INVITATION

THANK YOU SO MUCH FOR YOUR PATIENCE AND HONESTY! I would like to schedule your participation on one of the following days and time slots. Remember, you must account for the drive time in your log and include the time in your hours of service.

RECRUIT 2 PARTICIPANTS PER SESSION

	Wednesday August 22	**Thursday morning August 23**
1	7:30 to 9:30 a.m.	7:30 to 9:30 a.m.
2	8:00 to 10:00	8:00 to 10:00
3	8:30 to 10:30	8:30 to 10:30
4	9:00 to 11:00	9:00 to 11:00
5	9:30 to 11:30	9:30 to 11:30
6	10:00 a.m. to 12:00 noon	10:00 a.m. to 12:00 noon
7	10:30 a.m. to 12:30 p.m.	10:30 a.m. to 12:30 p.m.
8	11:00 a.m. to 1:00 p.m.	11:00 a.m. to 1:00 p.m.
--	(There is no 11:30 appointment.)	(There is no 11:30 appointment.)
--	(There is no 12:00 appointment.)	(A small number of afternoon appointments may be added.)
9	12:30 to 2:30 pm	
10	1:00 to 3:00	
11	1:30 to 3:30	
12	2:00 to 4:00	
13	2:30 to 4:30	
14	3:00 to 5:00	
15	3:30 to 5:30	
16	4:00 to 6:00	

TO QUALIFY FOR THE STUDY, RESPONDENT MUST AGREE TO ALL OF THE FOLLOWING STATEMENTS:

So, let's just quickly review how this whole driving experience is going to work, so you know what to expect:

- ☐ First, plan to arrive at least 15 minutes prior to your scheduled appointment time, which is (INSERT APPT. TIME), so you should plan to arrive by _____.

- ☐ Be sure to bring your CDL, which you will have to show to the receptionist, to ensure your eligibility. Also, be sure to come by yourself; do not bring a friend or child, as there will be nowhere for them to wait. Okay so far?

- ☐ At the site, you will be asked to complete a brief survey, which gathers some basic demographic information, and then you'll be escorted to one of the test rigs. You'll be accompanied by another professional truck driver who will explain the various courses you will be driving, and then you will take the wheel, and test out the various situations. Then we'll ask what you thought. Driving all of the scenarios and answering questions should take about 2 hours.

- ☐ Your identity will be kept strictly confidential. You will be identified by a code number on the data records. You will be videotaped and audiotaped in the cab of the vehicle, and the interview may also be audiotaped for research purposes only. These will also be kept confidential.

- ☐ If you complete the entire study, you will be paid $200. If you stay and complete the entire driving study and are selected for a half-hour interview, you will be paid a total of $225.

- ☐ You will receive a cash payment at the conclusion of your participation. We will give you a gas card for your mileage.

- ☐ By accepting payment for your time and completing all of the tasks, you agree not to discuss this research with anyone, publicly or privately, in order to avoid biasing future participants, for at least 6 months. Remember, you must log the driving time and the drive time counts towards your hours of service.

- ☐ Refreshments will be available throughout the day.

- ☐ And, please remember to **bring glasses or sunglasses** if you require them to read or drive.

- ☐ We will follow up with an email or letter confirming all of these details, including a map and driving directions to the test site. The day before your appointment, someone will call to remind you and confirm your participation. If you have any questions, please contact us at: 800-242-4118.

RECRUITER:

1. Record the driver's contact info
    1. Phone number(s)
    2. E-mail
    3. Postal address
    4. Preferred method and contact times.
2. Use only first name and last initial when providing recruiting updates to Battelle or other team members.

Connected Commercial Vehicle Driver Clinics
Project Description and Answers to Questions

This document has a description of the Driver Clinics project and answers to questions that may be asked. If a caller asks questions that Delve cannot answer, the caller will be asked to call Doug Pape at Battelle (614) 424-5667 or to send e-mail to DriverClinic@Battelle.org.

Use this description under the first question for a general open-ended question at the start of a call. The answers after that are for more specific questions.

What's involved?
You will drive out to the former Alameda Navail Air Station. It's in Alameda, south of Oakland. We will have you fill out a short questionnaire, take a drive in a specially equipped tractor, and fill out another questionnaire. After about two hours, you will be on your way home.

We'll need you to sign a consent form before you begin. The driving is all under controlled conditions on a closed course, nothing riskier than an ordinary day at work. We'll need your full name to start the process, but all of the data will be anonymous. Nobody at your company or in the public will ever know how well you drove or how you answered the questions.

If you complete the survey, we'll pay you $200 cash. We'll also give you gas cards to cover your travel. The one thing to keep in mind is, because we are paying you, you have to log the time as "on duty." That means it can't count as a day off. You'll have to plan that if you're an owner-operator or tell your dispatcher if you work for a company.

SAFETY

Is the test dangerous?
No. You will be wearing your seat belt in a new cab driving 35 mph on a closed course. Another professional driver in the cab with you will tell you where all the other vehicles are. No surprises are planned. It's situations you experience at work every day, but here the cars will be farther apart.

What if I get hurt at the clinic?
We will help you get to medical treatment right away. You are not our employee, so there won't be any worker's comp if you hurt yourself. Because the speeds are only 35 mph, you're more likely to twist your own ankle climbing out of the cab than you are to be injured in a crash.

Is the truck I will be driving safe? What are the safety concerns?
You will be driving a new truck. Our test drivers have worked out the situations carefully ahead of time, to make sure nobody is put at risk.

TECHNOLOGY

What does the technology do?
It's communication between vehicles so everybody knows where everybody else is. Think of it as "wi-fi for cars." If you're really interested, there are diagrams and videos on the web site DriverClinic.org.

What kinds of crashes can it avoid?
When you are at the clinic, you will drive a test where you see a warning when a car crosses your path at an intersection. There's also an indicator when a car is in your blind spot. You will see a warning when the car in front of you slows down too fast.

Won't all this distract the driver?
Actually, that's one of the questions we'd like to ask you after you have driven our truck.

Who's paying for all this?
The project is funded by the United States Department of Transportation.

Will I be driving on the highway?
No. We'll be using the old runways at Alameda as a closed test track. The only vehicles with you will be part of our test.

Who is developing the technology?
Several car and truck manufacturers are all developing their own products. They follow certain rules and standards so their equipment all can work together. Ford, GM, Mercedes-Benz, and five other companies.

Do passenger cars have the technology, too?
Yes. In fact, a number of car and truck manufacturers are developing their own products. They follow the same rules and standards so their equipment all can work together. The driver clinics for the passenger cars finished earlier this year.

Why are you recruiting drivers?
To see what you think of the technology and help us make it better.

COMING AND GOING

How long will I actually be driving at the clinic?
About half an hour.

How do I get selected for the extra interview?
We will choose people on the day of the clinic. I can't predict if you will be chosen or not. If we decide to invite you, you are free to say yes or no.

What type of truck will I be driving?
A brand new Freightliner Cascadia sleeper. It will be pulling an empty van trailer.

How much will I get paid?
If you complete the two-hour study, we will give you $200. If we invite you for an extra half-hour interview and you accept, that will be an additional $25. We will pay you cash.

What are the distances to get gas card?
If you drive more than about 25 miles one way, we will give you a card. The amount will work out to about 50 cents per mile.

What items do I need to bring with me?
Only your CDL and anything else you need to drive, like glasses or sunglasses.

How early should I arrive?
Please arrive at the gate at least 15 minutes before your appointment, so you can park and walk to the office.

How long will the event take?
You should be finished about two hours after you start.

Can I drive my rig to the test?
Yes, but please call ahead so we can make sure there's room.

Do I need to bring my truck with me?
No. You will be driving one of ours.

Am I allowed to bring my cell phone?
Yes. You're welcome to catch up on your messages while you're waiting in our driver lounge for your turn to drive. You'll need to put it away while you're behind the wheel.

How many drivers do you need?
We have to recruit a total of 100. Only a few will come from any one company.

AT THE SITE

What happens if I don't complete the event because I decide it's not for me when I get there or quit at some point during the event?
You are free to leave or quit at any time. You don't have to give a reason if you leave or quit. You will have to complete the whole study to receive the full payment.

Will food and drink be provided because of the duration of the event?
We will have snacks and drinks.

Will I be alone while in the truck?
No. One of our test drivers, a trucker himself, will be there with you. He will explain every event before it happens and answer your questions.

What are the types of things I will be doing in the truck?
You'll first just take a lap down the track to become familiar with the truck. Then you'll drive four separate events. Each time you'll get up to 35 mph, the car around you will do something like hide in your blind spot or stop suddenly in front of you. The technology will give you a warning. The test driver in the cab with you will explain each event before it happens so you know exactly what to expect.

CONFIDENTIALITY

Will my information be shared with any third parties?
No. Your personal information will be locked and kept separate from your opinions. Some outside agencies will have access to your information, but only to audit the research team to make sure they are respecting your privacy.

Will my information be shared with my employer?
Absolutely not. You need to coordinate your work schedule with your employer because of the Hours of Service rules. But none of your opinions, answers, or anything else will get back to your employer or anybody outside the research team.

Who will see my responses and will my name be attached?
In any reports we publish, your answers will be just one of about 100 other answers. The only people who see your individual responses will be the team's researchers, and they have all promised to respect your privacy. In fact, your name will not even be on the questionnaires.

Who is running the clinic?
Battelle is in charge of the team. The test drivers are from the Transportation Research Center in Ohio. A company called Automotive Events is organizing the details. The work is for the United States Department of Transportation.

Will you take video of my driving? Will you record my voice?
We will. But nobody outside the research team will see the video, and the team have all promised to respect your privacy.

Dear _____,

Thank you for registering for our Driver Clinic. Your appointment is at _____ on _____.

The clinic is at the Transportation Research Center Inc. It is between Marysville and Bellefontaine on Route 33, about an hour northwest of Columbus. Exit at State Route 347. The TRC entrance is immediately east of the exit. A map is on our web site www.DriverClinic.org. Click on Locations.

When you arrive, drive up to the gatehouse, where they will have your name. Please plan to arrive at least 15 minutes before your appointment, so we can take you from the gatehouse to the test center.

You should be finished about two hours after you start. If we ask to stay for an extra interview and you decide to accept, that will be an extra half hour.

If you need glasses or sunglasses, bring them. And don't forget your CDL!

The other side of this page has other details to keep in mind.

If you need to cancel or change your appointment, please call us back at 1-800-242-4118.

See you soon!

The Driver Clinics Team

Things to keep in mind:

- ✓ Come by yourself; do not bring a friend or child, as there will be nowhere for them to wait.

- ✓ At the site, you will be asked to complete a brief survey, which gathers some basic demographic information, and then you'll be escorted to one of the test rigs. You'll be accompanied by another professional truck driver who will explain the various courses you will be driving, and then you will take the wheel, and test out the various situations. Then we'll ask what you thought. Driving all of the scenarios and answering questions about each of the safety systems should take about 2 hours.

- ✓ Your identity will be kept strictly confidential. You will be identified by a code number on the data records. You will be videotaped and audiotaped in the cab of the vehicle, and the interview may also be audiotaped for research purposes only. These will also be kept confidential.

- ✓ If you complete the entire study, you will be paid $200. If you stay and complete the entire driving study and are selected for half-hour interview, you will be paid a total of $225.

- ✓ You will receive a cash payment at the conclusion of your participation. We will give you a gas card for your mileage.

- ✓ By accepting payment for your time and completing all of the tasks, you agree not to discuss this research with anyone, publicly or privately, in order to avoid biasing future participants, for at least 6 months.

- ✓ Remember, you must log the driving time, and it counts towards your hours of service.

- ✓ We'll need to look at your CDL at the site.

- ✓ If you need glasses or sunglasses, bring them along.

- ✓ The day before your appointment, someone will call to remind you and confirm your participation.

- ✓ If you have any questions, please call us back at 1-800-242-4118.

Connected Commercial Vehicle Driver Clinics
On-Site Re-Screening Checklist

Greet arriving participants with a friendly smile and thank them for coming. Ask if they need a small snack or other convenience before beginning. Ask if the participant has any questions before beginning.

When the participant is ready, follow this checklist to confirm the participant's eligibility.

CDL

1. Ask to see the participant's CDL.
2. Confirm that it is a Class A Commercial Driver License and that the photo matches the participant.
3. Write the participant's name on the back of the Informed Consent Form
4. Write the participant's birthdate (from the CDL) on the front page.
5. Confirm that the participant is at least 21 years old (born before June 1991).
6. Return the CDL to the participant.
7. DO NOT write the Participant Study Number on the Informed Consent Form.

Self-Certifications

Participants should have already answered these questions on the phone, but check again to be sure.

1. Have you professionally driven a combination vehicle within the past year? Expect YES.
2. Is your CDL currently suspended or revoked? Expect NO.
3. Are your currently out of service? Expect NO.
4. You realize that since we're going to pay you, that you have to log the time as on duty? Expect YES.
5. Do you have a couple hours left today, and you'll be ok for your next shift? Expect YES.
6. Are you in reasonably good health? Expect YES.
7. Have you had more than two moving violations in the past three years? Expect NO.
8. Have you caused an injury crash in the past three years? Expect NO.
9. Are you taking any medicines that will interfere with your driving today? Expect NO.
10. Is any member of your immediate family employed in the design, engineering, or testing of technologies for automotive or trucking applications? Expect NO.
11. Is any member of your immediate family employed by Battelle, TRC Inc., or Automotive Events? Expect NO.

Informed Consent Form

1. Give the Informed Consent Form to the participant.
2. Ask the participant to read it.
3. Tell one of the Battelle staff that the participant is waiting.

C-2. Informed Consent Form

This is the Informed Consent Form that was discussed with and signed by the participants.

DEPARTMENT OF TRANSPORTATION

CONNECTED COMMERCIAL VEHICLE INFORMED CONSENT

Title:	Connected Commercial Vehicle Driver Clinic
Sponsor	United States Department of Transportation
Principal Investigator:	Doug Pape
Name of Institution:	Battelle Memorial Institute (Battelle)
Address:	505 King Avenue, Columbus, OH 43201

Participant Study Number: _____

Date of Birth (from license) _____

NATURE AND PURPOSE OF THE STUDY

You're invited to take part in a research study to learn professional drivers' opinions of new safety equipment. The project is evaluating a technology, called V2V, or Vehicle-to-Vehicle communication. V2V is a safety system where vehicles communicate wirelessly with other vehicles or with the roadway to provide warnings about potentially dangerous situations. You're being asked to volunteer because you're a truck driver and you're interested in participating in research.

This research study is sponsored by the United States Department of Transportation and is under the direction of Mr. Doug Pape from Battelle. Battelle's Institutional Review Board (IRB), a committee responsible for assuring this study is designed to protect your rights as a human subject, approved this study.

In this study, we'd like to learn your opinions about the new technologies. We're interested in what you think about the warnings, and whether you think they are easy to understand and useful. We hope that the results of this study will help improve the safety equipment in vehicles.

This study will involve approximately 100 CDL-A holders. Your part in the study will take about two hours.

The study is divided into four parts:

1. QUESTIONNAIRE. We'll ask you to complete a questionnaire about your driving experience, familiarity with in-cab electronics, and opinions about electronic safety systems.

2. DRIVE. We'll ask you to drive a tractor-trailer equipped with V2V. During the DRIVE time, there will be about five scenarios that are similar to situations you have

probably experienced. Some of these are a car in your blind spot, a vehicle abruptly stopping in front of you, and crossing a busy intersection. The scenarios are intended to trigger a warning. After each one, we'll ask you for your opinion about the warning and how useful it may be in the situations you encounter on the job.

3. QUESTIONNAIRE. We'll ask you to complete another questionnaire. We'd like to learn whether you think the system would be helpful in the real world, and whether you've been in situations where the system could have prevented an accident.

4. INTERVIEW. We're selecting drivers to interview, and we may ask to interview you to learn more about your opinions about the system. Regardless of whether you are interviewed, we'll conclude the study with a discussion of your experience, and you can ask any questions you wish about the system or the study.

VOLUNTARY PARTICIPATION
You're free to refuse participation in this study. You can also change your mind and withdraw your consent at any time without giving a reason.

RISKS
This study involves the same amount of risk as you encounter driving for your job. We'll tell you exactly what to expect before each scenario. All other vehicles in this test are driven by professional drivers. No surprises are planned. Two organizations' safety teams have reviewed the study. Another truck driver will be in the cab with you to explain what's going to happen and to monitor the equipment. Please follow his instructions, but if you feel uncomfortable with any scenario, you don't have to do it.

You'll have an opportunity to become familiar with the test vehicle before the experiments begin. For your safety, remain in the vehicle and in the safety zones. There is a remote possibility of a collision on the track, so we ask that you drive with care.

If you're injured while taking part in this research study, we'll contact an emergency medical service to transport you to a medical center or hospital. Battelle won't be able to provide you with any medical treatment or financial compensation, except as provided through remedies available by law.

Your time at the study counts towards your hours-of-service, so there is a risk that you may disrupt your work schedule, if you haven't accounted for time to participate.

BENEFITS
There's no direct benefit to you for volunteering, but your participation in this research may benefit society in general by helping us to develop safer vehicles.

TERMINATION
We may end your participation in the study without your consent if you don't sign this consent form, if you don't follow instructions, or if you don't meet the selection criteria in the screening questionnaire. It's also possible that the research team may decide to end the study early, because of weather conditions, safety concerns, or equipment failures. If the team ends the study, you will receive full payment.

CONFIDENTIALITY

We'll treat your identity in this research study as private. Shortly after participation, your name will be separated from your information, and a code number will be assigned to your information that is sent to other members of the project team. Your information includes the questionnaires you complete, the audio recording of your interview (if you are interviewed), the data about the speed and direction of the vehicle as you drive, and the video recording of the inside of the cab. It's possible that you could be identified from the video recording of the cab. Images of your face will be seen only by researchers in this study who have promised to respect your privacy. No recognizable image of you will appear in any report or web site, and your opinions and comments will be anonymous.

By signing this consent, you're giving the Battelle research team permission to use and share the information you provide us for this study. You're also giving the Battelle team permission to give your name, to two groups, if they request it. These groups may use your records to check the information collected in the study and to check how the study is conducted or for other uses allowed by law, without violating your confidentiality, to the extent permitted by law. The two groups are

- The United States Department of Transportation
- Battelle's Institutional Review Board

You're also giving permission for regulatory groups, such as the United States Department of Health and Human Services, to view your data if they choose to do so for auditing purposes.

We'll keep all audio, video, digital, and paper records in a secure location. The information other team members receive won't include information that could identify you, but it's possible that you may be recognized from the video recording in the cab.

The Department of Transportation may also re-analyze the data from this study at a later date, and may carry out extra tests on data collected during the study or perform further statistical tests on the data. By signing this consent form, you agree that we can keep your personal information and all data collected in this study in a research database indefinitely for future research.

FINANCIAL CONSIDERATIONS

For your time and effort in helping us with our study, you'll receive a payment of $200 when you complete the study. You must complete the study in order to receive payment. If you are invited to participate in an interview and do so, you will receive an additional $25. There are no costs to you to participate in this study. If you drove more than 25 miles to reach the the clinic, you'll receive compensation to cover your gas expenses.

OBTAINING ADDITIONAL INFORMATION

If you have any questions about this study, you may call Doug Pape at (614) 424-5667 or Denny Stephens at (614) 424-4469. If you have any questions about your rights as a research participant, you may call Battelle's IRB Manager, Gary Sapp at (614) 424-7648.

AUTHORIZATION

I have read and understand this consent form, and I volunteer to take part in this research study. I understand that I will receive a copy of this form. I understand that my consent does not take away any legal rights in the case of negligence or other legal fault of anyone who is involved in the study. I further understand that nothing in this consent form overrides any applicable federal, state, or local laws regarding informed consent.

Participant Volunteer

_____ _____/_____
Name (Printed) Date Time

_____
Signature

Person Obtaining Consent

I, _____, verify I have discussed this research study and its nature, purpose, objectives, methods, associated risks, and benefits with the subject volunteer. All study procedures were reviewed in detail, and the subject was given ample time and opportunity to ask questions and all questions were answered fully. The discussion and signing of the informed consent document occurred prior to commencement of any study related procedures. The subject was provided with a copy of the signed consent form.

_____ _____/_____
Signature (Person Obtaining Consent) Date Time

Participant's Certifications

I, _____, hereby certify that I am at least 21 years of age and have a valid Class A Commercial Drivers License (CDL-A) that is not suspended or revoked. I am in reasonably good health. I have not had more than two moving violations in the past three years, and have not caused an injury crash in the past three years. I also certify that I will log my participation time as "on duty" and I understand the effect of my participation on my work schedule.

_____ _____/_____
Signature Date Time

C-3. Pre-drive Questionnaire

After the participants signed the Informed Consent Form, they were given a pen and asked to fill out this form asking for background and demographic information.

Participant #	Date, Time
OH / CA	

DAC Pre-Drive Questionnaire

1. Age: _____

2. How many years have you had held a CDL-A? _____

3. How many years have you driven a tractor-trailer? _____

4. What types of routes do you have experience driving? (circle all that apply)
    a. Local
    b. Over the road
    c. City driving
    d. Truckload
    e. Less than truckload

5. What types of trucks do you have professional experience driving? (circle all that apply)
    a. Straight truck with no trailer
    b. Tractor with van semitrailer
    c. Tractor with flatbed semitrailer
    d. Tractor with tank semitrailer
    e. Truck with a pull trailer
    f. Tractor with more than one trailer
    g. Vocational (mixer, refuse, etc.)
    h. Class 6 or below
    i. Passenger (bus or motorcoach)

6. Do you usually drive as an … ?

    a. Employee driver
    b. Owner-operator

7. What is your primary truck? (circle one)
    a. Freightliner
    b. International
    c. Kenworth
    d. Mack
    e. Mitsubishi Fuso
    f. Peterbilt
    g. Sterling
    h. Volvo
    i. Western Star
    j. Other

Participant #	Date, Time
OH / CA	

8. If you frequently drive another make, what is it?
    a. Freightliner
    b. International
    c. Kenworth
    d. Mack
    e. Mitsubishi Fuso
    f. Peterbilt
    g. Sterling
    h. Volvo
    i. Western Star
    j. Other
    k. I usually drive only the one make.

9. Which of the following devices are installed or available to you in your primary truck? (Some appear under more than one name.)

Electronic Device	Installed	Don't Know	Not Installed
Adaptive Cruise Control			
Cadec			
CB Radio			
Cell Phone			
Cruise Control			
DriveCam or other video camera			
Eaton Vorad			
Electronic Stability Control (ESC)			
Electronic On-Board Recorder (EOBR)			
Electronic Log Book			
Forward Collision Warning			
GPS Navigation System			
Iteris			
Lane Departure Warning			
OnGuard			
Qualcomm			
Rear Vision Camera			
Roll Stability Control			
Tire Pressure Monitoring			
Wingman			

Participant #	Date, Time
OH / CA	

10. Which devices would you like to have installed or available in your truck?

Electronic Device	Desirable	Don't Know	Not Desirable
Adaptive Cruise Control			
Cadec			
CB Radio			
Cell Phone			
Cruise Control			
DriveCam or other video camera			
Eaton Vorad			
Electronic Stability Control (ESC)			
Electronic On-Board Recorder (EOBR)			
Electronic Log Book			
Forward Collision Warning			
GPS Navigation System			
Iteris			
Lane Departure Warning			
OnGuard			
Qualcomm			
Rear Vision Camera			
Roll Stability Control			
Tire Pressure Monitoring			
Wingman			

11. Which of the following features have you experienced on a passenger car, either yours or somebody else's?

Feature	Experienced	Have Not Experienced
Adaptive Cruise Control		
Head-Up Display		
Navigation System		
Lane Departure Warning System		
Rear Vision Camera		
Park Assist		
Cross-Traffic Alerting System		
Bluetooth		
Forward Collision Alerts		
Tire Pressure Monitoring		

Thank you!

Please tell the host that you have finished the questionnaire and are ready to drive.

Participant #	Date, Time
OH / CA	

Study Withdrawal, Termination, or Adverse Event	
Describe reason for withdrawal or termination or event. Describe action taken, if necessary.	Date
	Adverse event? (circle one) YES NO
	If yes, date reported to IRB
	If yes, date reported to U.S. DOT

C-4. In-vehicle Protocols and Debrief Questionnaires

The pages in this booklet were in a three-ring binder that the Test Conductor held during the driving session. The sketches were used to explain the scenarios to the participants, and the Test Conductors recorded the responses after each scenario in the booklet.

Participant #	Date, Time
OH CA	

Tractor Orientation

When the participant enters the cab, the test conductor will put the participant at ease. The test conductor will allow the participant to adjust the

- Seat
- Mirrors
- Steering Wheel
- Windshield Wipers
- Air Conditioning

The test conductor will cover the following topics using words similar to these.

Safety

Safety is our first priority. To demonstrate the vehicle-to-vehicle communication features, we will put you in realistic driving situations. But these are not intended to be dangerous situations. You will always have plenty of time to brake.

How a situation works

We're going to show you four features of the safety system. It's the same four you saw in the video indoors. The passenger car and moving truck will be working with us. I will always tell you where they are going to be. There are no surprises. I will show you a diagram of what's going to happen. If you have any questions, be sure to ask me before we start driving.

Familiarization drive

Start off by driving down toward this curve (the north loop of the Skid Pad). When you get up to about 35 mph, I'll have you brake so you are familiar with the feel of the brakes. Then I'll have you come to a stop as you leave the curve.

If anybody asks,
The engine is a Detroit Diesel DD13 12.8L 450 HP @ 1800 RPM, 2080 GOV RPM
The transmission is an Eaton Fuller Ultrashift

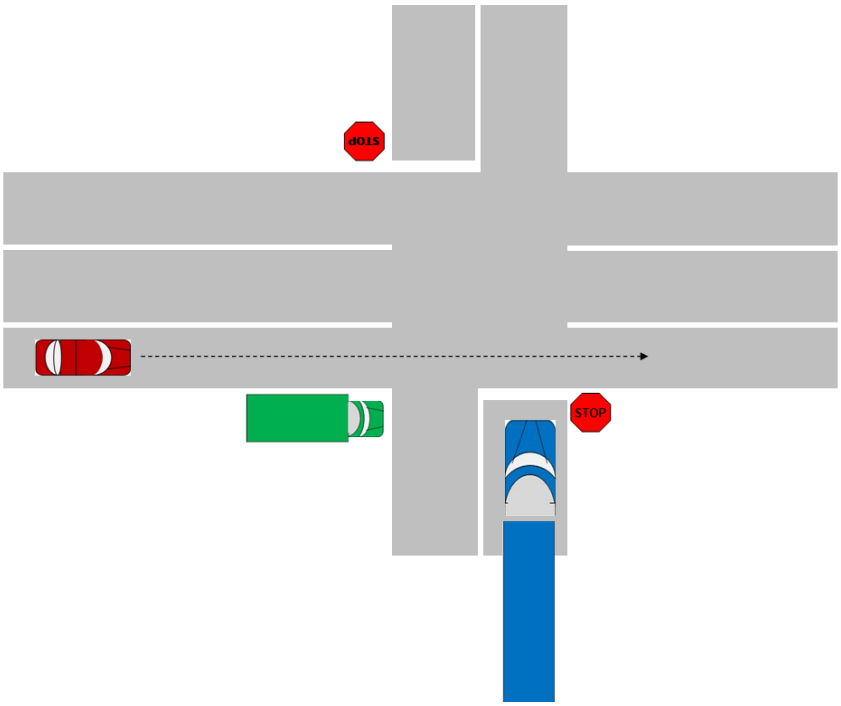
Participant #	Date, Time
OH CA	

Busy Intersection

Your first experience will be the Busy Intersection safety feature. It warns you when it is not safe to enter an intersection because somebody else is coming from the cross direction. As you pull forward, one of our helper cars will be driving past. When I tell you, you will begin to pull out. Don't really pull in his path; just pull a foot or so forward like you're starting to enter the intersection. You should get a warning down here on the instrument panel and hear a sound telling you not to enter the intersection.

Imagine that you are stopped at an intersection that you want to drive straight through. It is a 2-way stop; the traffic coming from your left and right have the right of way and do not stop. Also imagine that your view is blocked, for example by a parked truck, making it difficult to see traffic heading toward the intersection. As you release the brake to creep forward, you will receive a warning that the car is headed toward the intersection.

Do you have any questions before we begin?



Execution of the "FCW Stopped RV in Same Lane" Scenario

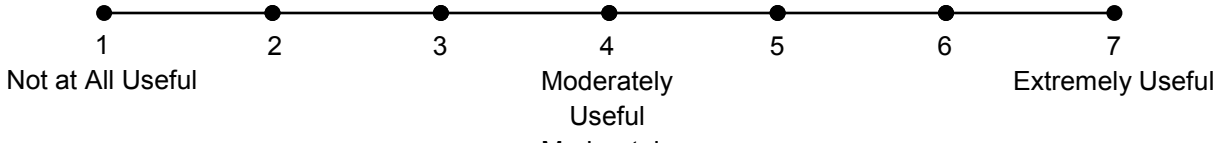
- Confirm the van isin position. Tell RV1 to proceed.
- Tell the participant when to release the brake.

Do you have any questions about what you just experienced?

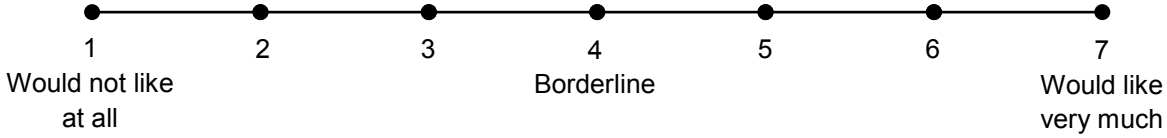
Participant #	Date, Time
OH CA	

Busy Intersection In-Vehicle Debrief

1. How useful do you think a Busy Intersection warning would be in the real world?

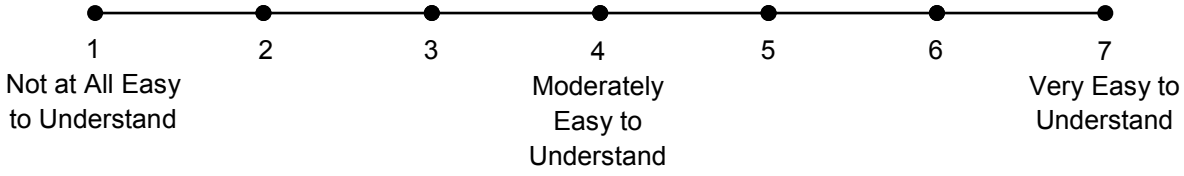


2. Would you like to have a safety feature like this on your own truck?



3. How effective was the warning to you?

4. Was the warning easy to understand?

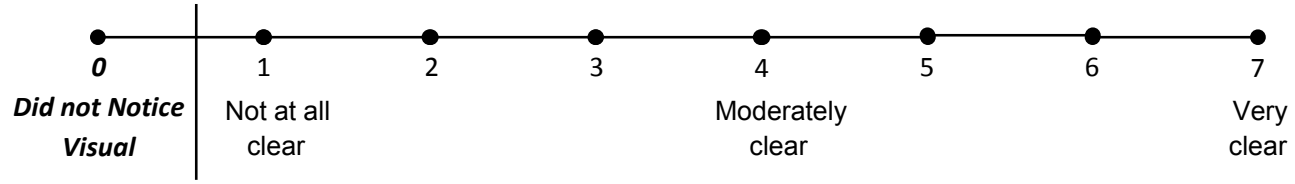


   a. If answer on Question 4 is less than 4 (moderately or less), ask, “What about the warning did you find confusing?”

Participant #	Date, Time
OH CA	

5. Which type of alert was the most useful? (choose one, where applicable)
   - ☐ Auditory alert only
   - ☐ Visual alert only
   - ☐ Auditory and Visual

6. Was the visual warning clear and obvious?



7. Could you describe any concerns, suggestions for improvement, or any other comments you might have for this safety feature?

8. Experimenter Notes

What warning did the participant receive?

_____ Caution (yellow) only

_____ Imminent Warning (red) only

_____ Yellow then red

_____ Red then yellow

_____ Nothing happened.

_____ Something else happened.

Notes of interest specific to this scenario:

Participant #	Date, Time
OH CA	

Forward Collision Warning

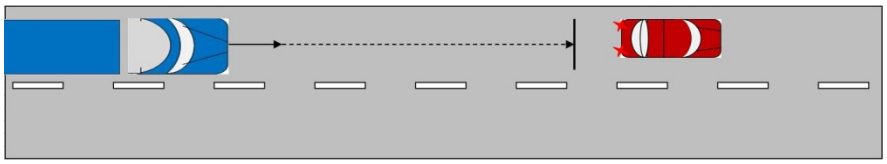
Now we are ready for the Forward Collision Warning. It warns you when there is a danger of a rear-end collision with a stopped car ahead. It is intended to help you avoid or at the very least reduce the severity of a rear-end collision.

Imagine that somebody is stopped ahead in your lane. The Forward Collision Warning safety feature will tell you about it.

First, we would like you to get up to 35 mph. As you drive, we will approach a stopped car in our path. Try to maintain 35 mph until you get the warning, and then bring our truck to a complete stop within our lane.

Remember that your first priority is driving safely. As a precaution, the driver of that car has gotten out and is standing off to the right in the grass.

Do you have any questions before we get started?



Execution of the "FCW Stopped RV in Same Lane" Scenario

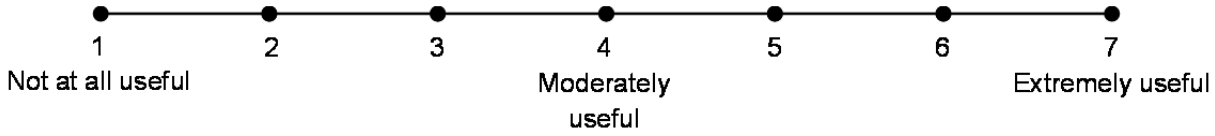
- Confirm that RV1 is in position and that the driver is out of the vehicle.
- Provide basic guidance to participant when needed on travel lane, speed
- **You may need to instruct participant to stop if FCW is not issued within expected window.**

Do you have any questions about what you just experienced?

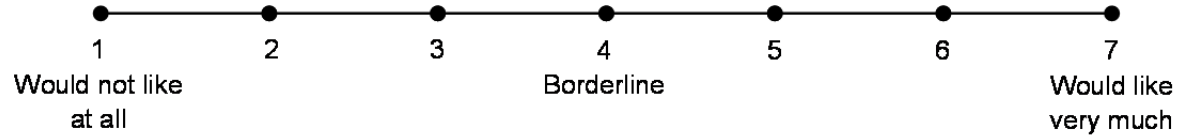
Participant #	Date, Time
OH CA	

FCW In-Vehicle Debrief

9. How useful do you think this forward collision warning would be in the real world?

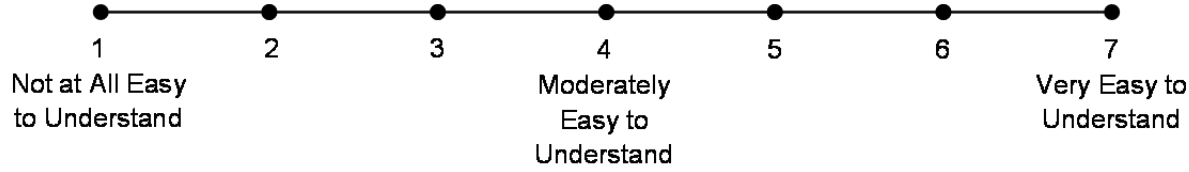


10. Would you like to have a safety feature like this in your own truck?



11. How effective was the warning to you?

12. Was the warning easy to understand?

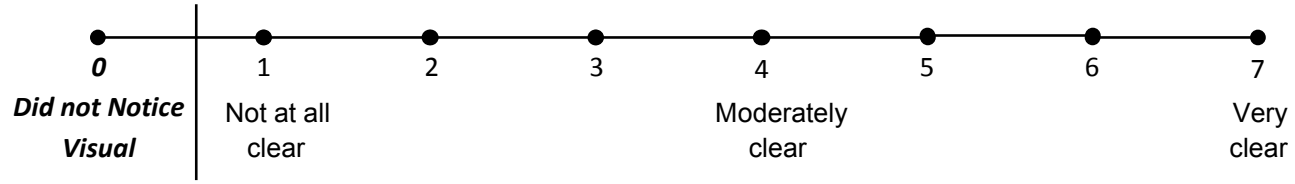


13. *If the answer on question 4 is less than 4 (moderately or less), ask:* "What about the warning did you find confusing?"

Participant #	Date, Time
OH CA	

14. Which type of alert was the most useful for the forward collision warning? (choose one, where applicable)
    - ☐ Auditory alert only
    - ☐ Visual alert only
    - ☐ Auditory and Visual

15. Was the visual warning clear and obvious?



16. Do you have any concerns, ideas for improvement, or other comments for the forward collision warning

17. Experimenter Notes: FCW Stopped RV in Same Lane

What warning did the participant receive?

_____ Caution (yellow) only

_____ Imminent Warning (red) only

_____ Yellow then red

_____ Red then yellow

_____ Nothing happened.

_____ Something else happened.

Notes of interest specific to this scenario:

Participant #	Date, Time
OH CA	

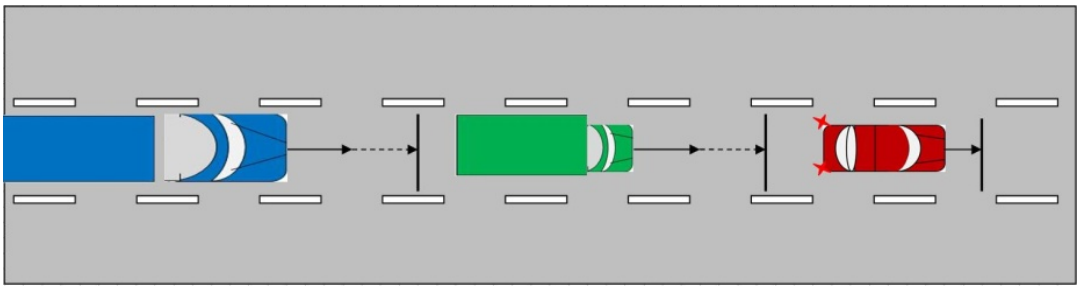
Emergency Electronic Brake Lights

Next is the Emergency Electronic Brake Lights warning. It warns you of a suddenly slowing car ahead of you. This is useful when your view ahead is blocked by another truck.

Imagine that three vehicles are traveling together in the same lane; your truck is third in the row, and your view of the car is blocked by the other truck you are following. For some reason, like a deer crossing the road or a crash up ahead, the front vehicle brakes rapidly. The Electronic Brake Lights tell you before you see brake lights from the rental truck.

Do you understand? Here's what's going to happen.

The car in front is going to get up to 35 mph. You and that rental truck in front of us are going to follow at a safe distance. When we are all up to speed, the car, will suddenly brake. You won't be able to see its brake lights, but the display here will tell you. This abrupt braking will require both you and the rental truck in front of you to slow to a stop in our lane. Remember that your first priority is driving safely.



Do you have any questions before we get started?

Participant #	Date, Time
OH CA	

Execution of the EEBL Scenario

- Communicate to both RVs that HV is ready to proceed
- Provide basic guidance to participant when needed on travel lane and following distance
- When at speed, use the radio to discreetly communicate to RV1 that steady state has been achieved and that the RV1 should execute the braking within approximately 5 seconds by saying, *"OK, please hold your speed at 35 mph and continue to follow at a safe distance."*

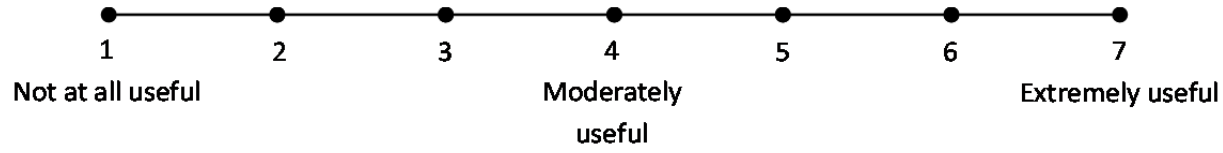
- **You may need to instruct the participant to stop if EEBL is not issued within the expected window.**

Do you have any questions about what you just experienced?

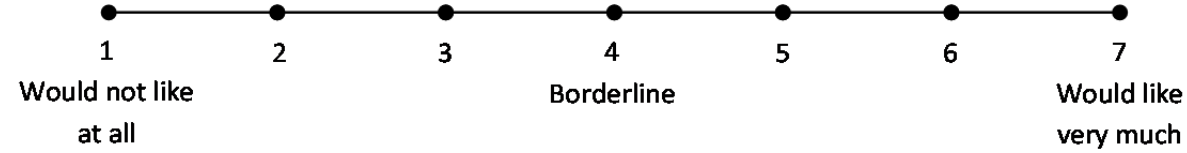
Participant #	Date, Time
OH CA	

EEBL In-Vehicle Debrief

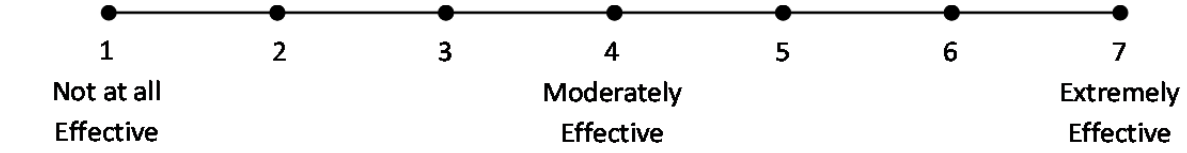
18. How useful do you think this emergency brake light warning would be in the real world?



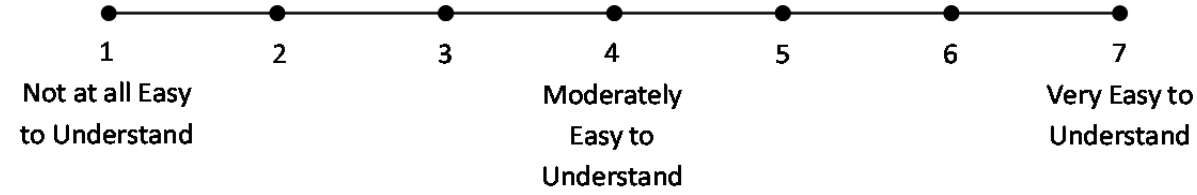
19. Would you like to have a safety feature like this in your own truck?



20. How effective was the warning to you?



21. Was the warning easy to understand?

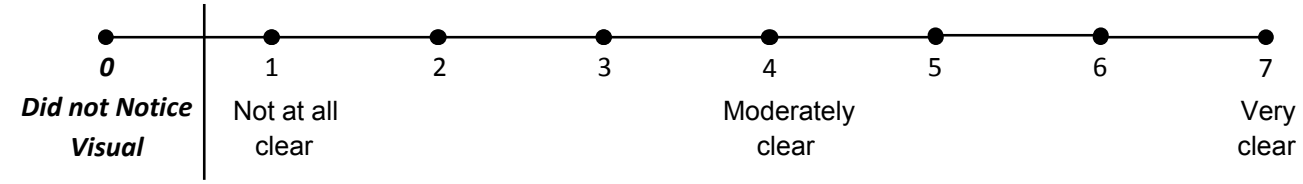


22. *If the answer on question 4 is less than 4 (moderately or less), ask:* "What about the warning did you find confusing?"

Participant #	Date, Time
OH CA	

23. Which type of alert was the most useful for the emergency brake light warning? (choose one)
    - ☐ Auditory alert only
    - ☐ Visual alert only
    - ☐ Auditory and Visual

24. Was the visual warning clear and obvious?.



25. Do you have any concerns, ideas for improvement, or other comments for the emergency brake light warning?

26. Experimenter Notes

What warning did the participant receive?

_____ Caution (yellow) only

_____ Imminent Warning (red) only

_____ Yellow then red

_____ Red then yellow

_____ Nothing happened.

_____ Something else happened.

Notes of interest specific to this scenario:

Participant #	Date, Time
OH CA	

Blind Spot Warning

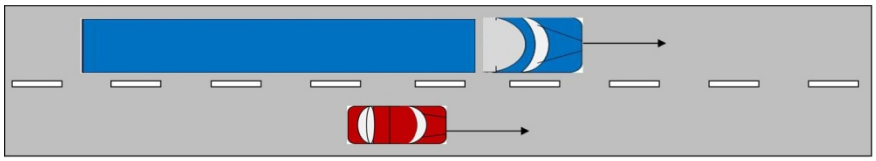
Now we are ready to test the Blind Spot and Lane Change Warning. It warns you when somebody is in your right side blind spot.

Imagine that you are driving and want to make a lane change to the right. There is a car in the lane in your blind spot.

We will have you get up to 35 mph in the left lane. As you drive in your lane, a car will approach us and enter our blind spot in the right lane. A Blind Spot advisory will tell you he's there. Then, I will also ask you to put on your right turn signal, and you will receive another message warning you not to change lanes.

Don't change lanes because there will be a car next to you. Stay in your lane and I'll tell you when to stop.

Do you have any questions before we get started?



Execution of the BSW Scenario

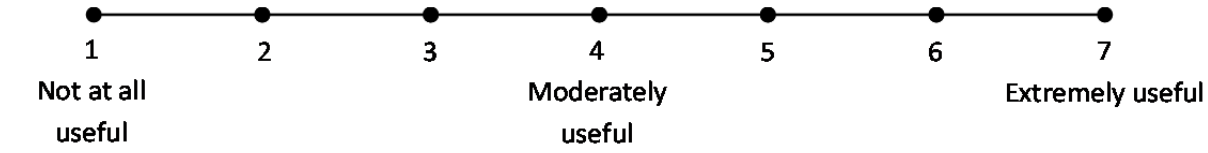
- Communicate to RV1 that HV is ready to proceed
- Provide basic guidance to participant when needed on travel lane and speed
- When at speed, use the radio to discreetly communicate to RV1 that steady state has been achieved .
- **You may need to instruct the participant to stop if EEBL is not issued within the expected window.**

Do you have any questions about what you just experienced?

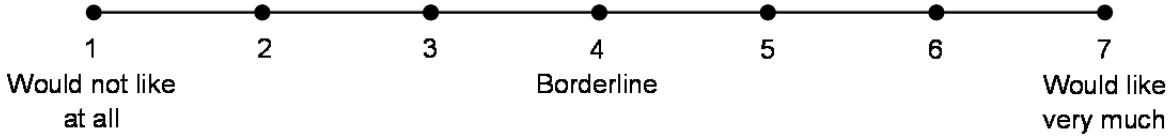
Participant #	Date, Time
OH CA	

BSW In-Vehicle Debrief

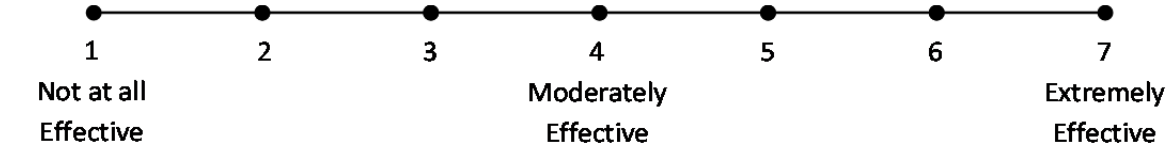
27. How useful do you think this blind spot warning would be in the real world?



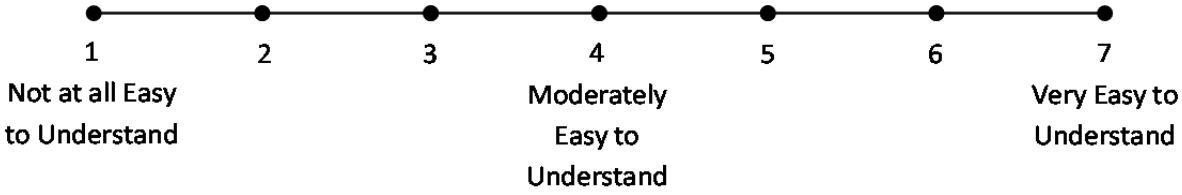
28. Would you like to have a safety feature like this in your own truck?



29. How effective was the warning to you?



30. Was the warning easy to understand?

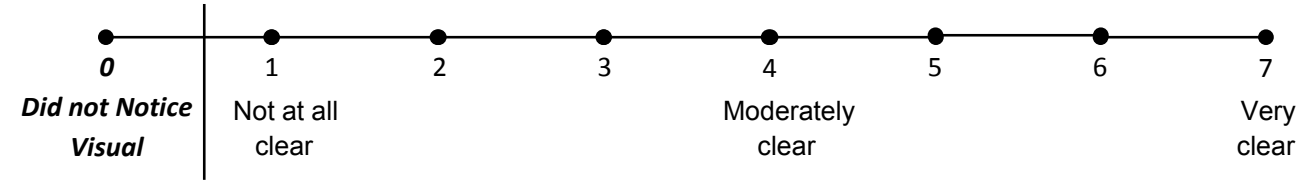


31. *If the answer on question 4 is less than 4 (moderately or less), ask:* "What about the warning did you find confusing?"

Participant #	Date, Time
OH CA	

32. Which type of alert was the most useful for the blind spot warning? (choose one)
    - ☐ Auditory alert only
    - ☐ Visual alert only
    - ☐ Auditory and Visual

33. Was the visual warning clear and obvious?



34. Do you have any concerns, ideas for improvement, or other comments for the blind spot warning?

35. Experimenter Notes

_____ Caution (yellow) only

_____ Imminent Warning (red) only

_____ Yellow then red

_____ Red then yellow

_____ Nothing happened.

_____ Something else happened.

Notes of interest specific to this scenario:

C-5. Post-drive Questionnaire

After participants returned from the driving session, they were given this questionnaire to fill out.

Participant #	Date, Time
OH CA	

Connected Commercial Vehicle Driver Clinics
Post-Drive Questionnaire

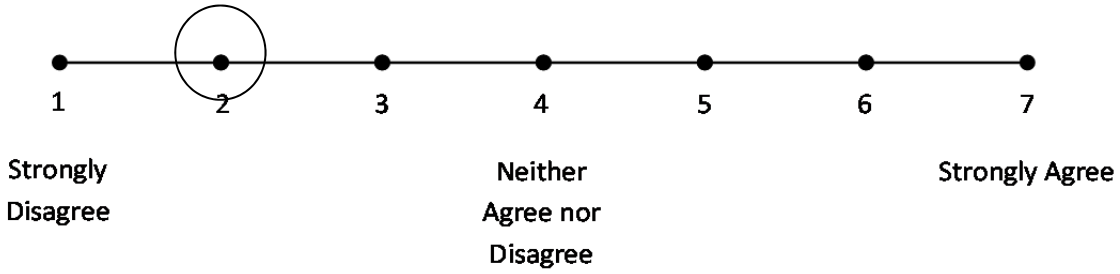
Thank you for taking time out of your busy schedule to experience the of vehicle-to-vehicle safety features.

This questionnaire is divided into seven sections:
Section 1 – The entire Vehicle-to-Vehicle safety system
Section 2 – Busy Intersection feature
Section 3 – Forward Collision feature
Section 4 – Electronic Brake Lights feature
Section 5 – Blind Spot and Lane Change feature
Section 6 – Final Opinions

Thanks again for your feedback.

Circle the number that best represents your opinion for the questions with rating scales.

Example:

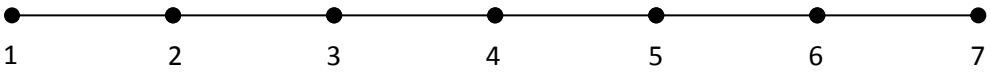


Participant #	Date, Time
OH CA	

Section 1: Questions related to all safety features you experienced today

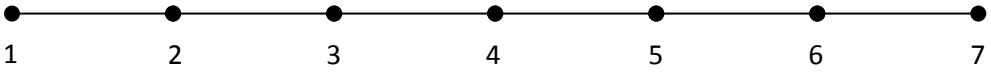
Imagine that the safety features you experienced today were grouped together as one Vehicle-to-Vehicle Communication safety package. Please answer the following questions accordingly.

1. I would like to have this Vehicle-to-Vehicle Communication safety feature on my truck.



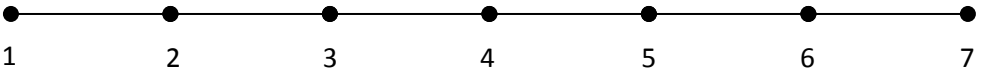
Strongly Disagree — Neither Agree nor Disagree — Strongly Agree

2. Monitoring or interpreting information provided by these safety features is no more distracting than using my truck's stereo system.



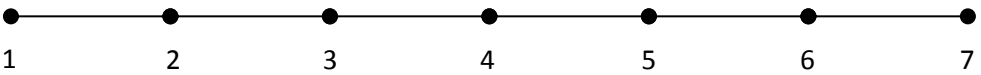
Strongly Disagree — Neither Agree nor Disagree — Strongly Agree

3. How likely is it that drivers will depend solely on these safety features to alert them to dangers in the environment?



Extremely high likelihood of dependence — Some likelihood of dependenc — No likelihood of dependence

4. How well do you feel drivers would be able to tell the difference between warnings from the different safety features you experienced today?



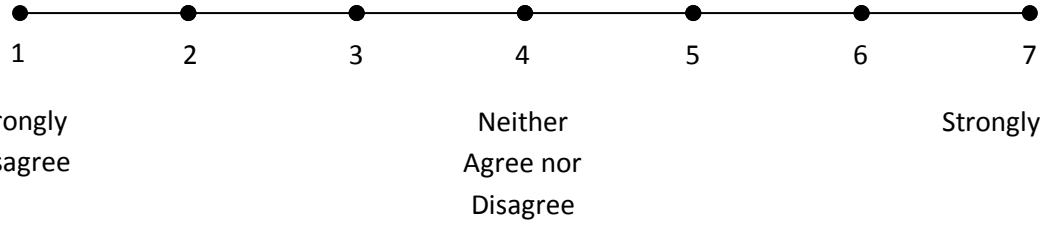
Extremely high likelihood of confusing warnings — Some likelihood of confusing warnings — No likelihood of confusing warnings

Participant #	Date, Time
OH CA	

5. Please rank the following options in terms of overall desirability, with 1 being the MOST preferred and 6 being LEAST. Use numbers 1-6 only once.

Available Option	Rank
Adaptive Cruise Control (slows down when somebody is in front of you)	
Forward Collision Warning System (Eaton Vorad or Meritor OnGuard)	
GPS Navigation System	
Roll Stability Control or Electronic Stability Control	
Tire Pressure Monitoring System	
Vehicle-to-Vehicle Warnings (All of the safety features you experienced today)	

6. It is possible that the Vehicle-to-Vehicle Communication safety feature may become <u>temporarily unavailable</u>, and not warn you when it otherwise would. With that in mind, please answer the following: I would want the device to notify me when the Vehicle-to-Vehicle Communication safety feature becomes unavailable.



7. After experiencing these Vehicle-to-Vehicle safety features first hand, please tell us how well you think you understand this technology and how it works. (check only one)

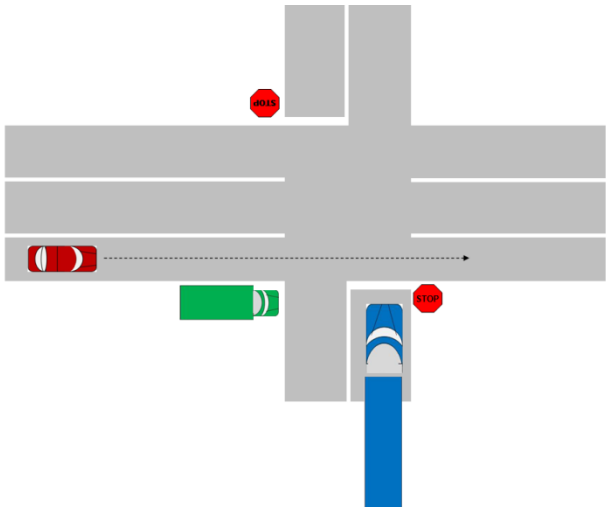
___ I don't understand it.
___ I understand it, but still have some questions.
___ I fully comprehend how this technology works.

Section 2: Busy Intersection

Participant #	Date, Time
OH CA	

The Busy Intersection feature warns drivers when it is not safe to enter an intersection because of a high chance of a collision with crossing vehicles.

During the busy intersection situation, you stopped behind the stop bar at the intersection. You were instructed to release the brake pedal, allowing the vehicle to move forward as if you were about to continue across the intersection, heading straight. The Busy Intersection feature warned you of the approaching car. This situation showed you how the feature might alert you to an unseen crossing vehicle, as you slowly enter the intersection.



8. What do you feel is the most beneficial aspect of the safety feature?

9. What, if anything, would you change about the safety feature?

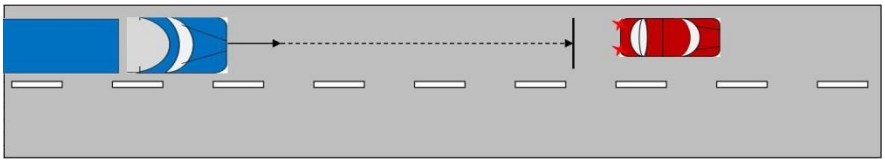
10. Under what environments and conditions do you feel the safety feature would provide the most benefit? (circle all that apply)
    a. Nighttime driving
    b. Daytime driving
    c. Driving on slippery roads (rain, ice, snow)
    d. Driving under poor visibility conditions (rain, fog, snow, glare)
    e. Driving on unfamiliar roadways
    f. Driving when your view of the road ahead is partially blocked (by cars, curves, terrain)
    g. Other, please specify:

Participant #	Date, Time
OH CA	

Section 3: Forward Collision

The Forward Collision feature warns drivers of an impending rear-end collision with the vehicle in front of them, in the same lane and direction of travel. It is intended to help drivers avoid rear-end collisions with other vehicles travelling in the same direction.

During the forward collision situation, you drove your truck up to a stopped car, until you received the warning. Forward Collision warned you that there was a chance of a rear-ender. This situation shows how the feature might work when other vehicles quickly stop in front of you.



11. What do you feel is the most beneficial aspect of the safety feature?

12. What, if anything, would you change about the safety feature?

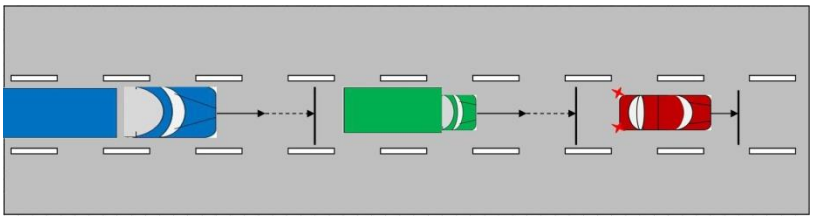
13. Under what environments and conditions do you feel the safety feature would provide the most benefit? (circle all that apply)
    a. Nighttime driving
    b. Daytime driving
    c. Driving on slippery roads (rain, ice, snow)
    d. Driving under poor visibility conditions (rain, fog, snow, glare)
    e. Driving on unfamiliar roadways
    f. Driving when your view of the road ahead is partially blocked (by cars, curves, terrain)
    g. Other, please specify:

Participant #	Date, Time
OH CA	

Section 4: Electronic Brake Lights

The Electronic Brake Lights feature alerts a driver when there is a stopped vehicle or vehicle suddenly stopping in their current direction of travel. This can be particularly useful when the driver's forward sightline is blocked, for example by other vehicles or due to low visibility.

During the electronic brake light situation you experienced today, the red vehicle suddenly put on its brakes. Your view of the red car was partially blocked by the green truck, which you were following. This sudden braking required both you and the vehicle in front of you to slow to a stop. Electronic Brake Lights warned you of the red car's sudden stop. This situation showed you how the feature might work when other vehicles or bad weather causes poor visibility of the traffic ahead.



14. What do you feel is the most beneficial aspect of the safety feature?

15. What, if anything, would you change about the safety feature?

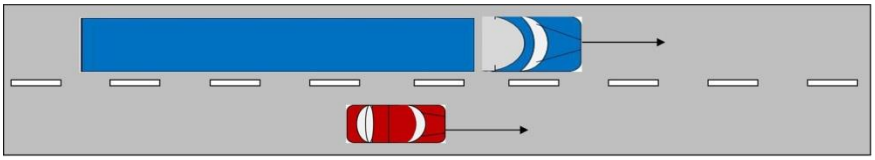
16. Under what environments and conditions do you feel the safety feature would provide the most benefit? (circle all that apply)
    a. Nighttime driving
    b. Daytime driving
    c. Driving on slippery roads (rain, ice, snow)
    d. Driving under poor visibility conditions (rain, fog, snow, glare)
    e. Driving on unfamiliar roadways
    f. Driving when your view of the road ahead is partially blocked (by cars, curves, terrain)
    g. Other, please specify:

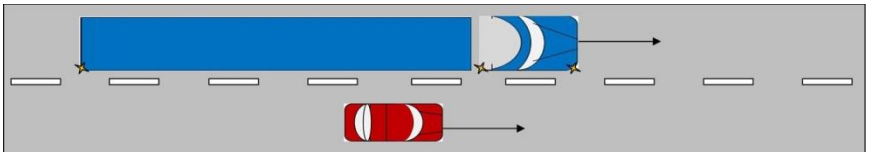
Participant #	Date, Time
OH CA	

Section 5: Blind Spot and Lane Change

The Blind Spot feature alerts drivers when a vehicle is in their blind spot. The Lane Change feature warns drivers during a lane change attempt if a vehicle traveling in the same direction is about to enter their blind-spot.

During the blind spot situation, the car entered your blind spot in an adjacent lane (see top figure). The feature alerted you to the vehicle, and it warned you when you turned on your signal (bottom figure). This situation showed you the difference between a blind spot alert and a lane change warning.





17. What do you feel is the most beneficial aspect of the safety feature?

18. What, if anything, would you change about the safety feature?

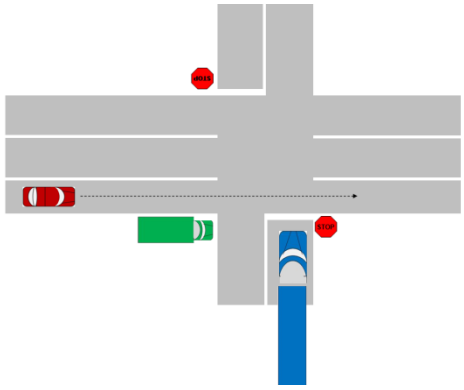
19. Under what environments and conditions do you feel the safety feature would provide the most benefit? (circle all that apply)
    a. Nighttime driving
    b. Daytime driving
    c. Driving on slippery roads (rain, ice, snow)
    d. Driving under poor visibility conditions (rain, fog, snow, glare)
    e. Driving on unfamiliar roadways
    f. Driving when your view of the road ahead is partially blocked (by cars, curves, terrain)
    g. Other, please specify:

Participant #	Date, Time
OH CA	

Section 6. Final Opinions

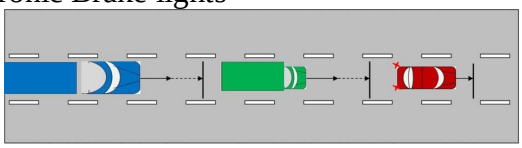
20. Rank in order of usefulness of each feature, starting with 1 being the MOST useful to 4 being the LEAST useful.

____ Busy intersection

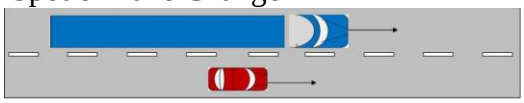


____ Forward collision

____ Electronic Brake lights



____ Blind Spot or Lane Change



21. Any final thoughts or comments on your overall experience today that you would like to provide?

THANK YOU! ☺ Please tell the host you are finished.

C-6. In-depth Interview

The interviewer followed this guide while conducting the in-depth interviews with the selected participants.

Driver Clinic In-Depth Interview Outline
Draft December 2011

OVERALL OBJECTIVE: To understand professional (CDL-A) drivers' opinions and reasons for accepting or not accepting communication-based safety systems. The qualitative information gathered during these interviews will add texture and deeper understanding of the quantitative data gathered throughout the driver clinics.

OVERVIEW: The interview outline will be determined by the nature and extent of participant responses on the pre-drive, in-vehicle, and post-drive questionnaires. Interviews are dynamic in nature; therefore, the outline presented here is a guide, not a questionnaire. Interviewees may be asked only a subset of the items below, and topics will be covered as determined by participant experience and interview time. The topics may or may not be covered in the order presented. It is the role of the interviewer to ensure that all topics are explored in sufficient detail to add depth to questionnaire responses.

FORMAT: Participants will be interviewed individually. Battelle's human factors specialist will conduct the interview, and a second Battelle staff member will usually be present to take notes or ask an occasional follow-up question. The interviews at TRC, Inc., will be in an office or conference room, and the interviews at Alameda will be in a rented camper. These are not specialized research facilities, and equipment to accommodate remote observation is not planned. We will try to keep each interview to 30 minutes. Half of the interviewed participants will have Section II (on the entire system) and half will have Section III (on the individual applications).

I. INTRODUCTION - 5 min.

A. Participant and interviewer introductions
B. Introduction to Interview *[skim questionnaire responses to see which topics below to cover in detail]*
C. Review confidentiality and recording

II. DISCUSSION OF V2V COMMUNICATION – 25 min.

A. You were introduced to V2V communication when you arrived, and then you had the opportunity to experience how the system would work in real-life applications.
   - What went through your mind during, and shortly after, that initial introduction? Why?
   - What do you think of this safety initiative, where vehicles will be able to "talk" to each other, and warn the driver when unsafe conditions arise (such as the ones you experienced today)?
   - What do you think are the main benefits of this type of safety initiative? How useful is it? Why?
   - What are some of the main drawbacks? Do you have concerns? *[if necessary, probe for distraction from the road, nuisance alarms, developing a crutch, security or confidentiality]* If so, what and why?
   - Can you foresee what it might be like, in the future, when all or most vehicles on the road will be equipped with these safety platforms? Explain.
   - How does V2V compare in usefulness to other safety features you've experienced? *[refer to pre-drive questionnaire to see participant's driving, vehicle experience]*
   - Would you want to have it installed in your cab, or not? Why?
   - What would you expect to pay for this application, if anything?

- Do you think this is more or less effective than other safety technology, like the stability control or the collision-warning radar?
- What do you think is the best way to improve highway safety?

III. REVIEW REACTIONS TO INDIVIDUAL SCENARIOS - 25 min.

A. Let's talk about each of the scenarios that you experienced today. *[refer to in-vehicle debrief questionnaire and post-drive questionnaire; use diagrams to refresh participant's memory of each scenario]*

- **Emergency Electronic Brake Lights**
  - What did you think of this scenario? How did it make you feel?
  - What went through your mind?
  - Have you ever experienced this situation in real life? How "real" was it on the test track?
  - How easy was it to understand the warning and what it was asking you to do? (DETERMINE ROOT CAUSE IF ANSWER WAS <4 on Q.5)
  - Would you improve or change anything about the warning (visual, audible, location)? Why or why not?
  - How worthwhile is this type of warning in real life situations? Why or why not?
  - Do you feel like this application is more or less effective in certain situations?
  - If this application was available, how likely are you to consider purchasing it? Why or why not? How would you feel if your employer installed it on the truck you drive?

- **Forward Collision Warning**
  - REPEAT SAME OR SIMILAR PROBES AS ABOVE
- **Blind Spot / Lane Change Warning**
  - REPEAT SAME OR SIMILAR PROBES AS ABOVE
- **Intersection Movement Assist**
  - REPEAT SAME OR SIMILAR PROBES AS ABOVE
- **Curve Overspeed Warning**
  - REPEAT SAME OR SIMILAR PROBES AS ABOVE

IV. WRAP UP, THANK AND ESCORT TO GREETER; GET READY FOR NEXT PERSON

C-7. Cash Receipt

Participants signed these receipts after they received their cash incentive and gas cards.

Connected Commercial Vehicles
Driver Clinic

Cash Receipt

I _____ have received $ _____ cash
printed name

from the Commercial Vehicle Driver Clinic.

I also received a “gas card” for $ _____.

_x_____ date _____2012_

APPENDIX D.

Materials for Trade Show Booths

Team member Meritor WABCO included the project in its booth at two trade shows. The displayed a poster and distributed flyers. This promoted the outreach efforts of the project and offered drivers the opportunity to participate in the clinics.

Battelle

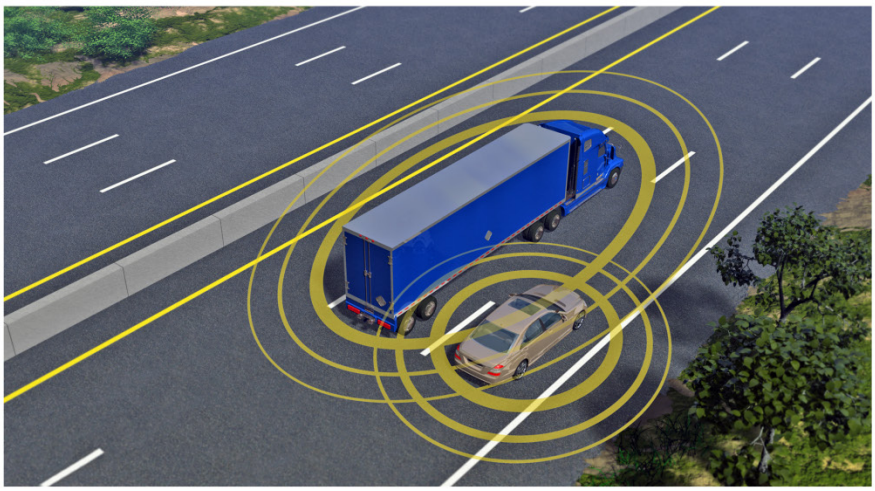
Figure D-1. This two-page flyer was distributed at Meritor WABCO's booth. Copies of the page on the right often accompanied the break room flyer when it was personally delivered to motor carriers in central Ohio.

MERITOR WABCO

Connected Commercial Vehicle
Safety Applications Development

Meritor WABCO is working with the U.S. Department of Transportation and with other leading companies to help truckers see in their blind spot.

Ask how you can take a test drive and tell us your opinion.



Radios transmit the paths of surrounding vehicles.

New equipment in your cab can provide

- Blind Spot Warning
- Forward Collision Warning
- Busy Intersection Assistant
- Emergency Electronic Brake Lights
- Curve Speed Warning
- Low Clearance Warning

Partners

U.S. Department of Transportation
Battelle The Business of Innovation
MERITOR WABCO
DENSO
DAIMLER Daimler Trucks North America
Mercedes-Benz Research & Development North America, Inc.
UMTRI

Battelle

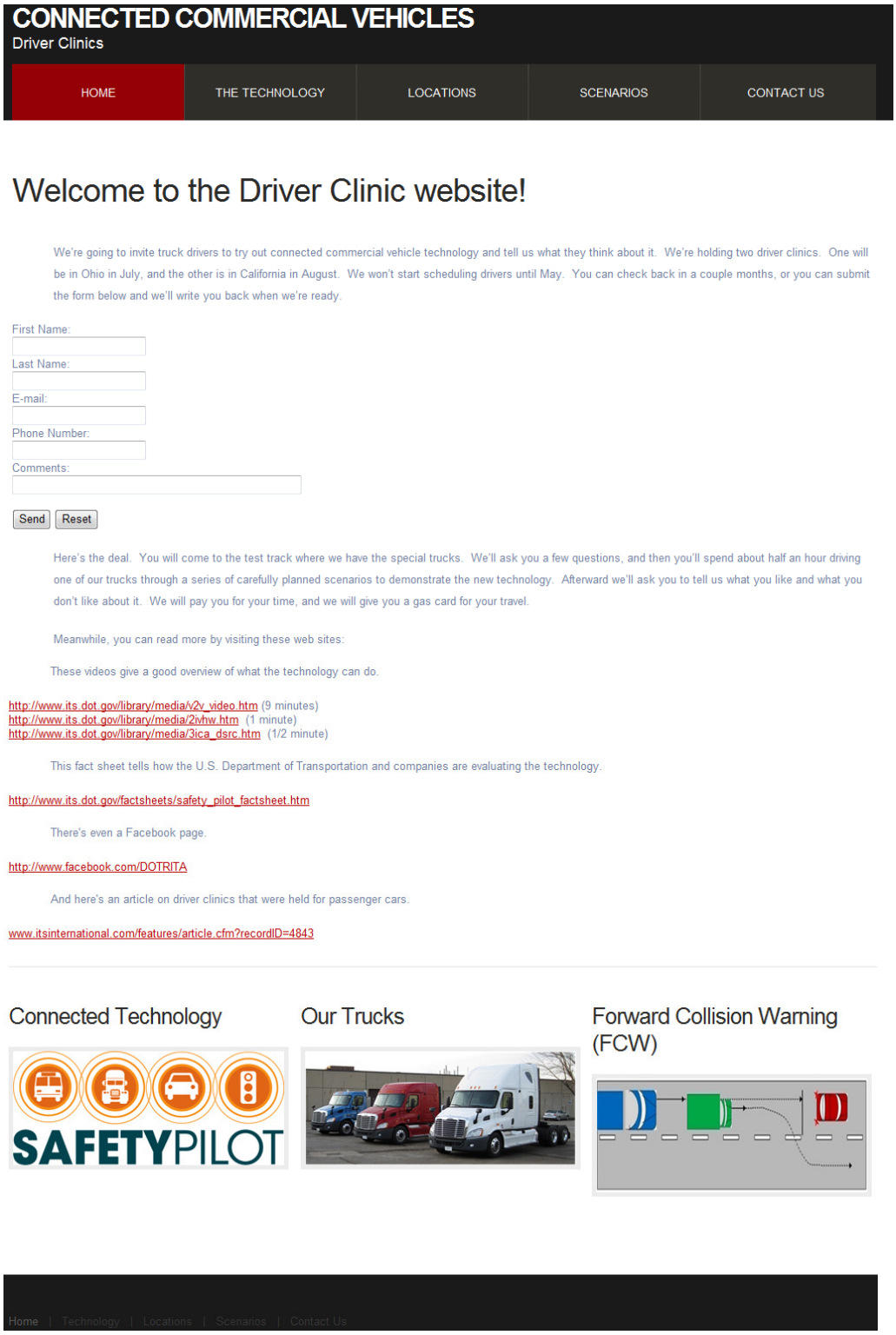
Figure D-2. Meritor WABCO displayed this poster at two trade shows.

APPENDIX E.

DriverClinic.org Web Site

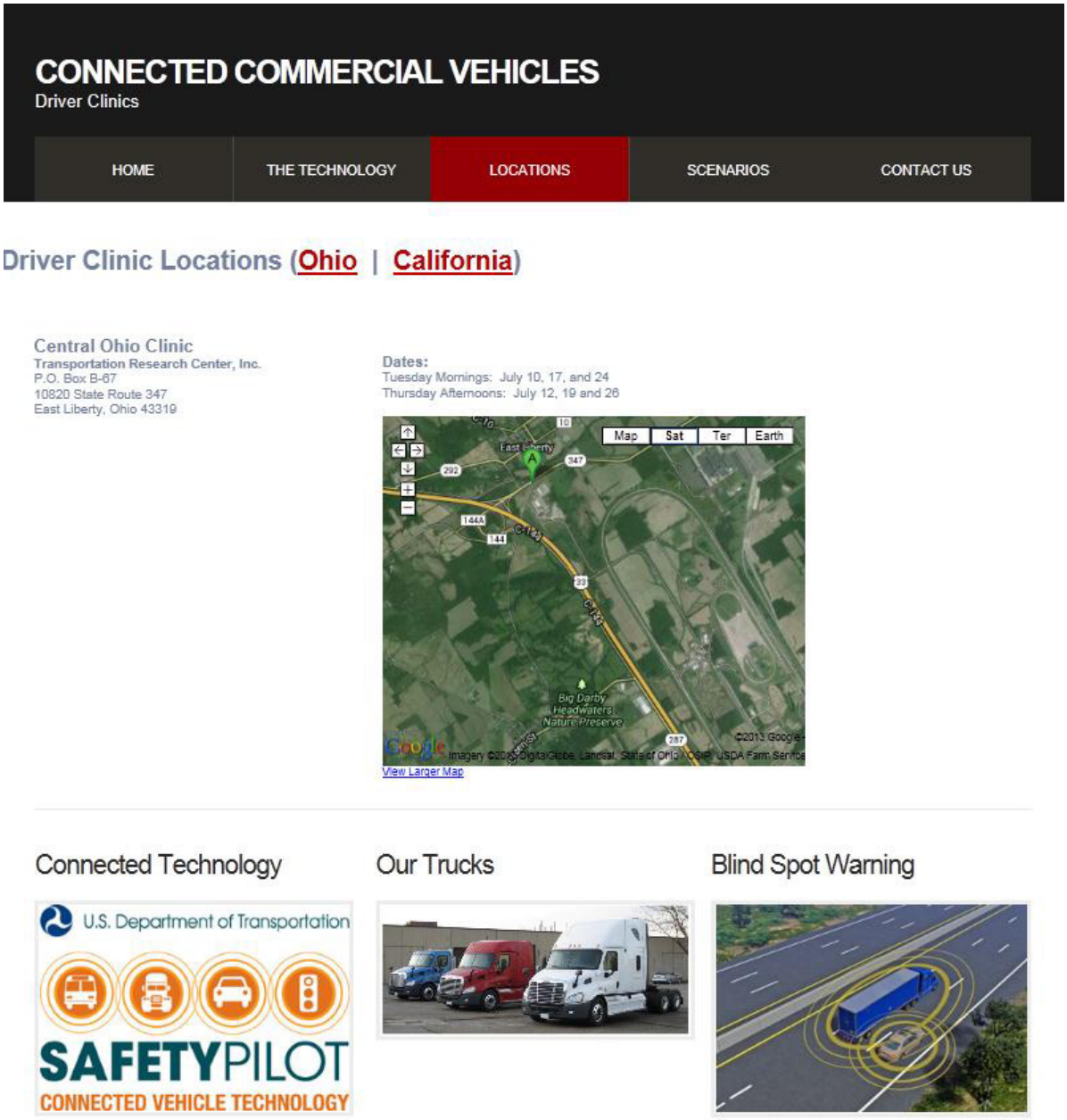
The front page of the DriverClinic.org web site was as in Figure E-1. A number of prospects filled out the form, which generated an e-mail message that the project staff forwarded to the recruiter.

The second page of the web site, the "Technology" link, had the two sides of the booth flyer (Figure D-1) and the poster (Figure D-2). The third page (Figure D-2) had an image from Google Maps with a link to create directions to the clinic site. It had a map to TRC Inc. in July and a map to Alameda Point in August. The fourth page of the web site, the "Scenarios" link, had the sketches of the scenarios, similar to Figure 2-14. The final page of the site, "Contact Us," had Battelle's name and the special e-mail address, DriverClinic@Battelle.org. Battelle's street address and web site were included to lend credibility to the site.



Battelle

Figure E-1. The front page of DriverClinic.org had images of equipment and links to USDOT web sites with information and videos on connected vehicles.



Battelle

Figure E-2. The DriverClinic.org web site had a page with a map to TRC Inc. in July. In August, the link to California had a map to Alameda Point.

APPENDIX F.

Facebook Page

Battelle

Figure F-1. This figure shows how the Facebook page looked as the California clinic was approaching. Two events, for the two days of the clinic, are in the left hand column.

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
www.its.dot.gov

FHWA-JPO-13-110

U.S. Department of Transportation