DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

Docket No. NHTSA-2010-0053

Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices

AGENCY: National Highway Traffic Safety Administration (NHTSA), Department of Transportation (DOT).

ACTION: Notice of proposed Federal guidelines.

SUMMARY: The National Highway Traffic Safety Administration (NHTSA) is concerned about the effects of distraction due to drivers' use of electronic devices on motor vehicle safety. Consequently, NHTSA is issuing nonbinding, voluntary NHTSA Driver Distraction Guidelines (NHTSA Guidelines) to promote safety by discouraging the introduction of excessively distracting devices in vehicles.

This notice details the contents of the first phase of the NHTSA Driver Distraction Guidelines. These NHTSA Guidelines cover original equipment in-vehicle device secondary tasks (communications, entertainment, information gathering, and navigation tasks not required to drive are considered secondary tasks) performed by the driver through visual-manual means (meaning the driver looking at a device, manipulating a device-related control with the driver's hand, and watching for visual feedback).

The proposed NHTSA Guidelines list certain secondary, non-driving related tasks that, based on NHTSA's research, are believed by the agency to interfere inherently with a driver's ability to safely control the vehicle. The Guidelines recommend that those in-vehicle devices be designed so that they cannot be used by the driver to perform such tasks while the driver is driving. For all other secondary,

non-driving-related visual-manual tasks, the NHTSA Guidelines specify a test method for measuring the impact of task performance on driving safety while driving and time-based acceptance criteria for assessing whether a task interferes too much with driver attention to be suitable to perform while driving. If a task does not meet the acceptance criteria, the NHTSA Guidelines recommend that in-vehicle devices be designed so that the task cannot be performed by the driver while driving. In addition to identifying inherently distracting tasks and providing a means for measuring and evaluating the level of distraction associated with other non-driving-related tasks, the NHTSA Guidelines contain several design recommendations for in-vehicle devices in order to minimize their potential for distraction.

NHTSA seeks comments on these NHTSA Guidelines and any suggestions for how to improve them so as to better enhance motor vehicle safety.

DATES: *Comments:* You should submit your comments early enough to ensure that the docket receives them not later than **[INSERT DATE 60 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]**.

Public Meetings: NHTSA will hold public meetings in March 2012 in three locations: Washington, D.C.; Los Angeles, California; and Chicago, Illinois. NHTSA will announce the exact dates and locations for each meeting in a supplemental Federal Register Notice.

ADDRESSES: You may submit comments to the docket number identified in the heading of this document by any of the following methods:

- Federal eRulemaking Portal: Go to http://www.regulations.gov. Follow the online instructions for submitting comments.
- Mail: Docket Management Facility: U.S. Department of Transportation, 1200 New Jersey Avenue S.E., West Building Ground Floor, Room W12-140, Washington, D.C. 20590-0001

- Hand Delivery or Courier: 1200 New Jersey Avenue S.E., West Building Ground Floor, Room W12-140, between 9 a.m. and 5 p.m. ET, Monday through Friday, except Federal holidays.
- Fax: 202-493-2251.

Instructions: For detailed instructions on submitting comments, see the Public Participation heading of the Supplementary Information section of this document. Note that all comments received will be posted without change to http://www.regulations.gov, including any personal information provided. Please see the "Privacy Act" heading below.

Privacy Act: Anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act Statement in the *Federal Register* published on April 11, 2000 (65 FR 19477-78) or you may visit http://DocketInfo.dot.gov .

Docket: For access to the docket to read background documents or comments received, go to http://www.regulations.gov or the street address listed above. Follow the online instructions for accessing the dockets.

FOR FURTHER INFORMATION CONTACT: For technical issues, you may contact Dr. W. Riley Garrott, Vehicle Research and Test Center, telephone: (937) 666-3312, facsimile: (937) 666-3590. You may send mail to this person at: The National Highway Traffic Safety Administration, Vehicle Research and Test Center, P.O. Box B-37, East Liberty, OH 43319.

SUPPLEMENTARY INFORMATION:

These proposed NHTSA Guidelines will lead to issuance of final NHTSA Guidelines, which will not have the force and effect of law and will not be regulations. Therefore, NHTSA is not required to provide notice and an opportunity for comment. NHTSA is doing so, however, to ensure that its final NHTSA Guidelines benefit from the input of all knowledgeable and interested persons.

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I. Executive Summary

A. The Problem of Driver Distraction and Related Research

The term "distraction," as used in connection with these guidelines, is a specific type of inattention that occurs when drivers divert their attention away from the driving task to focus on another activity. These distractions can be from electronic devices, such as navigation systems and cell phones, or more conventional distractions such as interacting with passengers and eating. These distracting tasks can affect drivers in different ways, and can be categorized into the following types:

- Visual distraction: Tasks that require the driver to look away from the roadway to visually obtain information;
- Manual distraction: Tasks that require the driver to take a hand off the steering wheel and manipulate a device;
- Cognitive distraction: Tasks that require the driver to avert their mental attention away from the driving task.

The impact of distraction on driving is determined not just by the type of distraction, but also the frequency and duration of the task. That is to say, even if a task is less distracting, a driver who engages in it frequently or for long durations may increase the crash risk to a level comparable to that of much more difficult task performed less often.

NHTSA is concerned about the effects of driver distraction on motor vehicle safety. Crash data show that 17 percent (an estimated 899,000) of all police-reported crashes reportedly involved some type of driver distraction in 2010. Of those 899,000 crashes, distraction by a device/control integral to the vehicle was reported in 26,000 crashes (3% of the distraction-related police-reported crashes).

For a number of years, NHTSA has been conducting research to better understand how driver distraction impacts driving performance and safety. The research has involved both integrated and portable devices, various task types, and both visual-manual and auditory-vocal tasks (i.e., tasks that use voice inputs and provide auditory feedback). Additionally, both NHTSA and the Federal Motor Carrier Safety Administration (FMCSA) have sponsored analyses focused on distracted driving using data from naturalistic driving studies performed by the Virginia Tech Transportation Institute (VTTI).

The automobile industry, Europe, and Japan have all conducted valuable research that has increased the available knowledge regarding driver distraction and its effects on safety. The results of this work are summarized in various sets of guidelines that minimize the potential for driver distraction during visual-manual interactions while the vehicle is in motion. NHTSA has drawn heavily upon these existing guidelines in the development of its Driver Distraction Guidelines.

B. NHTSA Driver Distraction Program

In April 2010, NHTSA released an "Overview of the National Highway Traffic Safety Administration's Driver Distraction Program,"[1] which summarized steps that NHTSA intends to take to reduce crashes attributable to driver distraction. One part of this program is the development of nonbinding, voluntary guidelines for minimizing the distraction potential of in-vehicle and portable devices. The guidelines will be developed in three phases. The first phase will explore visual-manual interfaces of devices installed in vehicles. The second phase will include portable and aftermarket devices. The third phase will expand the guidelines to include auditory-vocal interfaces.

C. Today's Proposal

This notice proposes the first phase of these NHTSA Driver Distraction Guidelines, which cover certain devices installed in vehicles as original equipment that are operated by the driver through visual-manual means (meaning the driver looking at a device, manipulating a

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[1] "Overview of the National Highway Traffic Safety Administration's Driver Distraction Program," DOT-HS-811-299, April 2010. Available at http://www.nhtsa.gov/staticfiles/nti/distracted_driving/pdf/811299.pdf.

device-related control with the driver's hand, and watching for visual feedback from the device). The driver distraction research discussed above shows that the types of tasks correlated with the highest crash/near crash risk odds ratios tend to have primarily visual-manual means of interaction, and, accordingly, this first phase of guidelines focuses on visual-manual interfaces.

The purpose of the NHTSA Guidelines is to limit potential driver distraction associated with secondary, non-driving-related, visual-manual tasks (e.g., information, navigation, communications, and entertainment) performed using integrated electronic devices. The NHTSA Guidelines are not appropriate for conventional controls and displays (e.g., heating-ventilation-air conditions controls, instrument gauges or telltales) because operating these systems is part of the primary driving task. Likewise, the NHTSA Guidelines are not appropriate for collision warning or vehicle control systems, which are designed to aid the driver in controlling the vehicle and avoid crashes. These systems are meant to capture the driver's attention.

To facilitate the development of guidelines, NHTSA studied the various existing guidelines relating to driver distraction prevention and reduction and found the "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems" developed by the Alliance of Automobile Manufacturers (Alliance Guidelines[2]) to be the most complete and up-to-date. The Alliance Guidelines provided valuable input in current NHTSA efforts to address driver distraction issues. While NHTSA drew heavily on that input in developing the NHTSA Guidelines, it did

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[2] Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC.

incorporate a number of changes in an effort to further enhance driving safety, enhance guideline usability, improve implementation consistency, and incorporate the latest driver distraction research findings.

Since light vehicles comprise the vast majority of the vehicle fleet, NHTSA focused its distraction research on this type of vehicle, instead of heavy trucks, medium trucks, motorcoaches, or motorcycles. Therefore, the NHTSA Guidelines contained in this notice cover light vehicles, i.e., all passenger cars, multipurpose passenger vehicles, and trucks and buses with a Gross Vehicle Weight Rating (GVWR) of not more than 10,000 pounds. While much of what NHTSA has learned about light vehicle driver distraction undoubtedly applies to other vehicle types, additional research would be desirable to assess whether all aspects of these NHTSA Guidelines are appropriate for those vehicle types.

The NHTSA Guidelines limit potential driver distraction associated with non-driving-related, visual-manual tasks through several approaches:

1. The NHTSA Guidelines list certain secondary, non-driving-related tasks that, based on NHTSA's research, are believed by the agency to interfere inherently with a driver's ability to safely control the vehicle. The Guidelines recommend that those in-vehicle devices be designed so that they cannot be used by the driver to perform such tasks while the driver is driving. The list of tasks considered to inherently interfere with a driver's ability to safely operate the vehicle include: displaying images or video not related to driving; displaying automatically scrolling text; requiring manual text entry of more than six button or key presses during a single task; or requiring reading more than 30 characters of text (not counting punctuation marks). The NHTSA Guidelines specify that this

recommendation is intended to prevent the driver from engaging in tasks such as watching video footage, visual-manual text messaging, visual-manual internet browsing, or visual-manual social media browsing while driving. The recommendation is not intended to prevent the display of images related to driving, such as images related to the status of vehicle occupants or vehicle maneuvering or images depicting the rearview or blind zone areas of a vehicle.

2. For all other secondary, non-driving-related visual-manual tasks, the NHTSA Guidelines specify a test method for measuring the impact of performing a task on driving safety and time-based acceptance criteria for assessing whether a task interferes too much with driver attention to be suitable to perform while driving. If a task does not meet the acceptance criteria, the NHTSA Guidelines recommend that in-vehicle devices be designed so that the task cannot be performed by the driver while driving. More specifically, the NHTSA Guidelines include two test methods for assessing whether a task interferes too much with driver attention. One test method measures the amount of time that the driver's eyes are drawn away from the roadway during the performance of the task. The research mentioned above shows that long glances by the driver away from the roadway are correlated with an increased risk of a crash or near-crash. The NHTSA Guidelines recommend that devices be designed so that tasks can be completed by the driver while driving with glances away from the roadway of 2 seconds or less and a cumulative time spent glancing away from the roadway of 12 seconds or less. The second test method uses a visual occlusion technique to ensure that a driver can complete a task in a series of 1.5 second glances with a

cumulative time spent glancing away from the roadway of not more than 9 seconds.

3. In addition to identifying inherently distracting tasks and providing a means for measuring and evaluating the level of distraction associated with other non-driving-related tasks, the NHTSA Guidelines contain several design recommendations for in-vehicle devices in order to minimize their potential for distraction. The NHTSA Guidelines recommend that all device functions designed to be performed by the driver through visual-manual means should require no more than one of the driver's hands to operate. The NHTSA Guidelines further recommend that each device's active display should be located as close as practicable to the driver's forward line of sight and include a specific recommendation for the maximum downward viewing angle to the geometric center of each display.

The agency believes that the NHTSA Guidelines are appropriate for any device that the driver can easily see and/or reach (even if it is intended for use solely by passengers), and, accordingly, any task that is associated with an unacceptable level of distraction should be made inaccessible to the driver while driving. However, the NHTSA Guidelines are not appropriate for any device that is located fully behind the front seat of the vehicle or for any front-seat device that cannot reasonably be reached or seen by the driver.

NHTSA has opted to pursue nonbinding, voluntary guidelines rather than a mandatory Federal Motor Vehicle Safety Standard (FMVSS) for three principal reasons. First, this is an area in which learning continues, and NHTSA believes that, at this time, continued research is both necessary and important. Second, technology is changing rapidly, and a static rule, put in place at this time, may face unforeseen problems and issues as new technologies are developed and introduced. Third, available data are not sufficient at this time to permit accurate estimation of the benefits and costs of a mandatory rule in this area. NHTSA's firm belief that there are safety benefits to be gained by limiting and reducing driver distraction due to integrated electronic devices is sufficient reason for issuing the NHTSA Guidelines, but in order to issue a rule, we need a defensible estimate of the magnitude of such benefits and the corresponding costs. (See Executive Order 13563.)

Since these voluntary NHTSA Guidelines are not a FMVSS, NHTSA's normal enforcement procedures are not applicable. As part of its continuing research effort, NHTSA does intend to monitor manufacturers' voluntary adoption of these NHTSA Guidelines to help determine their effectiveness and sufficiency.

The main effect that NHTSA expects to achieve through its NHTSA Guidelines is better-designed in-vehicle integrated electronic device interfaces that do not exceed a reasonable level of complexity for visual-manual secondary tasks. While voluntary and nonbinding, the NHTSA Guidelines are meant to discourage the introduction of egregiously distracting non-driving tasks performed using integrated devices (i.e., those that the NHTSA Guidelines list as being inherently distracting and those that do not meet the acceptance criteria when tested under the test method contained in the Guidelines).

NHTSA seeks comments as to how to improve the NHTSA Guidelines so as to improve motor vehicle safety. Because these Guidelines are voluntary and nonbinding, they will not require action of any kind, and for that reason they will not confer benefits or impose costs. Nonetheless, and as part of its continuing research efforts, NHTSA welcomes comments on the potential benefits and costs that would result from voluntary compliance with the draft Guidelines.

NHTSA will review submitted comments and plans to issue a final version of the visual-manual portion of its NHTSA Guidelines in the form of a Federal Register notice during the first half of calendar year 2012.

II. Background

A. Acronyms Used in Document

ADAM	Advanced Driver Attention Metrics
AM	Amplitude Modulation
ANPRM	Advance Notice of Proposed Rulemaking
CAMP	Collision Avoidance Metrics Partnership
CANbus	Controller Area Network bus
CD	Compact Disc
CDS	Crashworthiness Data System (NASS-CDS)
DFD	Dynamic Following and Detection
DOT	Department of Transportation
EOT	Enhanced Occlusion Technique
EORT	Eyes-Off-Road Time
FARS	Fatality Analysis Reporting System
FM	Frequency Modulation
FMCSA	Federal Motor Carrier Safety Administration
FMVSS	Federal Motor Vehicle Safety Standard
FR	Federal Register
GES	General Estimates System (NASS-GES)
GVWR	Gross Vehicle Weight Rating
HMI	Human-Machine Interface
HVAC	Heating, Ventilation, and Air Conditioning
ISO	International Standards Organization
ISOES	International Society for Occupational Ergonomics and Safety
IVIS	In-Vehicle Information Systems
JAMA	Japanese Automobile Manufacturers Association
LCT	Lane Change Task
MGD	Mean Glance Duration
MNTE	Manual Number and Text Entry
NASS	National Automotive Sampling System
NHTSA	National Highway Traffic Safety Administration

NMVCCS	National Motor Vehicle Crash Causation Survey
NPRM	Notice of Proposed Rulemaking
NTTAA	National Technology Transfer and Advancement Act
OE	Original Equipment
OMB	Office of Management and Budget
PAR	Police Accident Report
PDT	Peripheral Detection Task
R	Task Resumability Ratio
SAE	SAE International
SDLP	Standard Deviation of Lane Position (lane position variability)
SHRP2	Strategic Highway Research Program 2
STI	Systems Technology Incorporated
STISIM	Systems Technology Incorporated Driving Simulator
TEORT	Total Eyes-Off-Road Time
TGT	Total Glance Time to Task
VTTI	Virginia Tech Transportation Institute

B. The Driver Distraction Safety Problem

There has been a large amount of research performed on the topic of driver distraction and its impact on safety. Research noted here will provide a brief overview of the distraction safety problem. Many other reports and papers have been published on various aspects of driver distraction. Some of these additional reports and papers may be found at www.distraction.gov.

NHTSA data on distracted driving-related crashes and the resulting numbers of injured people and fatalities is derived from the Fatality Analysis Reporting System (FARS)[3] and the National Automotive Sampling System (NASS) General Estimates System (GES).[4]

The most recent data available, 2010 data, show that 17 percent of all police-reported crashes (fatal, injury-only and property-damage-only) involve reports of distracted driving. As can be seen in Table 1, the percent of all police-reported crashes that involve distraction has remained consistent over

[3] FARS is a census of all fatal crashes that occur on the roadways of the United States of America. It contains data on all fatal crashes occurring in all 50 states as well as the District of Columbia and Puerto Rico.
[4] NASS GES contains data from a nationally-representative sample of police-reported crashes. It contains data on police-reported crashes of all levels of severity, including those that result in fatalities, injuries, or only property damage. National numbers of crashes calculated from NASS GES are estimates.

the past five years. These distraction-related crashes lead to thousands of fatalities and over 400,000 injured people each year, on average.

An estimated 899,000 of all police-reported crashes involved a report of a distracted driver in 2010. Of those 899,000 crashes, 26,000 (3%) specifically stated that the driver was distracted when he was adjusting or using an integrated device/control. From a different viewpoint, of those 899,000 crashes, 47,000 (5%) specifically stated that the driver was distracted by a cell phone (no differentiation between portable and integrated). It should be noted that these two classifications are not mutually exclusive, as a driver who was distracted by the radio control may have also been on the phone at the time of the crash and thus the crash may appear in both categories. While all electronic devices are of interest, the current coding does not separate other electronic devices other than cell phones.

TABLE 1 -- POLICE-REPORTED CRASHES AND CRASHES INVOLVING DISTRACTION, 2006 – 2010 (GES)

Year	Number of Police-Reported Crashes	Police-Reported Crashes Involving a Distracted Driver	Distraction-Related Crashes Involving an Integrated Control/Device*	Distraction-Related Crashes Involving an Electronic Device*
2006	5,964,000	1,019,000 (17%)	18,000 (2%)	24,000 (2%)
2007	6,016,000	1,001,000 (17%)	23,000 (2%)	48,000 (5%)
2008	5,801,000	967,000 (17%)	21,000 (2%)	48,000 (5%)
2009	5,498,000	957,000 (17%)	22,000 (2%)	46,000 (5%)
2010	5,409,000	899,000 (17%)	26,000 (3%)	47,000 (5%)

* The categories for Integrated Control/Device and Electronic Device are not mutually exclusive. Therefore the data *cannot* be added or combined in any manner.

Identification of specific driver-activities and driver-behavior that serves as the distraction has presented challenges, both within NHTSA's data collection and on police accident reports. Therefore, a large portion of the crashes that are reported to involve distraction do not have a specific behavior or activity listed; rather they specify *other distraction* or *distraction unknown*. One could assume that some portion of those crashes involve an electronic device, either portable or integrated.

NHTSA is making substantial data collection revisions to FARS and working on revisions to Model Minimum Uniform Crash Criteria (MMUCC) to better capture and classify the crashes related to distraction.[5] One such improvement is the ability to separate the involvement of integrated vehicle equipment as the distraction in fatal crashes in FARS. With this improvement, NHTSA looks to track the involvement of integrated devices over time in fatal crashes. As manufacturers are increasingly developing communications systems that can integrate portable devices into the vehicle or developing fully-integrated systems in the vehicle, this tracking of data will be essential in monitoring distraction involvement in fatal crashes.

i. Estimation of Distraction Crash Risk Via Naturalistic Driving Studies

One approach to estimating the driving risks due to various types of distraction is naturalistic driving studies. Naturalistic data collection is an excellent method of determining distraction risks because test participants (drivers) volunteer to drive an instrumented vehicle in the same manner that they normally do for some period of time. Unlike commanded task testing, in which an in-vehicle experimenter instructs a test participant when to perform a task, in naturalistic studies test participants perform tasks at will. The unobtrusive data recording instrumentation installed in the vehicle eliminates the distraction under-reporting problem seen in police accident reports by recording data that describes what test participants are doing at any time while driving.

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[5] Since this is a re-coding of state records into a uniform data set, and does not make contact with any specific subjects, no OMB clearance is required for these revisions.

For light vehicles, the NHTSA-sponsored 100-Car Naturalistic Driving Study,[6, 7, 8, 9, 10] performed by the Virginia Tech Transportation Institute (VTTI), provides information about the effects of performing various types of secondary tasks on crash/near crash risks. Secondary tasks include communications, entertainment, informational, interactions with passengers, navigation, and reaching for objects tasks (along with many others) that are not required for driving. For the 100-Car Study, VTTI collected naturalistic driving data for 100 vehicles from January 2003 through July 2004. Each participant's vehicle was unobtrusively fitted with five video cameras, sensors that measured numerous vehicle state and kinematic variables at each instant of time, and data acquisition. The vehicles were then driven by their owners during their normal daily activities for 12 to 13 months while data were recorded. No special instructions were given to drivers as to when or where to drive and no experimenter was present in the vehicle during the driving. All of this resulted in a large data set of naturalistic driving data that contains information on 241 drivers (100 primary drivers who performed most of the driving and 141 secondary drivers who drove the instrumented vehicles for shorter periods of time) driving for almost 43,000 hours and traveling approximately 2 million miles.

Data from the 100-Car Naturalistic Driving Study provides the best information currently available about the risks associated with performing a variety of secondary tasks while driving light vehicles (vehicles under 10,000 pounds GVWR). However, even though this was a large, difficult, and

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[6] Neale, V. L., Dingus, T. A., Klauer, S.G., Sudweeks, J., and Goodman, M., "An Overview of the 100-Car Naturalistic Study and Findings," ESV Paper 05-0400, June 2005.

[7] Dingus, T. A., Klauer, S.G., Neale, V. L., Petersen, A., Lee, S. E., Sudweeks, J., Perez, M. A., Hankey, J., Ramsey, D., Gupta, S., Bucher, C., Doerzaph, Z. R., Jermeland, J., and Knipling, R.R., "The 100-Car Naturalistic Driving Study, Phase II – Results of the 100-Car Field Experiment," DOT HS 810 593, April 2006.

[8] Klauer, S.G., Dingus, T.A., Neale, V.L., Sudweeks, J.D., and Ramsey, D.J., "The Impact of Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data," DOT HS 810 594, April 2006.

[9] Guo, F., Klauer, S.G., McGill, M.T., and Dingus, T.A., "Task 3 – Evaluating the Relationship Between Near-Crashes and Crashes: Can Near-Crashes Serve as a Surrogate Safety Metric for Crashes?," DOT HS 811 382, September 2010.

[10] Klauer, S.G., Guo, F., Sudweeks, J.D., and Dingus, T.A., "An Analysis of Driver Inattention Using a Case-Crossover Approach On 100-Car Data: Final Report," DOT HS 811 334, May 2010.

expensive study to perform, from an epidemiological viewpoint, the study was small (100 primary drivers, 15 police-reported and 82 total crashes, including minor collisions). Drivers from only one small portion of the country, the Northern Virginia-Washington, DC, metro area, were represented.

The 100-Car Study was deliberately designed to maximize the number of crash and near-crash events through the selection of subjects with higher than average crash- or near-crash risk exposure.[11] This was accomplished through the selection of a larger sample of drivers below the age of 25, and by the inclusion of a sample that drove more than the average number of miles.

Due to the rapid pace of technological change, some devices (e.g., smart phones) and secondary tasks of great current interest (e.g., text messaging) were not addressed by 100-Car Study data because they were not widely in use at the time.

Subsequent to the 100-Car Naturalistic Driving Study, the Federal Motor Carrier Safety Administration (FMCSA) sponsored an analysis of naturalistic driving data[12] to examine the effects of driver distraction on safety for commercial motor vehicles (three or more axle trucks, tractors-semitrailers (including tankers), transit buses, and motor coaches). This analysis used data collected during two commercial motor vehicle naturalistic driving studies. Since the data analyzed was collected during two studies, this study will, hereinafter, be referred to as the "Two Study FMCSA Analyses."

The Two Study FMCSA Analyses combined and analyzed data from two large-scale commercial motor vehicle naturalistic driving studies: the Drowsy Driver Warning System Field Operational Test[13]

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[11] Neale, V. L., Dingus, T. A., Klauer, S.G., Sudweeks, J., and Goodman, M., "An Overview of the 100-Car Naturalistic Study and Findings," ESV Paper 05-0400, June 2005.
[12] Olson, R.L., Hanowski, R.J., Hickman, J.S., and Bocanegra, J., "Driver Distraction in Commercial Vehicle Operations," FMCSA-RRR-09-042, September 2009.
[13] Hanowski, R.J., Blanco, M., Nakata, A., Hickman, J.S., Schaudt, W.A., Fumero, M.C., Olson, R.L., Jermeland, J., Greening, M., Holbrook, G.T., Knipling, R.R., and Madison, P., "The Drowsy Driver Warning System Field Operational Test, Data Collection Methods," DOT HS 811 035, September 2008.

and the Naturalistic Truck Driving Study.[14] The combined database contains naturalistic driving data for 203 commercial motor vehicle drivers, 7 trucking fleets, 16 fleet locations, and approximately 3 million miles of continuously-collected kinematic and video data. This data set was filtered using kinematic data thresholds, along with video review and validation, to find safety-critical events (defined in this report as crashes, near-crashes, crash-relevant conflicts, and unintentional lane deviations). There were a total of 4,452 safety-critical events in the database: 21 crashes, 197 near-crashes, 3,019 crash-relevant conflicts, and 1,215 unintentional lane deviations. In addition, 19,888 time segments of baseline driving data were randomly selected for analysis.

One major source of differences in the results obtained from analyses of the 100-Car Study with those obtained from the Two Study FMCSA Analyses is the different time frames in which their data collections were performed. The 100-Car Naturalistic Driving Study data collection was from January 2003 through July 2004. The Drowsy Driver Warning System Field Operational Test collected data from May 2004 through September 2005 and the Naturalistic Truck Driving Study collected data from November 2005 through May 2007. Due to the current rapid changes occurring in portable and other consumer electronics, the specific types of electronic device related distraction observed across studies, while similar, were not identical. For example, while the Two Study FMCSA Analyses found a high safety critical event risk due to drivers engaging in text messaging, there was no text messaging observed during the 100-Car Study. This is because the widespread popularity of text messaging did not occur until after the 100-Car Study data collection was completed.

ii. Summary of Naturalistic Driving Study Distraction Risk Analyses

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[14] Blanco, M., Hickman, J.S., Olson, R.L., Bocanegra, J.L., Hanowski, R.J., Nakata, A., Greening, M., Madison, P., Holbrook, G.T., and Bowman, D., "Investigating Critical Incidents, Driver Restart Period, Sleep Quantity, and Crash Countermeasures in Commercial Vehicle Operations Using Naturalistic Data Collection," in press, 2008.

Figure 1 gives a graphical representation of some of the secondary task risk odds ratios determined by the 100-Car Naturalistic Driving Study and the Two Study FMCSA Analyses. In this figure, a risk odds ratio of 1.00 (shown as "1" in the figure) equates to the risks associated with baseline driving. Risk odds ratios above 1.00 indicate secondary tasks that increase driving risks while risk odds ratios below 1.00 indicate protective effects (i.e., performing these secondary tasks makes a crash or near-crash event less likely to occur than driving and not performing any secondary task.) This figure provides a quick, visual, summary of the risks associated with performing a variety of secondary tasks while driving both light and heavy vehicles.

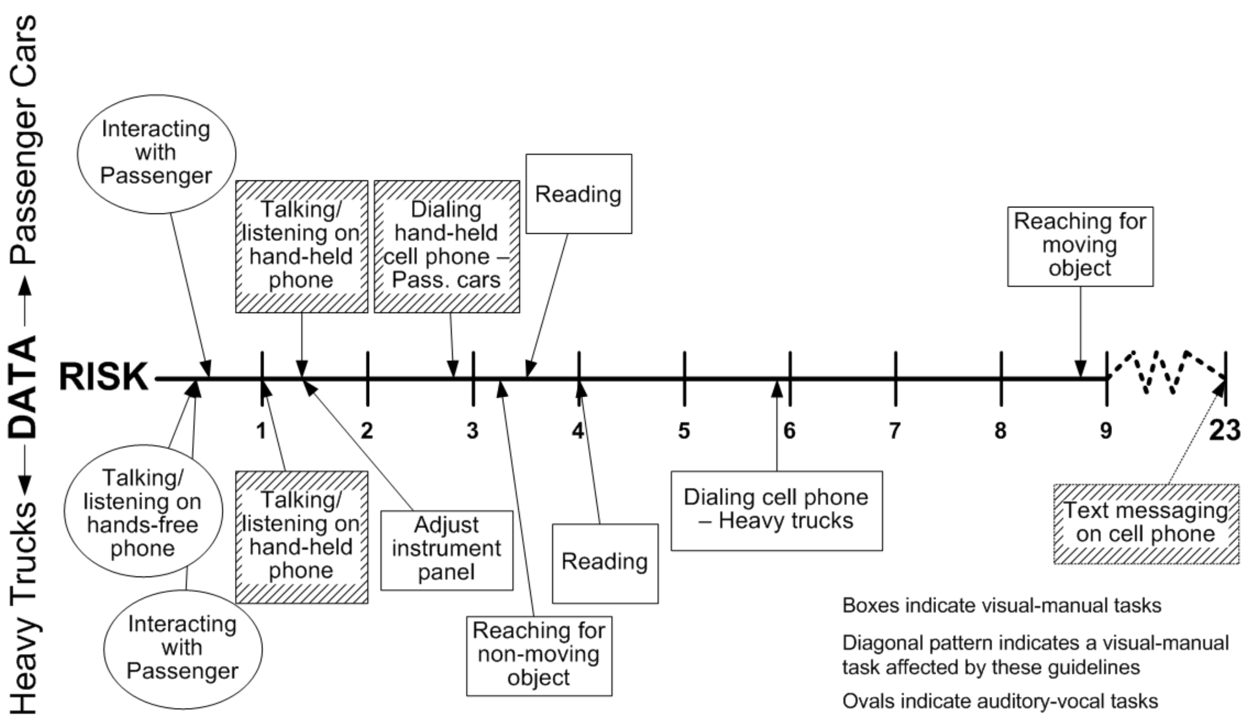

Figure 1: Risk Odds Ratios Determined by the Original 100-Car Study Analyses and Two Study FMCSA Analyses

In summary, the various naturalistic data study analyses established several important things about driver distraction which are directly relevant to the NHTSA Guidelines for reducing driver distraction due to device interface design:

- Secondary task performance is very common while driving. They were observed during the majority (54%) of the randomly selected baseline time segments analyzed during the 100-Car Study analyses. Some secondary task performance involves the use of electronic devices; these secondary tasks are the primary focus of this document.
- Secondary task performance while driving has a broad range of risk odds ratios associated with different secondary tasks. The observed risk odds ratios range from 23.2, indicating a very large increase in crash/near-crash risk (a risk ratio of 1.0 means that a secondary task has the same risk as average driving; a risk ratio of 23.2 means that risk associated with performance of this secondary task is **increased** by 2,220 percent compared to average driving), to 0.4 (any value less than 1.0 indicates a situation with less risk than average driving indicating a protective effect; a risk ratio of 0.4 means that risk associated with performance of this secondary task is **reduced** by 60 percent compared to average driving). This indicates that it may well be possible to improve at least some of the secondary tasks with high risk odds ratios (i.e., risky tasks) so as to make them substantially safer to perform. The logical place to reduce crash/near-crash risk odds ratios for these secondary tasks is through improvements to their driver interface.
- It is clear from naturalistic driving research that the secondary tasks with the highest risk odds ratios tend to have primarily visual-manual interaction means with only a relatively small cognitive component. Of course, every secondary task results in some cognitive load; however, tasks that could be said to not require a lot of thought, such as Reaching for a Moving Object, are towards the right side of Figure 1. Only the secondary tasks, "Interacting with Passenger" and

"Talking/Listening on Hands-Free Phone," are almost exclusively cognitive in nature. Both of these secondary tasks have risk odds ratios that are statistically significantly less than 1.00 (at the 95 percent confidence level). These two heavily cognitive secondary tasks appear to have protective effects.

For this reason, and because it is far less clear how to measure the level of cognitive distraction, the NHTSA Guidelines will initially only apply to the visual-manual aspects of devices' driver interfaces. Subsequent phases of development of these NHTSA Guidelines are planned to extend them to cover the auditory-vocal portions of device interfaces.

- Long (greater than 2.0 seconds) glances by the driver away from the forward road scene are correlated with increased crash/near-crash risk. When drivers glance away from the forward roadway for greater than 2.0 seconds out of a 6-second period, their risk of a an unsafe event substantially increases relative to the baseline.

C. NHTSA's Driver Distraction Program

NHTSA's safety mission is to "save lives, prevent injuries, and reduce economic costs due to road traffic crashes." One focus of this mission is the prevention of road traffic crashes for which driver distraction is a contributing factor.[15]

In April 2010, NHTSA released an "Overview of the National Highway Traffic Safety Administration's Driver Distraction Program,"[16] which summarized steps that NHTSA intends to take to

[15] Information on NHTSA's efforts to address this problem can be found at http://www.distraction.gov/.

[16] "Overview of the National Highway Traffic Safety Administration's Driver Distraction Program," DOT-HS-811-299, April 2010. Available at http://www.nhtsa.gov/staticfiles/nti/distracted_driving/pdf/811299.pdf.

"help in its long-term goal of eliminating a specific category of crashes- those attributable to driver distraction." NHTSA's Driver Distraction Program consists of four initiatives:

1. Improve the understanding of the extent and nature of the distraction problem. This includes improving the quality of data NHTSA collects about distraction-related crashes along with better analysis techniques.
2. Reduce the driver workload associated with performing tasks using both built-in and portable in-vehicle devices by working to limit the visual and manual demand associated with secondary tasks performed using in-vehicle devices. Better device interfaces will help to minimize the amount of time and effort involved in a driver performing a task using the device. Minimizing the workload associated with performing non-driving, or "*secondary,*" tasks with a device will permit drivers to maximize the attention they focus toward the *primary* task of driving.
3. Keep drivers safe through the introduction of crash avoidance technologies. These include the use of crash warning systems to re-focus the attention of distracted drivers as well as vehicle-initiated (i.e., automatic) braking and steering to prevent or mitigate distracted driver crashes.

Although not the focus of this notice, NHTSA is, in parallel with its NHTSA Guidelines development effort, performing a large amount of research in support of the crash avoidance technologies initiative. For example, NHTSA has completed, and reports should be published shortly, research about how to best warn distracted drivers. We are also performing a large amount of research on forward collision avoidance and mitigation technologies such as Forward Collision Warning, Collision Imminent Braking, and Dynamic Brake Assist.

4. Educate drivers about the risks and consequences of distracted driving. This includes targeted media messages, drafting and publishing sample text-messaging laws for consideration and possible use by the states, and publishing guidance for a ban on text messaging by Federal government employees while driving.

This notice is part of NHTSA's effort to address the second of these initiatives, reducing driver workload by working to limit the visual and manual demand associated with in-vehicle device interface designs. As discussed in NHTSA's Driver Distraction Program, NHTSA's intent is to "*develop voluntary guidelines for minimizing the distraction potential of in-vehicle and portable devices*."[17] The current notice only contains voluntary NHTSA Guidelines for integrated in-vehicle devices; portable devices will be addressed by Phase 2 of the NHTSA Guidelines.

Drivers perform secondary tasks (communications, entertainment, informational, and navigation tasks not required to drive[18]) using an in-vehicle electronic device by interacting with the device through its driver interface. These interfaces can be designed to accommodate interactions that are visual-manual (visual display and manual controls), auditory-vocal, or a combination of the two. Some devices may allow a driver to perform a task through either manual control manipulation with visual feedback or through voice command with auditory feedback to the driver.

For the purposes of this document, a driver's interactions with device interfaces are described in terms of two functional categories based upon the mode of interaction: visual-manual and auditory-vocal. Visual-manual interactions involve the driver looking at a device, making inputs to the device by hand (e.g., pressing a button, rotating a knob), and visual feedback being provided to the driver.

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[17] Ibid, P. 21.
[18] Navigation tasks clearly have to be performed to drive. However, such tasks as destination entry do not have to be performed while driving but can instead be performed while the vehicle is stationary.

Auditory-vocal interactions involve the driver controlling the device functions through voice commands and receiving auditory feedback from the device. Note that a single device's driver interface may accommodate both visual-manual and auditory-vocal interactions.

These proposed voluntary NHTSA Guidelines are appropriate for in-vehicle device tasks that are performed by the driver through visual-manual means. The goal of the NHTSA Guidelines is to discourage the implementation of tasks performed using in-vehicle electronic devices unless the tasks and device driver interfaces are designed to minimize driver workload experienced by a driver when performing the tasks while driving. The NHTSA Guidelines specify criteria and a test method for assessing whether a secondary task performed using an in-vehicle device may be suitable for performance while driving, due to its minimal impact on driving performance and, therefore, safety. The NHTSA Guidelines also seek to identify secondary tasks that interfere with a driver's ability to safely control the vehicle and to categorize those tasks as being unsuitable for performance by the driver while driving.

III. Why Distraction Guidelines?

NHTSA is proposing voluntary NHTSA Guidelines to limit and/or reduce visual-manual driver distraction due to integrated electronic devices, instead of a mandatory Federal Motor Vehicle Safety Standard (FMVSS), for several reasons. First, the rapid pace of technology evolution cannot be fully addressed with a static rule put in place at this time. Second, data is not sufficient at this time to permit accurate estimation of the benefits of a possible distracted driving rule, though NHTSA firmly believes that there are safety benefits to be gained by limiting and reducing driver distraction due to integrated electronic devices. Finally, NHTSA rules must have repeatable, objective means for determining compliance and driver distraction testing involves drivers with inherent individual differences that present a unique challenge. Each of these reasons is discussed in detail below.

- In 2002, the Alliance of Automobile Manufacturers developed a set of guidelines to address the agency's call that manufacturers should develop a set of design principles to which future products would be designed. The intent was to address the increasing use of navigation units, infotainment, and complex controls appearing in vehicles that, if used while driving, could present an additional source of distraction for drivers leading to an increase in crashes. Since that time, NHTSA has been monitoring and conducting driver distraction research using a sample of the designs that have been developed in accordance with the Alliance Guidelines. Our observations are as follows: 1) manufacturers have different interpretations of the guidelines themselves, leading to different implementations, 2) newer techniques exist to evaluate these interfaces than existed nearly a decade ago, 3) the guidelines have not kept pace with technology, and 4) more recent data compiled from naturalistic driving studies implies that more stringent criteria are needed. Given these observations, we believe it is appropriate to issue Federal guidelines to ensure that current and future products continue to be designed in such a way as to mitigate driver distraction as opposed to adding to it. In addition, we believe Federal guidelines are appropriate because they can keep pace with rapidly changing technology by providing a benchmark for designers while allowing the agency and other researchers to continue their work in this rapidly evolving area, including the assessment of test procedures for regulatory purposes.
- In-vehicle communications and electronics are currently evolving at a pace that is not amenable to regulation. We believe that establishing Federal guidelines at this time is

appropriate for these rapidly changing in-vehicle technologies, since it will provide a comprehensive means to ensure the reasonableness of designs. As new systems, features, functions, and types of control inputs are developed, NHTSA should be able to develop voluntary NHTSA Guidelines to address any potential safety issues as they arise. These NHTSA Guidelines can be issued more quickly than regulations that go through the rulemaking process.

- Existing data provide a sufficient basis on which to establish general NHTSA Guidelines that, if followed, will deter manufacturers from introducing in-vehicle information and communications systems that induce the kinds and duration of visual-manual distraction that are demonstrably unsafe. In future years, data from a major naturalistic research study that is currently being conducted through the Strategic Highway Research Program 2 (SHRP2)[19] should provide better information on the precise causation of distraction related incidents.
- Additionally, the test method developed by NHTSA in these NHTSA Guidelines in its current form would not meet the statutory requirements for establishing compliance with a FMVSS. Specifically, NHTSA's authorizing legislation requires that FMVSS contain objective and repeatable procedures, such as engineering measurement, for determining compliance or non-compliance of a vehicle with the standard. Driver distraction testing involves human drivers with inherent individual differences that present a unique challenge. A FMVSS with a compliance test procedure that entails driver involvement

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[19] Information about SHRP2 is at: http://trb.org/StrategicHighwayResearchProgram2SHRP2/Blank2.aspx.

would not meet those requirements due to the individual variability of the drivers involved in the test.

Consider a brake compliance test; it tests the manufactured parts that comprise the braking, wheel, and tire systems. NHTSA has gone to considerable effort to tightly prescribe the actions of the professional test driver so that they do not influence test results. The main sources of test non-repeatability are the manufacturing tolerances of the vehicle components and the variability in the road surface. Again, NHTSA has tried to specify the road surface so as to minimize test variability. Due to the tight specification of test driver's actions and road surface, brake compliance testing is highly repeatable.

In comparison, driver distraction tests involve average drivers as a critical part of the test of the in-vehicle system. The driver's actions cannot be tightly prescribed, as was done for brake testing. Unfortunately, the level of driver distraction due to performing a task using a device inherently depends upon the personal characteristics and capabilities of the driver. The driver's manual dexterity, multi-tasking ability, driving experience, state of health, age, intelligence, and motivation (among other factors) may all influence the level of distraction experienced while performing a task. In an effort to "average out" individual differences, a group of 24 test participants is used for the NHTSA Driver Distraction Guideline tests described in this document. Furthermore, these NHTSA Guidelines contain provisions designed to ensure that test participants are not biased either for or against a task/device. However, there remains a chance that one group of 24 test subjects will produce a test result that finds a task or device suitable for performance while the vehicle is in motion, while testing with another group of 24 subjects may find that the task or device should be locked out. Therefore, the test would not be repeatable and therefore is not appropriate for a FMVSS.[20]

IV. NHTSA Research to Develop Driver Distraction Metrics and Measurement Methods

A. Timeline of NHTSA Driver Distraction Measurement Research

NHTSA has been performing research addressing issues related to driver distraction for nearly 20 years. Early research examined truck driver workload and the effects of using a route navigation system on driving performance. In the last decade, research has been focused on assessing the impact of cell phone use on driver performance and behavior. As the availability of in-vehicle electronic devices has increased, NHTSA's research focus has shifted to development of methods and metrics for measuring distraction resulting from the use of any such device while driving. Each research study has contributed to the development of a broad set of metrics that characterize the impact of the performance of distracting tasks on driving performance in a repeatable and objective manner. The development of valid and sensitive measures of distraction effects on driving performance is challenging because distraction measurement inherently involves human test subjects. This section summarizes several recent NHTSA studies that focused on developing a valid, robust protocol for measuring driver distraction caused by the use of in-vehicle electronic devices.

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[20] One possible solution to the issue of non-repeatability due to individual variability has been thought of by NHTSA. The idea is to remove repeatability as an issue by only testing any given task on a device one time. A company that wished to know whether a task and/or device is acceptable for being performed while a vehicle is not in "Park" would perform the NHTSA specified test using all of the NHTSA specified test procedures for test participant selection, test conduct, etc., and document the results. If NHTSA subsequently was interested in monitoring whether that particular task and/or device met the distraction test's acceptance criteria, NHTSA would consider the company's documented record of the test as conclusive proof of meeting the acceptance criteria of the test and not perform the test itself. NHTSA would only perform testing if a company had not performed the test. However, NHTSA has never tried such an approach and does not wish to consider such a novel approach with a complex topic such as driver distraction.

B. "15-Second Rule" Study

In the 1990s, SAE International worked to develop a recommended practice for determining whether or not a particular navigation system function should be accessible to the driver while driving. The draft recommended practice (SAE J2364)[21, 22] asserted that if an in-vehicle task could be completed within 15 seconds by a sample of drivers in a static (e.g., vehicle parked) setting, then the function was suitable to perform while driving. NHTSA conducted a preliminary assessment of the diagnostic properties of this proposed rule. Ten subjects, aged 55 to 69 years, completed 15 tasks, including navigation system destination entry, radio tuning, manual phone dialing, and adjusting the Heating, Ventilation, and Air Conditioning (HVAC) controls in a test vehicle. Correlations between static task performance and dynamic task performance were relatively low. The results were interpreted to suggest that static measurement of task completion time could not reliably predict the acceptability of a device. Based on these results, NHTSA looked to other metrics and methods for use in assessing secondary task distraction in subsequent research.

C. Collision Avoidance Metrics Partnership (CAMP) Driver Workload Metrics Project[23]

The Driver Workload Metrics project conducted by the Collision Avoidance Metrics Partnership (CAMP) consortium,[24] in cooperation with NHTSA, sought to develop performance metrics and test

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[21] Green, P., "Estimating Compliance with the 15-Second Rule for Driver-interface Usability and Safety," Proceedings of the Human Factors and Ergonomics Society 43rd Annual Meeting, 1999.
[22] Green, P., "The 15-second Rule for Driver Information Systems," ITS America Ninth Annual Meeting Conference Proceedings, Washington, DC, 1999.
[23] Angell, L., Auflick, J., Austria, P. A., Kochhar, D., Tijerina, L., Biever, W., Diptiman, T., Hogsett, J., and Kiger, S., "Driver Workload Metrics Task 2 Final Report," DOT HS 810 635, November 2006.
[24] CAMP included researchers from Ford, GM, Nissan, and Toyota.

procedures for assessing in-vehicle system secondary task distraction and its impact on driving performance. The CAMP identified four categories of driving performance metrics as having direct implications for safety: driver eye glance patterns, lateral vehicle control, longitudinal vehicle control, and object-and-event detection. A number of potential surrogates thought to have predictive value with respect to the above-mentioned performance measures were identified. CAMP's analyses sought to determine which performance metrics discriminated between driving with a secondary task and driving alone. The majority of metrics that passed the evaluation criteria were related to eye-glance behavior. Visual-manual tasks affected driving performance more than auditory-vocal tasks. The project concluded that eye-glance data contain important information for assessing the distraction effects of both auditory-vocal and visual-manual tasks. One significant conclusion of this work was that the interference to driving caused by in-vehicle secondary tasks was multidimensional and no single metric could measure all effects.

D. Measuring Distraction Potential of Operating In-Vehicle Devices[25]

Following the Driver Workload Metrics project, in 2006, NHTSA explored the feasibility of adapting one or more existing driver distraction measurement protocols for use with production vehicles rather than pre-production prototypes. NHTSA wanted a well-documented, simple, non-destructive test that would allow test vehicles to be obtained by lease and therefore minimize research costs. Additional protocol criteria included: (1) ease of implementation, (2) the test protocol's state-of-development, including extent of use and documentation, (3) the level of training and staffing required, (4) objective measures, and (5) the availability and interpretability of data.

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[25] Ranney, T.A., Baldwin, G.H.S., Vasko, S.M., and Mazzae, E.N., "Measuring Distraction Potential of Operating In-Vehicle Devices," DOT HS 811 231, December 2009.

Test venues meeting these criteria included the personal computer-based Advanced Driver Attention Metrics (ADAM) Lane Change Task (LCT)[26] and the Systems Technology Inc. (STI) low-cost, low-fidelity driving simulator (STISIM-Drive). The LCT is a standalone driving simulation that requires drivers to execute lane changes when prompted by signs appearing in the scenario. The LCT combines vehicle control performance, object detection, and response speed into a single summary performance measure. Based on CAMP[27] study recommendations, the STISIM driving scenario used involved car following with occasional oncoming traffic, in combination with the Peripheral Detection Task (PDT) to provide a visual object-event detection component. A Seeing Machines faceLab eye tracking system was used with both primary test venues.

Two initial experiments were conducted to evaluate the metrics associated with the STISIM and LCT test venues and to assess the metrics' sensitivity for detecting known and hypothesized differences between different secondary tasks. Results showed that most metrics were sensitive to changes in visual-manual load associated with visual search tasks. STISIM driving performance and PDT metrics were the most sensitive objective metrics and were generally more sensitive than LCT metrics. A third experiment that compared the sensitivity of measures obtained in the laboratory with that of an established test track protocol showed similarity among patterns of workload ratings. However, the laboratory simulator measures were more sensitive to secondary task load differences than the corresponding test track measures.

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[26] Mattes, S., "The lane change task as a tool for driver distraction evaluation," in GfA/17th Annual Conference of the International-Society-for-Occupational-Ergonomics-and-Safety (ISOES) Stuttgart, Germany: Ergonomia Verlag OHG, Bruno-Jacoby-Weg 11, D-70597, 2003.

[27] Angell, L., Auflick, J., Austria, P. A., Kochhar, D., Tijerina, L., Biever, W., Diptiman, T., Hogsett, J., and Kiger, S., "Driver Workload Metrics Task 2 Final Report," DOT HS 810 635, November 2006.

Overall, the laboratory environment provided better control of test conditions, particularly visibility, and less measurement error than the test track. The limited fidelity of the simulator did not reduce the sensitivity of the simulator-based metrics for detecting the targeted differences between task conditions. The breadth of STISIM/PDT measurement capabilities is also consistent with the general consensus that multiple measures are necessary to fully characterize distraction effects. Thus, the driving simulator protocol was retained for further research.

E. Developing a Test to Measure Distraction Potential of In-Vehicle Information System Tasks in Production Vehicles[28]

In 2009, NHTSA continued its efforts to develop a sensitive method of driver distraction measurement using production vehicles. Research was conducted using the visual occlusion technique, which involves periodic interruption of vision (via electronically shuttered goggles or some other apparatus) during the performance of a secondary task to simulate the driver glancing at the roadway while driving. By summing the duration of periods of unoccluded vision, the technique provides an estimate of the time that the driver looks away from the roadway to perform the secondary task. Because in the traditional occlusion method, participants have no primary task load (to simulate the demands of driving), the task completion time estimates do not include time during which participants continue to work on the secondary task during occluded intervals. To address this “blind operation” concern, an Enhanced Occlusion Technique (EOT) was also examined. This technique incorporated an auditory tracking task intended to simulate the demands of driving without interfering with the visual demands of occlusion.

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[28] Ranney, T.A., Baldwin, G.H.S., Parmer, E., Domeyer, J., Martin, J., and Mazzae, E. N., “Developing a Test to Measure Distraction Potential of In-Vehicle Information System Tasks in Production Vehicles,” DOT HS 811 463, November 2011.

The study compared task completion times obtained with the traditional occlusion protocol with those obtained using the EOT to assess their relative abilities to assess the distraction effects of secondary tasks. The experiment also sought to determine the extent to which blind operation is eliminated by the EOT. Data from occlusion trials were also used to compute indices of task resumability (R), which indicate how amenable a task is to completion under conditions of interruption, as in driving. Three navigation system tasks were used, including destination entry by address, selecting a previous destination, and searching a list of cities. Results showed that the EOT eliminated some blind operation, but not all of it. Specifically, with traditional occlusion, approximately 23 percent of the actions required to perform the task was accomplished during occluded intervals. With the EOT, the corresponding percentage was 11 percent. The R metrics differed between the traditional occlusion and EOT conditions, but neither R metric revealed differences between secondary task conditions. This led to the conclusion that task resumability (R) does not reflect the same performance degradation revealed by the driving performance metrics. The destination entry by address task was associated with a significantly higher level of (auditory) tracking error than the previous destination task.

A complementary experiment was conducted as part of this project using a multiple-target detection task to assess the distraction potential of three navigation systems with comparable functionality. Participants performed two navigation system tasks (destination entry by address and previous destination) using one original equipment system and two portable systems, each differing in their rated usability. Metrics revealed strong and consistent differences between baseline driving and driving with a secondary task. Three objective metrics (car-following coherence, detection task mean response time and the proportion of long glances) revealed differences between the destination entry by address and previous destination tasks generally. Based on the results of these experiments, it was concluded that it is feasible to use a simulator-based test to assess the distraction potential of secondary tasks performed with original equipment systems integrated into production vehicles. Test results indicated that a broad range of metrics, including measures of car-following, lateral vehicle control, target detection, and visual performance, were consistently and robustly sensitive to differences between categories of secondary tasks and between baseline driving and driving while performing secondary tasks. Fewer metrics were found to be sensitive to differences between visual-manual task conditions: lane-position variability (SDLP), the time required for a following vehicle to react to lead vehicle speed changes, and detection task response time.

While the EOT represented an improvement over the traditional occlusion paradigm for providing information about the time required to perform various secondary tasks, task duration estimates obtained with either the traditional occlusion protocol or the EOT both differed from comparable values obtained in a controlled driving situation. Due to their increased sensitivity for detecting differences within task conditions, the SDLP, the time required for a following vehicle to react to lead vehicle speed changes, detection task response time and proportion of correct responses are considered core metrics for assessing distraction potential using driving simulation methods. Measures based on eye position data, primarily the proportion of long glances away from the forward roadway, also exhibited differences between tasks.

F. Distraction Effects of Manual Number and Text Entry While Driving[29]

In 2010, NHTSA conducted research to further develop its driving simulator method in order to assess the distraction potential of secondary tasks performed using in-vehicle information systems in production vehicles or portable electronic devices. The "Dynamic Following and Detection" (DFD)

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[29] Ranney, T.A., Baldwin, G.H.S., Parmer, E., Martin, J., and Mazzae, E. N., "Distraction Effects of Manual Number and Text Entry While Driving ," DOT HS 811 510, August 2011.

method combines car following and visual target detection, can be used with different vehicles, and requires minimal set up effort. Performance degradation in measures of lateral position, car following, and visual target detection, which are recorded for trials with secondary tasks, is compared to baseline driving performance and trials with a benchmark task (destination entry). NHTSA conducted a study to assess the effects of performing Manual Number and Text Entry (MNTE) tasks using integrated and portable devices in a driving simulator scenario to compare the DFD metrics with metrics specified in the Alliance of Automobile Manufacturers Driver-Focus Telematics Guidelines (the Alliance Guidelines). This study was also intended to evaluate different test participant selection criteria and sample sizes.

Specifically, the study examined Alliance Guidelines' Principle 2.1, which states:

> *Systems with visual displays should be designed such that the driver can complete the desired task with sequential glances that are brief enough not to adversely affect driving.*[30]

The Alliance proposed two alternatives for assessing compliance. Alternative A includes two criteria that should be met: (1) durations of single glances to the task should generally not exceed 2 seconds; and (2) total glance time to the task (TGT) should not exceed 20 seconds. Alternative B identifies two driving performance measures (lane exceedance frequency and car-following headway variability) and outlines a generic test protocol in which task-related degradation is related to degradation on a benchmark task (radio tuning).

For the MNTE study, an experiment was conducted in which 100 participants aged 25 to 64 years performed number and text entry tasks during 3-minute drives using the STISIM driving

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[30] P. 38, Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC.

simulator. Sensors connected to the steering, brake, and throttle of a single stationary 2010 Toyota Prius (with engine off) provided control inputs to the fixed-base driving simulator. The significant overlap in data collection requirements between Alliance and DFD protocols allowed the necessary data for a side-by-side comparison to be obtained from a single experiment. The experiment had three independent variables: (1) portable device (hard button cell phone or touch-screen cell phone)[31]; (2) benchmark (radio tuning or destination entry); and (3) driver age. Secondary tasks performed included two methods of phone dialing (10-digit dialing[32] and contact selection), text messaging, destination entry and radio tuning.

Study results showed that text messaging was associated with the highest level of distraction potential. Ten-digit dialing was the second most distracting task; radio tuning had the lowest level. Although destination entry was no more demanding than radio tuning when task duration effects were eliminated with DFD metrics, it exposes drivers to more risk than radio tuning and phone tasks due to its considerably longer duration. Modest differences between phones were observed, including higher levels of driving performance degradation associated with the touch screen relative to the hard button phone for several measures. Additional analyses demonstrated that the way in which task duration is considered in the definition of metrics influenced the outcomes of statistical tests using the metrics. The results are discussed in the context of the development of guidelines for assessment of the distraction potential of tasks performed with in-vehicle information systems and portable devices.

Additional analyses were conducted to compare the DFD and Alliance Guidelines' decision criteria in a simulated compliance scenario. With the large sample size (N = 100), both protocols

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[31] Test participants were unfamiliar with the device being used as per the test procedure requirements.
[32] Dialing using 10 digits was the only number of digits examined in this study.

supported the conclusion that neither text messaging nor 10-digit dialing is suitable for combining with driving; however, when a smaller (N = 40) sample was used, the protocols led to different conclusions. Considering only the vehicle performance metrics (not the eye glance metrics), samples of 20 participants did not provide sufficient statistical power to differentiate among secondary tasks.

Driver age had significant effects on both primary and secondary task performance; younger drivers completed more secondary task trials on a given drive with relatively less primary task interference than older drivers. Tests conducted using samples with wide age ranges (25-64) required larger samples to compensate for reduced homogeneity relative to samples with narrow age ranges.

Based on these results, two issues were identified as having implications for developing guidelines to assess the distraction potential of tasks performed with in-vehicle and portable systems. The first issue pertains to the question of how to incorporate task duration into the construction and interpretation of metrics. Secondary tasks differ in duration and these differences influence the overall exposure to risk. Metrics that summarize performance over varying durations are influenced by differences in task duration. In contrast, metrics that normalize for task duration summarize task performance over equivalent time intervals and thus represent the expected magnitude of performance degradation at any point in time during which a task is performed. These approaches provide complementary information, which could be used together to characterize the total exposure to risk associated with different tasks. One approach toward integration involves using duration-controlled metrics to estimate the average level of performance degradation associated with a particular secondary task and then multiplying this estimate by the average or some specified percentile (e.g., 85^{th}) task duration to estimate the total exposure to risk associated with performing the task once.

The finding having the most prominent implications for developing driver distraction guidelines for visual-manual interactions was that the driving simulation method of measuring distraction potential is most sensitive to differences in distraction levels of secondary tasks when performed using more than 40 test participants of homogeneous age range.

G. Principal Findings of NHTSA Driver Distraction Metric Research

Each of the research studies described above provided information which laid the foundation for the NHTSA Guidelines. The principal findings include the following:

- Visual-manual secondary tasks affected driving performance more than auditory-vocal tasks.[33] This could change as auditory-vocal interfaces become more prevalent and allow drivers to perform more complex secondary tasks.
- Eye-glance data contained important information for assessing the distraction effects of both auditory-vocal and visual-manual tasks.[34]
- The interference to driving caused by in-vehicle secondary tasks was multidimensional and no single metric could measure all effects.[35]
- CAMP Driver Workload Metrics project concluded that cognitive distraction played a much smaller role than visual distraction.[36] Again, this could change as auditory-vocal interfaces become more prevalent and allow drivers to perform more complex secondary tasks.

The research involved the development of sensitive test procedures and metrics for measuring driver distraction. Some of the conclusions drawn from the research which contributed to the basis of content in the NHTSA Guidelines include:

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[33] Angell, L., Auflick, J., Austria, P. A., Kochhar, D., Tijerina, L., Biever, W., Diptiman, T., Hogsett, J., and Kiger, S., "Driver Workload Metrics Task 2 Final Report," DOT HS 810 635, November 2006.
[34] Ibid.
[35] Ibid.
[36] Ibid.

- Experimentation involving a fixed-based driving simulator in a laboratory environment provided better control of test conditions, particularly visibility, and less measurement error than did experimentation utilizing a test track.[37]
- Limited fidelity of driving simulation did not reduce the sensitivity of simulator-based metrics for detecting targeted differences between task conditions.[38]
- Metrics found to be sensitive to differences between visual-manual task conditions include lane-position variability (SDLP), the time required for a following vehicle to react to lead vehicle speed changes, and detection task response time.[39]
- Metrics found to be sensitive to differences between auditory-vocal task conditions included the time required for a following vehicle to react to lead vehicle speed changes, detection task response time, and detection task proportion of correct responses.[40]
- Core metrics for assessing distraction potential using driving simulator-based methods include lane-position variability, the time required for a following vehicle to react to lead vehicle speed changes, detection task response time, and the proportion of correct responses due to their increased sensitivity for detecting differences within task conditions.[41]
- Differences in sample size and sample construction (test participant age) have significant differences on test outcome. Sample sizes larger than 40 participants are needed for the vehicle

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[37] Ranney, T.A., Baldwin, G.H.S., Vasko, S.M., and Mazzae, E.N., "Measuring Distraction Potential of Operating In-Vehicle Devices," DOT HS 811 231, December 2009.
[38] Ibid.
[39] Ranney, T.A., Baldwin, G.H.S., Parmer, E., Domeyer, J., Martin, J., and Mazzae, E. N., "Developing a Test to Measure Distraction Potential of In-Vehicle Information System Tasks in Production Vehicles," DOT HS 811 463, November 2011.
[40] Ibid.
[41] Ibid.

performance metrics in order to provide adequate statistical power and avoid effects of sample composition.[42]

- A driving scenario involving a following task with constant lead vehicle speed seems to provide a less realistic level of driving task difficulty and may not sufficiently engage test participants in the test protocol.[43]

With regard to specific tasks and their treatment in the NHTSA Guidelines for visual-manual tasks, the following research findings provided key input:

- Text messaging was found to be more distracting than any other secondary task considered in this study on a number of metrics. The Alliance and DFD metrics and decision criteria both supported the conclusion that text messaging is not suitable for performance while driving.[44]
- Phone dialing using 10 digits was found to be only slightly less distracting than text messaging. For larger sample sizes, the Alliance and DFD metrics and decision criteria both suggested that 10-digit phone dialing is not suitable for performance while driving.[45] This study did not examine 7-digit phone dialing. However, NHTSA is currently performing research to examine the suitability of 7-digit phone dialing while driving.

V. Driver Distraction Prevention and Reduction Guidelines

A. Currently Existing Driver Distraction Guidelines

[42] Ibid.
[43] Ibid.
[44] Ranney, T.A., Baldwin, G.H.S., Parmer, E., Martin, J., and Mazzae, E. N., "Distraction Effects of Manual Number and Text Entry While Driving ," DOT HS 811 510, August 2011.
[45] Ibid.

On July 18, 2000, NHTSA held a public meeting to address a growing concern in the traffic safety community – driver distraction. This meeting addressed the rapid emergence of informational and entertainment devices, as well as cellular telephones. Consistent with NHTSA's regulatory authority, the Agency issued a challenge to the automotive industry – develop interface guidelines to reduce the distraction potential of emerging technologies. The Alliance of Automobile Manufacturers accepted the challenge by developing a set of "best practices" for "telematic" (communication, entertainment, information, and navigation) devices. The first version of the Alliance's Statement of Principles, Criteria and Verification Procedures on Driver Interactions with Advanced In-Vehicle Information and Communication Systems (referred to elsewhere in this document as the Alliance Guidelines), were published in December 2000. Updates to the Alliance Guidelines was published in April 22, 2002 (Version 2.0), November 19, 2003 (Version 2.1), and, the most recent version (Version 3.0), on June 26, 2006.[46]

The Alliance Guidelines consist of 24 principles (organized into five groups: Installation Principles, Information Presentation Principles, Principles on Interactions with Displays/Controls, System Behavior Principles, and Principles on Information about the System) that apply to each device's driver interface to ensure safe operation while driving. Each principle includes, when appropriate for that principle, a rationale, verification methods, acceptability criteria, and examples. Quoting from the Alliance Guidelines,[47] its principles are as follows:

Section 1: Installation Principles

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[46] Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC.

[47] PP 1 - 5, Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC.

Principle 1.1: The system should be located and fitted in accordance with relevant regulations, standards, and the vehicle and component manufacturers' instructions for installing the systems in vehicles.

Principle 1.2: No part of the system should obstruct the driver's field of view as defined by applicable regulations.

Principle 1.3: No part of the physical system should obstruct any vehicle controls or displays required for the driving task.

Principle 1.4: Visual displays that carry information relevant to the driving task and visually-intensive information should be positioned as close as practicable to the driver's forward line of sight.

Principle 1.5: Visual displays should be designed and installed to reduce or minimize glare and reflections.

Section 2: Information Presentation Principles

Principle 2.1: Systems with visual displays should be designed such that the driver can complete the desired task with sequential glances that are brief enough not to adversely affect driving.

Principle 2.2: Where appropriate, internationally agreed upon standards or recognized industry practice relating to legibility, icons, symbols, words, acronyms, or abbreviations should be used. Where no standards exist, relevant design guidelines or empirical data should be used.

Principle 2.3: Available information relevant to the driving task should be timely and accurate under routine driving conditions

Principle 2.4: The system should not produce uncontrollable sound levels liable to mask warnings from within the vehicle or outside or to cause distraction or irritation.

Section 3: Principles on Interactions with Displays/Controls

Principle 3.1: The system should allow the driver to leave at least one hand on the steering control.

Principle 3.2: Speech-based communication systems should include provision for hands-free speaking and listening. Starting, ending, or interrupting a dialog, however, may be done manually. A hands-free provision should not require preparation by the driver that violates any other principle while the vehicle is in motion.

Principle 3.3: The system should not require uninterruptible sequences of manual/visual interactions. The driver should be able to resume an operator-interrupted sequence of manual/visual interactions with the system at the point of interruption or at another logical point in the sequence.

Principle 3.4: In general (but with specific exceptions) the driver should be able to control the pace of interaction with the system. The system should not require the driver to make time-critical responses when providing input to the system.

Principle 3.5: The system's response (e.g. feedback, confirmation) following driver input should be timely and clearly perceptible.

Principle 3.6: Systems providing non-safety-related dynamic (i.e. moving spatially) visual information should be capable of a means by which that information is not provided to the driver.

Section 4: System Behavior Principles

Principle 4.1: Visual information not related to driving that is likely to distract the driver significantly (e.g., video and continuously moving images and automatically-scrolling text) should be disabled while the vehicle is in motion or should be only presented in such a way that the driver cannot see it while the vehicle is in motion.

Principle 4.2(a): System functions not intended to be used by the driver while driving should be made inaccessible for the purpose of driver interaction while the vehicle is in motion.

Principle 4.2 (b): The system should clearly distinguish between those aspects of the system, which are intended for use by the driver while driving, and those aspects (e.g. specific functions, menus, etc) that are not intended to be used while driving.

Principle 4.3: Information about current status, and any detected malfunction, within the system that is likely to have an adverse impact on safety should be presented to the driver.

Section 5: Principles on Information about the System

Principle 5.1: The system should have adequate instructions for the driver covering proper use and safety-relevant aspects of installation and maintenance.

Principle 5.2: Safety instructions should be correct and simple.

Principle 5.3: System instructions should be in a language or form designed to be understood by drivers in accordance with mandated or accepted regional practice.

Principle 5.4: The instructions should distinguish clearly between those aspects of the system that are intended for use by the driver while driving, and those aspects (e.g. specific functions, menus, etc) that are not intended to be used while driving

Principle 5.5: Product information should make it clear if special skills are required to use the system or if the product is unsuitable for particular users.

Principle 5.6: Representations of system use (e.g. descriptions, photographs, and sketches) provided to the customer with the system should neither create unrealistic expectations on the part of potential users, nor encourage unsafe or illegal use.

The Alliance Guidelines provide a comprehensive set of recommendations designed to limit visual-manual distraction while driving. The document includes relevant definitions, human factors principles for good device driver-interface design, methods for verifying compliance with the principles, and a number of examples. These Alliance Guidelines serves as an excellent foundation for the development of the NHTSA Guidelines.

In addition to the Alliance Guidelines, numerous other standards and guidelines documents have been developed. A summary of these is contained in the SAE paper "Driver Interface/HMI Standards to Minimize Driver Distraction/Overload."[48] The two other sets of these guidelines that most directly deal with driver distraction (in addition to the Alliance Guidelines) were:

- Commission Recommendation of 26 May 2008 on Safe and Efficient In-Vehicle Information and Communication Systems; Update of the European Statement of Principles on Human-Machine Interface (referred to as the "European Guidelines").[49]
- The Japan Automobile Manufacturers Association Guidelines for In-vehicle Display Systems – Version 3.0 (referred to as the "JAMA Guidelines").[50]

The European Guidelines consist of 34 principles that each in-vehicle device's driver interface should meet to ensure safe operation while driving, as well as 16 safety recommendations for drivers, employers, advertisers, and personnel working for vehicle-for-hire operations. Driver interface principles are grouped into the following areas: Overall Design Principles, Installation Principles, Information Principles, Interactions with Controls and Displays Principles, System Behavior Principles, and Information about the System Principles, most of which are similar to the corresponding principles in the Alliance Guidelines. The principles present in the European Guidelines that are not present in the Alliance Guidelines are typically understood in the latter and do not have verification methods given in the former. For example, the first European Guidelines principle is:

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[48] Green, P., "Driver Interface/HMI Standards to Minimize Driver Distraction/Overload," SAE Paper 2008-21-2002, 2008.
[49] Commission of the European Communities, "Commission Recommendation of 26 May 2008 on Safe and Efficient In-Vehicle Information and Communication Systems; Update of the European Statement of Principles on Human-Machine Interface," 2008.
[50] Japan Automobile Manufacturers Association, "Guideline for In-Vehicle Display Systems, Version 3.0," Japan Automobile Manufacturers Association, Tokyo, Japan, August 2004.

> The system supports the driver and does not give rise to potentially hazardous behavior by the driver or other road users.[51]

While this principle is not explicitly written in the Alliance Guidelines, reading them clearly shows that this principle is the underlying one for all of the Alliance Guidelines.

Unlike the Alliance Guidelines, the European Guidelines do not prescribe testing methods and acceptance criteria for determining whether a task can safely be performed by the driver while a vehicle is in motion. For example, one very important Alliance Guidelines principle, Principle 2.1, is:

> Systems with visual displays should be designed such that the driver can complete the desired task with sequential glances that are brief enough not to adversely affect driving.[52]

The Alliance Guidelines then follow this statement with many pages describing how to verify that a device's interface meets this principle. In contrast, the corresponding European Guidelines principle reads:

> Visually displayed information presented at any one time by the system should be designed in such a way that the driver is able to assimilate the relevant information with a few glances which are brief enough not to adversely affect driving.[53]

However, the European Guidelines limit statements about the verification process to:

> Compare design alternatives for the presentation of information: the number and duration of glances needed to detect and acquire relevant information presented at any one time should be minimized.[54]

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[51] P. 7, Commission of the European Communities, "Commission Recommendation of 26 May 2008 on Safe and Efficient In-Vehicle Information and Communication Systems; Update of the European Statement of Principles on Human-Machine Interface," 2008.
[52] P. 38, Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC.
[53] P. 13, Commission of the European Communities, "Commission Recommendation of 26 May 2008 on Safe and Efficient In-Vehicle Information and Communication Systems; Update of the European Statement of Principles on Human-Machine Interface," 2008.
[54] Ibid.

The JAMA Guidelines consist of four basic principles and 25 specific requirements that apply to each device's driver interface to ensure safe operation while driving. Specific requirements are grouped into the following areas: Installation of Display Systems, Functions of Display Systems, Display System Operation While Vehicle in Motion, and Presentation of Information to Users. Additionally, there are three annexes: Display Monitor Location, Content and Display of Visual Information While Vehicle in Motion, and Operation of Display Monitors While Vehicle in Motion, as well as one appendix: Operation of Display Monitors While Vehicle in Motion.

Approximately one-half of the specific requirements in the JAMA Guidelines are essentially identical to the corresponding principles in the Alliance and European Guidelines.

Like the Alliance Guidelines, the JAMA Guidelines prescribe acceptance criteria for determining whether a task can safely be performed by the driver while a vehicle is in motion. Based on the specified acceptance criteria, the JAMA Guidelines imply the use of the same testing methods (the JAMA Guidelines do not actually specify testing methods) as are contained in the Alliance Guideline's Alternative A verification options: *Eye Tracker Measurement*, *Video Recording of Test Participant's Eyes/Face*, and *Testing using Occlusion*. However, the JAMA acceptance criteria are more constraining than those found in the Alliance Guidelines. The JAMA Guidelines limit the maximum driver total glance time while performing a task (JAMA uses the same definition for task as is used in the Alliance Guidelines) to 8.0 seconds or 7.5 seconds if occlusion is used (compare to the Alliance Guidelines limits of 20.0 seconds for maximum driver total glance time or 15.0 seconds for occlusion).

The JAMA Guidelines also contain a recommended limit on the amount of dynamic test that can be displayed to the driver at one time. As the JAMA Guidelines state:

The number of letters (e.g., characters, kana, alphabets) displayed at a time shall not exceed 31,[55] *provided that a number such as "120" or a unit such as km/h" is deemed to be a single letter irrespective of the number of digits. Punctuation marks are not included in the count of letters.*[56]

The JAMA Guidelines are far shorter, and, as a result, far less detailed than either the Alliance or European Guidelines.

Of the various driver distraction prevention and reduction guidelines that were reviewed, NHTSA has decided that the current version of the Alliance Guidelines serves as the best basis for the development of the NHTSA Guidelines. They are the most complete of the three guideline sets considered and contain far more information about verification procedures than do the European or JAMA Guidelines. There are only a few contradictions between the three sets of guidelines, with the principal one being the JAMA Guidelines previously discussed prohibition on performing non-driving related tasks while in motion.

The Alliance and European Guidelines are quite similar; a device that meets one set of these guidelines will meet the other. The Japanese Guidelines are more restrictive – they do not allow quite a number of devices to function whenever the vehicle is in motion. As a result, a vehicle that strictly follows the JAMA Guidelines should meet all of the recommendations of both the Alliance and European Guidelines but not necessarily vice-versa.

When there are items contained in either the European or JAMA Guidelines that are not in the Alliance Guidelines, NHTSA has carefully considered them and included them in the NHTSA

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[55] The JAMA Guidelines appear inconsistent as to the maximum number of letters that they allow to be displayed at one time. The above quote, which is taken from page 7 of the JAMA Guidelines appears to set the maximum allow number of letters to 31. However, the statement on page 13, "display of 31 or more letters at a time is prohibited," appears to contradict this 31 character maximum value. NHTSA has selected the more conservative of these two values for its proposal.

[56] P. 7, Japan Automobile Manufacturers Association, "Guideline for In-Vehicle Display Systems, Version 3.0," Japan Automobile Manufacturers Association, Tokyo, Japan, August 2004.

Guidelines when we agree with them (e.g., the 30 character limit in the NHTSA Guidelines on the amount of text that may be read comes from the JAMA Guidelines).

As a convenience to readers, NHTSA has placed copies of the Alliance, European, and JAMA Guidelines into the distraction docket.[57]

B. Why NHTSA Is Issuing Its Own Guidelines for Limiting and Reducing Driver Distraction

NHTSA has decided to issue its own guidelines for limiting and reducing driver distraction associated with the use of in-vehicle electronic devices while driving. Voluntary guidelines developed by others in the past have been instrumental in the development of these NHTSA Guidelines. The NHTSA Guidelines are being issued for the following reasons:

- So as to have guidelines available for all passenger cars, multipurpose passenger vehicles, and trucks and buses with a Gross Vehicle Weight Rating (GVWR) of not more than 10,000 pounds.
- So as to have guidelines applicable to all communications, entertainment, information, and navigation devices installed in vehicles as original equipment.
- So as to incorporate the latest driver distraction research into the guidelines. There has been much research on driver distraction in the five years since the Alliance Guidelines were last updated; NHTSA believes that it is valuable to incorporate the results of this recent research into guidelines that serve to reduce or prevent driver distraction prevention.
- Per the Highway Safety Act of 1970, NHTSA is responsible for reducing deaths, injuries and economic losses resulting from motor vehicle crashes; in short, NHTSA is responsible for

[57] Docket No. NHTSA-2010-0053.

vehicle safety. While manufacturers also have a strong interest in safety, they are also influenced by other factors, such as market forces. Therefore, the NHTSA Guidelines will focus solely on safety and the safety impact of final (i.e., consumer-ready) products. In contrast, other guidelines focus more on the design process, which involves consideration of factors in addition to safety, and include metrics that can be used on prototype designs.

- NHTSA has identified some aspects of the current Alliance Guidelines that are loosely specified or provide multiple compliance assessment options that may correspond to different levels of associated safety. NHTSA would like to specify a test procedure that is straight-forward, clearly defined, and well-substantiated in order to aid the voluntary adoption of its NHTSA Guidelines. Minimizing the opportunity for variability in carrying out the test procedure will ensure that manufacturers would be able to easily and consistently implement the NHTSA Guidelines across their light vehicle fleets.

Before undertaking this guideline effort, NHTSA met with several manufacturers in 2010 to determine how they had implemented the Alliance Guidelines. During these meetings, NHTSA learned that implementation varies across, and sometimes within, manufacturers. This information has been useful to NHTSA to attain a better understanding of the practical considerations and constraints facing manufacturers when developing vehicle technologies. This information has been taken under consideration by NHTSA while drafting the new NHTSA Guidelines.

The NHTSA Guidelines, while adopting much of the content of the Alliance Guidelines, incorporate a number of changes in an effort to further enhance driving safety, to enhance guideline usability, to improve implementation consistency, and to incorporate the latest driver distraction research findings. The proposed NHTSA Guidelines and their rationales, including the rationale for departures from the Alliance Guidelines, are discussed in detail in later portions of this notice.

C. First Phase of NHTSA's Driver Distraction Guidelines Focuses on Original Equipment Devices with Visual-Manual Driver Interfaces

As discussed in NHTSA's Driver Distraction Program, NHTSA's intent is to "develop voluntary guidelines for minimizing the distraction potential of in-vehicle and portable devices." Electronic devices in a motor vehicle can divided into three broad classes, depending upon their origin. These devices may have been built into a vehicle when it is manufactured (i.e., original equipment devices), installed in a vehicle after it has been built (i.e., aftermarket devices), or brought into a vehicle (portable devices). The current notice only contains voluntary NHTSA Guidelines for visual-manual interactions associated with original equipment devices. Portable devices will be addressed by Phase 2 of the NHTSA Guidelines. These and the remaining phases of the NHTSA Guidelines are outlined in Table 2.

As noted earlier, drivers perform tasks using an in-vehicle electronic device by interacting with the device through its driver interface. The driver interfaces of these devices can be designed to accommodate interactions that are visual-manual, auditory-vocal, or a combination of the two.

The goal of the NHTSA Guidelines is to discourage the design of in-vehicle device interfaces that do not minimize driver distraction associated with secondary task performance. The NHTSA Guidelines specify criteria and a test method for assessing whether a secondary task performed using an in-vehicle device may be suitable for performance while driving, due to its minimal impact on driving performance and, therefore, safety. The NHTSA Guidelines also seek to identify secondary tasks that interfere with a driver's ability to safely control their vehicle and to categorize those tasks as ones that are not suitable for performance by the driver while driving.

For each of the three possible origins of in-vehicle electronic devices, both visual-manual and auditory-vocal interaction modes may be possible. Table 2 indicates the order in which NHTSA plans to develop its NHTSA Guidelines to address the different device origins and interfaces.

TABLE 2 -- MATRIX SHOWING NHTSA DRIVER DISTRACTION GUIDELINE PHASES BASED ON DEVICE ORIGINS AND INTERACTION TYPES

	Origin of Device		
Type of Interaction	**Original Equipment**	**Aftermarket**	**Portable**
Visual-Manual	NHTSA Driver Distraction Guidelines, Phase 1	NHTSA Driver Distraction Guidelines, Phase 2	NHTSA Driver Distraction Guidelines, Phase 2
Auditory-Vocal	NHTSA Driver Distraction Guidelines, Phase 3	NHTSA Driver Distraction Guidelines, Phase 3	NHTSA Driver Distraction Guidelines, Phase 3

This notice proposes Phase 1 of the NHTSA Driver Distraction Guidelines. NHTSA plans to issue Phase 2 (aftermarket and portable devices) of its NHTSA Guidelines in 2013 and Phase 3 (auditory-vocal interfaces) in 2014. Our NHTSA Guidelines are being developed in these phases because:

- While some international and voluntary consensus standards exist that relate to visual-manual interfaces for in-vehicle devices, no similar standards for devices with auditory-vocal interfaces exist. Auditory-vocal interfaces are newer than are visual-manual interfaces; as a consequence less research has been performed on driver distraction while using auditory-vocal interfaces. Research is needed on such subjects as how to best measure the level of driver distraction induced when auditory-vocal interfaces are used. Based on this shortage of research, NHTSA intends to delay the extension of its NHTSA Guidelines to cover auditory-vocal interfaces until Phase 3 of guideline development.
- From naturalistic driving research, the secondary tasks with the highest risk odds ratios tend to be primarily visual-manual in nature with only a relatively small cognitive component. Of

course, every secondary task results in some cognitive load; however, tasks such as Reaching for a Moving Object or Eating require that the driver's eyes and hands be used to perform non-driving tasks but do not require a lot of thought. It is not until the ninth highest risk odds ratio in Figure 1; Talking/Listening to a Hand-Held Device that a secondary task appears that is heavily cognitive in nature.[58] Furthermore, this secondary task's risk odds ratio is not statistically significantly different from 1.00 at the 95 percent confidence level. In fact, there are no secondary tasks in Figure 1 that have risk odds ratios which are statistically significantly greater than 1.00 that are primarily cognitive in nature.

- There may be special challenges associated with guidelines for both aftermarket and portable devices. Given that for some device types the only substantial difference between an integrated and a portable version of the device will be the device location (fixed or variable), most of the NHTSA visual-manual Driver Distraction Guideline criteria are expected to also be appropriate for aftermarket and portable devices with visual-manual driver interfaces. However, NHTSA thinks that additional research is necessary to determine if there are other considerations for guidelines for aftermarket and portable devices. Therefore, NHTSA intends to implement the extension of its NHTSA Guidelines to cover aftermarket and portable devices in Phase 2 of guideline development.

D. Past NHTSA Actions on Driver Distraction

[58] It could be argued that "Reading" generates high cognitive distraction. Clearly "Reading" generates a high visual load. Unfortunately, we do not, at this time, have the ability to measure the cognitive load generated by "Reading." However, it seems reasonable that the cognitive distraction generated would vary depending upon what is being read. NHTSA believes that what are most commonly being read by drivers are signs or simple printed material that are not expected to generate high cognitive distraction.

Before this notice, NHTSA had published one Federal register notice that was related to driver distraction. On June 3, 2008, NHTSA denied[59] a petition from the Center for Auto Safety requesting that NHTSA do the following:

1. Issue a Notice of Proposed Rulemaking (NPRM) to require that any personal communication systems integrated into a vehicle, including cellular phones and text messaging systems, be inoperative when the transmission shift lever is in a forward or reverse gear.
2. Issue an Advance Notice of Proposed Rulemaking (ANPRM) to consider requiring that other integrated telematic systems in vehicles that significantly increase crash rates be inoperative when the transmission shift lever is in a forward or reverse gear.
3. Increase efforts to support state programs to limit cell phone use by drivers in moving vehicles in the same manner that it supports state programs against drunk driving.

Part of NHTSA's rationale for denying the Center for Auto Safety petition was, as stated in the Federal register notice, the concern that:

> *If integrated cell phones and other telematic devices were required to be inoperative, drivers could instead use portable devices such as their regular cell phones.*[60]

NHTSA remains concerned about the possibility of drivers increasing their use of portable devices due to restrictions being placed on integrated devices. Based on this concern, NHTSA considers it essential that guidelines for aftermarket and portable devices be developed as rapidly as feasible following the development of NHTSA Guidelines for original equipment devices. As shown in Table 2 and explained in the discussion following this table, the development of NHTSA Guidelines for

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[59] Federal Register, Vol. 73, No. 107, pp. 31663-31665, June 3, 2008.
[60] Ibid, P. 31664.

aftermarket and portable visual-manual device interfaces (Phase 2) is planned to begin immediately following the completion of the original equipment visual-manual NHTSA Guidelines (Phase 1).

E. Challenges Relating to the Development of Interface Guidelines to Minimize Driver Distraction

Developing guidelines for device driver interfaces that minimize distraction and its impact on driving performance is complicated. Research is ongoing to identify the best methods and metrics by which to measure the effects of distraction on driving performance. Even though research on this topic has not been completed, NHTSA thinks it important to be proactive and provide guidance on how manufacturers may limit the range and complexity of in-vehicle device tasks that may be considered in the future so as to ensure the safety of drivers and fellow road users. Therefore, NHTSA presents in this notice its current "best" proposal based on information currently available.

The challenges involved in developing driver distraction guidelines and assessing whether covered devices meet associated criteria are many and non-trivial. These challenges include:

1. Ensuring that criteria that device tasks should meet are rigorously developed, validated, and substantiated by experimental data.
2. Developing Guideline criteria that are generalized to all device types covered by these NHTSA Guidelines, including a wide range of existing devices and tasks as well as ones that may appear in future vehicles but have not yet been conceived.
3. Identifying sensitive metrics for measuring distraction and the most appropriate characteristics of the sample population used to assess the metrics.

4. Developing a test scenario for use in assessing the degree to which in-vehicle device tasks meet Guideline criteria that simulates the demand of actual driving under suitable and "representative" conditions.
5. Developing a repeatable and well-defined test protocol for use in assessing the degree to which in-vehicle device tasks meet Guideline criteria that implement the chosen driving scenario.
6. Formulating a tightly specified task definition to ensure that similar tasks are assessed for their ability to meet Guideline criteria in a similar manner by all relevant manufacturers.
7. Establishing criteria for the sample of experimental subjects to be tested using the test protocol (i.e., number of test participants; test participant age ranges, experience, etc.).
8. Assessing whether minimizing total eyes-off-road time spent on a given secondary task actually results in an overall reduction in the total amount of eyes-off-road time spent on all secondary tasks, especially as the number of secondary tasks multiply with the introduction of more and more entertainment, communication and information devices, and capabilities.

Each of these challenges is elaborated upon in the following paragraphs.

1. The Guideline and task performance criteria that devices should meet need to be rigorously developed, valid, and substantiated by experimental data. While driver distraction is a topic for which most of the general public has opinions, decisions relating to what tasks a driver should be free to perform while driving should be made based on objective data. Having a data-based means of substantiating distraction guidelines provides a firm foundation to guarantee that measurable safety improvements are actually achieved.

2. Developing appropriate Guideline criteria for the broad range of current and future device task types and input methods is highly challenging. To date, a variety of manual means through which drivers can make control inputs to in-vehicle systems have been used. NHTSA Guidelines for systems

with visual-manual interaction means should cover all types of traditional input controls, touch screens, and means of providing feedback to the driver. Beyond control input method, the types of tasks available vary and the extent of electronic device related tasks that may become available in future vehicles cannot be known at this time. For these reasons, establishing guidelines that will remain relevant in the long-term is a challenging issue.

3. Various metrics for characterizing distraction's impact on driving performance have been developed, but are still being debated within the research community and industry. Metric sensitivity and the relationship between the metrics and crash risk are topics of much contention. Some metrics require testing large numbers of test participants in order to achieve sufficient statistical power to allow significant effects to be observed, if they exist. Acceptance criteria need to be selected and justified based on safety data.

4. A test scenario that simulates the demands of actual driving under suitable and "representative" conditions needs to be defined in order to provide a baseline for use in measuring the impact of distracted driving. It should be insensitive to the dynamics of the vehicles being tested so as to minimize the need for complex and expensive vehicle characterization testing.

The amount of interference created by secondary task performance while driving is dependent on the complexity of the driving scenario in which the secondary task is performed. Drivers will have more spare attentional capacity that may be used to perform secondary tasks in less complex traffic conditions than they would in more complex traffic conditions. Therefore, secondary task performance would be expected to impact driving performance less in a low complexity driving situation than in a high complexity one. Choosing the most appropriate level of driving scenario complexity for assessment of distraction effects is difficult and important.

5. A test procedure must be developed to be able to assess adherence to the driver distraction guidelines criteria. While typical compliance testing measures the effects of a known magnitude and type of stimulus on a specific vehicle design's motion or structural integrity, a test of driver distraction measures the effects of a stimulus, the magnitude of which is difficult to quantify, on the ability of a non-standardized and variable system (i.e., the driver) to control a vehicle safely. Given that the population of drivers varies widely in a number of aspects including driving skill, multi-tasking ability, attentional focus capacity, and propensity to perform non-driving tasks while driving, the sample of drivers needed for a test to determine adherence to the NHTSA Guidelines would need to be much larger than the sample size of one typically associated with a vehicle performance compliance test. Appropriate data reduction methods and tools also must be developed.

6. In order to have a standardized test for measuring the impact of secondary task performance on driving performance and safety, the test criteria must be well-specified. In particular, a clear definition of a "task" must be asserted to specify the series of driver actions needed to perform a secondary task that should be assessed for adherence to the NHTSA Guidelines' criteria. Unclear task specifications can result in inconsistent guideline adherence test performance throughout the industry. While the definition of task used in the Alliance Guidelines is short and conceptually clear, it can be difficult to determine for real devices whether something is one task or several. This is particularly challenging to do for devices and tasks that have not yet been developed.

7. Characteristics of the sample of test participants to be subjected to the test protocol (number of test participants; test participant criteria including age, experience, conflicts of interest, etc.) need to be identified. NHTSA is particularly worried about prior test participant experience with the devices that are being evaluated. Devices are frequently far more difficult to use (and hence, distracting) when

drivers are not familiar with them. However, the vast majority of device usage is by drivers who use a device daily and are highly familiar with their operation.

8. It must be determined whether minimizing the total eyes-off-road time spent on a given secondary task actually results in an overall reduction in the total amount of eyes-off-road time spent on all secondary tasks. This is particularly important as the number of non-driving secondary tasks seemingly multiplies as more entertainment, communication and information devices, and capabilities are introduced into vehicles. (Are the number and variety of secondary tasks in fact multiplying or does it just seem that way?) Many people have speculated that making it safer for drivers to perform secondary tasks while driving will encourage drivers to perform more secondary tasks while driving. This is another application of risk homeostasis theory; people have an acceptable level of risk that they are comfortable with and they compensate for reductions in risk by taking on additional risks so as to maintain a relatively constant level of risk.

There is undoubtedly a certain amount of truth to risk homeostasis theory with regard to driving safety. For example, over the last 50 years, numerous safety improvements have been implemented in motor vehicles. Risk homeostasis theory predicts that drivers would drive more dangerously so as to maintain their overall acceptable level of risk. One way to do this is by driving faster. There is some evidence that this has happened. Speed limits have been increased. While drivers used to speed when the national speed limit was 55 mph, they still speed today when interstate highway speed limits have been increased to 65 to 75 mph. However, there is a clearly decreasing trend in the number of motor vehicle fatalities, especially when they are normalized by the number of vehicle miles traveled.

What seems to have happened in the past is that safety improvements have been partially, but not totally, offset by riskier driving behavior (frequently by increases in driving speed). However, substantial improvement in safety has remained, even after the changes in driver behavior. True risk homeostasis did not occur, but we did see behavioral adaptation as drivers partially compensated for the decrease in risk.

NHTSA anticipates that similar changes in driver behavior may be seen due to these NHTSA Guidelines. Some portion of the otherwise expected improvement in safety and reduction in driver workload associated with task performance may be used by drivers to perform more secondary tasks. However, there should also be an improvement in overall driving safety.

While NHTSA's primary focus is driving safety, other things are also important to drivers. Drivers, like any other category of people, will seek to have their personal needs met. Drivers are not forced to perform additional secondary tasks just because they have a vehicle designed for safe in-vehicle secondary task performance. Drivers perform these additional secondary tasks to meet their own needs. Even though some portion of the expected improvement in safety may be negated by the performance of more secondary tasks, the overall quality of life will be improved for drivers and other road users.

VI. Justification for Specific Portions of NHTSA Guidelines for Reducing Driver Distraction during Interactions with In-Vehicle Systems

A. Intended Vehicle Types

These proposed NHTSA Guidelines are appropriate for all passenger cars, multipurpose passenger vehicles, and trucks and buses with a GVWR of not more than 10,000 pounds. These are what NHTSA has traditionally called "light vehicles." This category of vehicles has been the primary focus of NHTSA's past driver distraction research. Additionally, light vehicles have been a major platform for the push to incorporate built-in advanced technology, entertainment, and communications functions into vehicles. Focusing on this vehicle category serves as a step towards ensuring that the increasing features being offered in all vehicles do not produce an overwhelmingly distracting in-vehicle environment for the driver that can degrade safety. For these reasons, NHTSA has focused its distraction research on light vehicles. While much of what NHTSA has learned about light vehicle driver distraction undoubtedly applies to other vehicle types, additional research would be needed to assess whether all aspects of these NHTSA Guidelines are appropriate for application to those vehicle types.

B. Existing Alliance Guidelines Provide a Starting Point

The NHTSA Guidelines derive in part from the document "Statement of Principles, Criteria, and Verification Procedures on Driver Interactions with Advanced In-Vehicle Information and Communication Systems including 2006 Updated Sections" that was developed by the Alliance of Automobile Manufacturer's Driver-Focus Working Group (frequently referred to as the Alliance Guidelines).[61] Portions of the Alliance Guidelines have been carried over to the NHTSA Guidelines without changes. When the NHTSA Guidelines differ from the Alliance Guidelines, it is either due to recent research that has been performed since the development of the Alliance Guidelines or because NHTSA believes that the changes made will increase the safety of the motoring public.

A number of the Alliance Guideline principles are not included in the NHTSA Guidelines. While NHTSA generally agrees with the excluded principles, NHTSA thinks that these principles are not appropriate to include in these NHTSA Guidelines.

The excluded principles, and their reasons for exclusion, are as follows:

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[61] Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC.

- *Principle 1.1: The system should be located and fitted in accordance with relevant regulations, standards, and the vehicle and component manufacturers' instructions for installing the systems in vehicles.*[62]

NHTSA assumes that vehicle manufacturers will follow this principle when deciding where to locate devices within their vehicles. However, verification by NHTSA that devices meet this principle is difficult. The Alliance Guidelines verification section for this principle does not offer much guidance; it merely states:

> *Design to conform and validate by appropriate means as may be specified by relevant standards or regulations or manufacturer-specific instruction.*[63]

As discussed above, NHTSA intends to monitor whether vehicles meet these NHTSA Guidelines to help determine their effectiveness and sufficiency. Accordingly, the NHTSA Guidelines do not include principles for which there is no reasonable method for NHTSA to assess Guideline adherence. It is hard for NHTSA to do this, at least for some devices, without having access to information known to the manufacturer but not necessarily to NHTSA. For these reasons, we do not believe it is feasible for NHTSA to develop the methods needed to monitor adherence to this principle.

- *Principle 1.5: Visual displays should be designed and installed to reduce or minimize glare and reflections.*[64]

Vehicle manufacturers report that they follow this principle when installing when deciding where to locate devices within their vehicles. Additionally, verification by NHTSA that devices meet this principle is difficult. The Alliance Guidelines verification section for this principle again does not offer much guidance; it merely states:

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[62] P. 13, Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC.
[63] Ibid, P. 14.
[64] Ibid, P. 37.

Verification should be done by appropriate means (e.g., analysis, inspection, demonstration, or test).[65]

Furthermore, glare and reflections on device interfaces only indirectly contribute to driver distraction (and thereby affect safety). Finally, glare and reflection reduction and minimization is a complex problem that is best left to the vehicle designer. For all of these reasons, it does not seem feasible for NHTSA at this time to develop the complicated methods needed to monitor adherence to this principle.

- *Principle 5.1: The system should have adequate instructions for the driver covering proper use and safety-relevant aspects of installation and maintenance.*[66]
- *Principle 5.2: Safety instructions should be correct and simple.*[67]
- *Principle 5.3: System instructions should be in a language or form designed to be understood by drivers in accordance with mandated or accepted regional practice.*[68]
- *Principle 5.4: The instructions should distinguish clearly between those aspects of the system that are intended for use by the driver while driving, and those aspects (e.g. specific functions, menus, etc) that are not intended to be used while driving.*[69]

All four of these principles relate to the adequacy of the instructions that are provided to the driver. NHTSA does not have an objective means to determine instruction adequacy for a potentially broad range of device instructions. Therefore, we have excluded these four principles from the NHTSA Guidelines.

- *Principle 5.5: Product information should make it clear if special skills are required to use the system or if the product is unsuitable for particular users.* [70]

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[65] Ibid, P. 37.
[66] Ibid, P. 79.
[67] Ibid.
[68] Ibid.
[69] Ibid.
[70] Ibid.

- *Principle 5.6: Representations of system use (e.g. descriptions, photographs, and sketches) provided to the customer with the system should neither create unrealistic expectations on the part of potential users, nor encourage unsafe or illegal use.*[71]

Both of these principles relate to the appropriateness of content in information about the device provided to the driver by the vehicle manufacturer. NHTSA does not believe that it is appropriate for NHTSA to determine the appropriateness of content in information provided to the driver by the vehicle manufacturer. Therefore, we have excluded both of these principles from the NHTSA Guidelines.

C. International Harmonization and Voluntary Consensus Standards

NHTSA is aware of the fact that since vehicles designed in many countries are sold in the United States and that vehicles designed in the United States are sold in many countries, motor vehicle manufacturers' desire internationally harmonized regulations. Unfortunately, comprehensive, internationally-harmonized, driver distraction prevention and reduction guidelines do not yet exist. (Although the high degree of similarity between the Alliance and European Guidelines is a good start towards international harmonization, NHTSA would like to see these guidelines made more stringent so as to better protect the safety of the motoring public.) Where international and voluntary consensus standards exist that are useful for portions of the NHTSA Guidelines, they have been carefully considered and utilized when appropriate. Specifically, for performing occlusion testing, NHTSA has used International Standards Organization (ISO) International Standard 16673:2007, "Road Vehicles – Ergonomic Aspects of Transport Information and Control Systems – Occlusion Method to Assess Visual Demand due to the use of In-Vehicle Systems." Additionally, NHTSA has used SAE Surface Vehicle

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[71] Ibid.

Recommended Practice J941-2010, "Motor Vehicle Drivers' Eye Locations," published March 16, 2010, to determine the driver's eye point when determining the downward viewing angle to device displays.

NHTSA hopes that, in the future, it will be possible to develop the NHTSA Guidelines into an internationally harmonized practice.

The remainder of this section consists of a detailed discussion and justification of major items in the NHTSA Guidelines.

D. Statement of General Responsibilities

New in-vehicle technologies are being developed at an extremely rapid pace. NHTSA does not have the resources to evaluate the safety implications of every new device before it is introduced into vehicles. Such a practice would dramatically slow the rate of introduction of new technology into vehicles. Finally, and most importantly, adopting such a practice is unnecessary in light of the National Traffic and Motor Vehicle Safety Act of 1966's[72] requirement that each manufacturer bears primary responsibility for products that they produce that are in motor vehicles. A manufacturer that produces a vehicle or item of motor vehicle equipment that either does not comply with the FMVSSs or contains a defect creating an unreasonable risk to safety must recall the vehicle or equipment and provide the owner a remedy. 49 U.S.C. §§ 30118-30120.

Accordingly, a section has been included in the NHTSA Guidelines emphasizing that, to protect the general welfare of the people of the United States; manufacturers are responsible for refraining from introducing new in-vehicle devices that create unreasonable risks to the safety of the driving public.

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[72] 80th Congress, Statute 718.

E. Scope – Devices For Which The NHTSA Guidelines Are Appropriate

The NHTSA Guidelines are appropriate for all information, navigation, communications, and entertainment systems integrated into the vehicle by the vehicle manufacturer. Note that, unlike the Alliance Guidelines, these NHTSA Guidelines are considered to be appropriate for both conventional and advanced varieties of information, navigation, communications, and entertainment systems.

The NHTSA Guidelines are not appropriate for collision warning or vehicle control systems. These systems are intended to aid the driver in controlling the vehicle and avoiding crashes and, therefore, are justified in capturing the driver's attention. The purpose of collision warning systems, in particular, is to alert the driver quickly to an unsafe condition and motivate the driver to make control inputs in an effort to avoid a crash. The idea of minimizing distraction stemming from this type of system is in conflict with their purpose – providing safety warnings to inattentive drivers.

In addition, other conventional controls and displays such as heating-ventilation-air conditioning (HVAC), instrument panel gauges and telltales, etc., are also out-of-scope for the NHTSA Guidelines. This is because operating vehicle control systems and looking at the related displays are part of the primary driving task, and are therefore not considered a distraction. Furthermore, attempting to include these devices in the scope of these NHTSA Guidelines could result in conflicts with either current or possible future Federal Motor Vehicle Safety Standards.

F. Definition of a Task

NHTSA tasked the Virginia Tech Transportation Institute (VTTI) to examine the Alliance Guideline's existing definition of a task to assess whether improvements to the definition could be made. In addition to reviewing the Alliance Guidelines, VTTI interviewed nine outside experts from academia, government, and industry about their use, and possible improvements to, the Alliance Guideline's definition.

VTTI's interviews found that experts were generally satisfied with the Alliance Guideline's definition of a task but believed that it could use some clarifications. Based on their self-reporting, the experts were generally using the Alliance Guideline's definition of a task consistently except for differences as to the precise start and end points of a task. These differences could affect whether a task meets the acceptance criteria for assessing whether a secondary task performed using an in-vehicle device may be suitable for performance while driving, due to its minimal impact on driving performance and, therefore, safety.

Additional details regarding this VTTI expert panel effort will be summarized in a NHTSA report to be released in 2012.

One VTTI recommendation that has been adopted in the NHTSA Guidelines is to emphasize that only tasks that can be reasonably subjected to a test should be subjected to a test, i.e., do not test a task that is unbounded in duration and do not test a task that has no measurable magnitude or dose. Therefore, VTTI recommended that NHTSA refer to tasks in its NHTSA Guidelines as Testable Tasks. These Testable Tasks have well defined points at which the Start of Data Collection and End of Data Collection occur, which should resolve the differences seen between various experts on this issue of task start and end points.

Finally, VTTI recommended that NHTSA provide additional explanatory information and examples about Testable Task definitions. This information will be provided in a forthcoming NHTSA Technical Report.

G. Definition of Lock Out

To achieve the purpose of the NHTSA Guidelines, tasks that that do not meet the guideline criteria (or devices that are inherently distracting such as full-motion video displays) should be disabled so that they will not be accessible (i.e., be "locked out") to the driver while "driving" a motor vehicle.

On October 1, 2009, President Obama issued an Executive Order, "Federal Leadership on Reducing Text Messaging While Driving,"[73] that instructed Federal employees and contractors **not** to perform text messaging while driving a United States Government owned vehicle, while driving their personal vehicle on official, United States Government, business, or while driving and using a United States Government owned electronic device. The Executive Order defines driving as follows:

> *"Driving" means operating a motor vehicle on an active roadway with the motor running, including while temporarily stationary because of traffic, a traffic light or stop sign, or otherwise. It does not include operating a motor vehicle with or without the motor running when one has pulled over to the side of, or off, an active roadway and has halted in a location where one can safely remain stationary.*[74]

NHTSA is proposing to make its definition of "driving" in the context of these NHTSA Guidelines consistent with the Executive Order's definition of "driving." However, because these NHTSA Guidelines are meant for vehicle manufacturers designing in-vehicle integrated electronic device interfaces, the agency is proposing a definition that is framed in terms of the status of the vehicle rather than the conduct of the driver. Specifically, the NHTSA Guidelines recommend disabling unreasonably distracting tasks and/or devices while driving. For the NHTSA Guidelines, "while driving" is defined as any time the vehicle's engine is turned on and its transmission is not in "Park" (for

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[73] Executive Order, "Federal Leadership on Reducing Text Messaging While Driving," October 1, 2009, retrieved from http://www.whitehouse.gov/the_press_office/Executive-Order-Federal-Leadership-on-Reducing-Text-Messaging-while-Driving/ on March 22, 2011.

[74] The U.S. Department of Transportation's Federal Motor Carrier Safety Administration (FMCSA) and Pipeline and Hazardous Materials Safety Administration (PHMSA) use a slightly different definition of driving. Their definition limits driving to operating a commercial motor vehicle on a highway. NHTSA is basing its definition of driving upon the one contained in the Executive Order because NHTSA is concerned with all vehicles operating on any type of roadway.

automatic transmission vehicles; for manual transmission vehicles this changes to when the transmission is not in "Neutral" or the parking brake is "Off").[75]

H. *Per Se* Lock Outs

The NHTSA Guidelines contain a recommended list of "*per se*" lock outs for in-vehicle devices tasks that are considered unsafe for performance by the driver while driving. *Per se* lock outs are ones based on either public policy or law. They are meant for in-vehicle device tasks that are either obviously inappropriate for performance by a vehicle driver while driving or ones (such as photographic or graphical moving or still images not related to driving) for which the task-based test paradigm used to determine the acceptability of a task for performance while driving will not work due to the task being unbounded in some aspect.

After much consideration, NHTSA has decided to propose the following list of tasks considered to be suitable for lock out on a *per se* basis:

- Displaying photographic or graphical moving visual images not related to driving. This would include things such as video phone calls and other forms of video communication, as well as pre-recorded video footage, and television. Images considered to be related to driving include information that is useful in monitoring vehicle occupant status, maneuvering the vehicle, or assisting in route planning. Short, scrolling lists under the control of the driver (e.g., navigation

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[75] Without the addition of expensive equipment vehicle manufacturers cannot know when the driver has pulled over to the side of, or off of, an active roadway and has halted in a location where the vehicle can safely remain stationary. For automatic transmission-equipped vehicles, the vehicle manufacturer can determine the position of the gear shift (this information is available on the Controller Area Network Bus (CANbus) for all modern vehicles). So operationally, NHTSA is equating placing the vehicle in "park" with "the vehicle has halted in a location where the vehicle can safely remain stationary." For manual transmission vehicles, placing the vehicle in "park" is replaced by placing the vehicle in "neutral" with the parking brake on. Again, these are things that the vehicle manufacturer easily determine (available from the CANbus) and do not add extra cost.

system destinations) should not be significantly distracting provided the information is presented in accordance with these NHTSA Guidelines. A visual image depicting blind zone areas around the vehicle would be considered information related to the driving task. Also, weather information that relates to the vicinity of the car, intended route information (such as a closed exit), or emergency information (such as the approach of an emergency response vehicle) are all considered to be information related to driving.

- Displaying photographic or graphical static visual images not related to driving. This would include album art and personal photos, among other things.
- Automatically scrolling text.
- Manual text entry (e.g., drafting text messages, keyboard-based text entry). The driver should not input more than 6 button or key presses during the performance of a task. This limit is based on an assumed driver eyes-off-road time of 2.0 seconds per button or key press and NHTSA's maximum permitted total eyes-off-road time for a task of 12.0 seconds.
- Reading more than 30 characters, not including punctuation marks, of visually presented text (a number, no matter how many digits it contains, and a units designation (e.g., mpg) each count as only one character). This character limit is taken from the JAMA Guidelines and is intended to prevent such tasks as reading text messages, reading electronic books, and manual internet browsing. As pointed out by Transport Canada:

  The JAMA Guidelines are currently the most demanding recommendations set by the industry internationally.[76]

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[76] "Strategies for Reducing Driver Distraction from In-Vehicle Telematics Devices: A Discussion Document," prepared by the Standards Research and Development Branch of the Road Safety and Motor Vehicle Regulations Directorate of Transport Canada, TP 14133 E, April 2003.

NHTSA believes that all of these activities are either obviously inappropriate for performance by a vehicle driver (e.g., manual text entry while driving) or ones for which the task-based test paradigm used to determine lock outs on a task-by-task basis will not work (e.g., viewing video images not related to driving, viewing static images not related to driving, and automatically scrolling text) or both (e.g., reading more than 30 characters of visually presented text).

Rearview images presented for the purpose of aiding a driver to detect obstacles in the vehicle's path during a backing maneuver should not be locked out when presented in accordance with the allowable circumstances specified in FMVSS No. 111 since this information is driving related and for the purposes of improving safety.

I. Steering Wheel-Mounted Control Restrictions

The NHTSA Guidelines recommend that all device functions accessed via visual-manual interaction by the driver should be operable by using, at most, one of the driver's hands in order to be considered suitable for performance while driving.

For device controls located on the steering wheel, the Alliance Guidelines state that no device tasks should require simultaneous manual inputs from both hands, except in the following condition: one of the two hands maintains only a single finger input (e.g., analogous to pressing "shift" on a keyboard). After due consideration, NHTSA has decided that it is not comfortable with this exception. NHTSA is concerned that tasks that require the simultaneous use of both hands, even one for which only a single finger input is required from one hand, will result in an unsafe situation. Therefore, the NHTSA Guidelines recommend against driver interfaces that utilize this special case of two-handed control.

J. Maximum Downward Viewing Angle

The NHTSA Guidelines recommend that the each device's active display area be located as close as practicable to the driver's forward line of sight. They include a specific recommendation for the maximum downward viewing angle to the geometric center of each display.

To determine a display's downward viewing angle, a nominal driver eye point must be selected. The NHTSA Guidelines recommend that the nominal driver eye point be that contained in the March 2010 revision of SAE Surface Vehicle Recommended Practice J941 "Motor Vehicle Drivers' Eye Locations."

Each device's display(s) should be mounted in a position where the downward viewing angle, measured at the geometric center of each active display area, is less than at least one of the following two angles:

- The 2D Maximum Downward Angle, or
- The 3D Maximum Downward Angle.

The 2D Maximum Downward Angle is equal to:

- 30.00 degrees for a vehicle with the height of the nominal driver eye point less than or equal to 1700 millimeters above the ground.
- Given by the following equation for nominal driver eye point heights greater than 1700 millimeters above the ground:

$$\theta_{2DMax} = 0.014333\, h_{Eye} + 15.07$$

where:

- θ_{2DMax} is the 2D Maximum Downward Angle, and
- h_{Eye} is the height of the nominal driver eye point above the ground.

The 3D Maximum Downward Angle is equal to:

- 28.16 degrees for a vehicle with the height of the nominal driver eye point less than or equal to 1146.2 millimeters above the ground.
- Given by the following equation for nominal driver eye point heights greater than 1146.2 millimeters above the ground:

$$\theta_{3DMax} = 63.025357 \tan^{-1}[0.829722 \tan(0.263021 + 0.000227416\, h_{Eye})]$$

where:

- θ_{3DMax} is the 3D Maximum Downward Angle, and
- h_{Eye} is the height above the ground of the nominal driver eye point.

These recommendations for the maximum display downward viewing angle are the same as those contained in the Alliance Guidelines except that the nominal driver eye point is slightly different. The Alliance Guidelines set the nominal driver eye point at the point specified in the June 1997 revision of SAE Surface Vehicle Recommended Practice J941 "Motor Vehicle Drivers' Eye Locations." The Alliance Guidelines then add 8.4 mm to the height of the driver's nominal eye point. The driver's eye point location used by the NHTSA Guidelines is close to that used by the Alliance Guidelines for typical seat back angles. Therefore, this change is not expected to have any effects on the stringency of the NHTSA Guidelines compared to the Alliance Guidelines. The only reason for making this change is to avoid using an older version of an SAE standard when a newer version has already been adopted.

K. Tests Considered to Determine What Tasks Should Be Accessible While Driving

During development of the NHTSA Guidelines for visual-manual interfaces, the Agency considered seven test protocols and sets of acceptance criteria for determining whether performance of a task while driving is unreasonably distracting and should be locked out. This section will discuss the origins of these seven test protocols and sets of acceptance criteria. The subsequent section will discuss which of these test protocols and criteria NHTSA prefers for use in determining whether a task is unreasonably distracting.

Several of the candidate test protocols and sets of acceptance criteria were taken from the Alliance Guidelines. The Alliance Guidelines contain two alternatives for determining whether a task is unreasonably distracting for drivers while driving. These alternatives are discussed under Principle 2.1 of the Alliance Guidelines:

> *Systems with visual displays should be designed such that the driver can complete the desired task with sequential glances that are brief enough not to adversely affect driving.*[77]

The Alliance Guideline's Alternative A reads:

> *A visual or visual-manual task intended for use by a driver while the vehicle is in motion should be designed to the following criteria:*
> *A1. Single glance durations generally should not exceed 2 seconds; and*
> *A2. Task completion should require no more than 20 seconds of total glance time to display(s) and controls.*[78]

The Alliance Guidelines include the following three verification procedures for Alternative A:

1. *Eye Tracker Measurement*. An eye tracker is used to measure the number and length of glances to the device while performing a task while driving either in a driving simulator, on a test track, or on an actual roadway using a standard driving scenario.
2. *Video Recording of Test Participant's Eyes/Face*. Post-testing, video of the test participant's eyes and face is reviewed and the number and length of glances to the device while performing a task while driving either in a driving simulator, on a test track, or on an actual roadway using a standard driving scenario is determined.

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[77] Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC, P. 38.
[78] Ibid, P. 39.

3. *Occlusion Testing*. Test participants perform the secondary task (but not the driving task) while undergoing alternating periods of time when they can and cannot see. The periods of time when they can and cannot see are generated either by occlusion goggles or some other means such as an opaque shutter that is placed and removed periodically from in front of the test participants' eyes. When performing occlusion testing, the Alliance Guidelines reduce the maximum permitted single glance durations to 1.5 seconds (forced by the occlusion cycle time) and the maximum permitted total glance time to 15 seconds. Note that the Alliance Guidelines occlusion testing technique uses a different occlusion cycle time (1.5 seconds open/1.0 second closed) than that called for by ISO International Standard 16673:2007, "Road Vehicles – Ergonomic Aspects of Transport Information and Control Systems – Occlusion Method to Assess Visual Demand due to the use of In-Vehicle Systems" (1.5 seconds open/1.5 seconds closed).

In developing these Guidelines, NHTSA considered the Alliance Principle 2.1 Alternative A techniques for determining whether a task is unreasonably distracting to be performed by drivers while driving. For test participant and other road user safety reasons, NHTSA has decided to recommend that NHTSA Guideline testing for the purposes of determining whether a task is suitable for performance while driving should not be performed on either test tracks or public roadways. NHTSA's fear is that, if such testing were performed on either test tracks or public roadways, it might be discovered that a task is unreasonably distracting by having a crash occur. Therefore, the NHTSA Guidelines suggest limiting testing to that performed in driving simulators, vehicle mockups, or similar, non-dangerous, testing venues.

NHTSA considered three test protocols and sets of acceptance criteria for determining whether a task is too distracting to be performed by drivers while driving that were based on Alliance Principle 2.1 Alternative A. For the purposes of this notice, Alliance Alternative A Verification Option 1, *Eye*

Tracker Measurement, and Verification Option 2, *Video Recording of Test Participant's Eyes/Face* were considered together by NHTSA as *Option EGDS: Eye Glance Testing Using a Driving Simulator.* Alliance Alternative A Verification Option 3, *Testing using Occlusion,* was considered by NHTSA as *Option OCC: Occlusion Testing*. Additionally, NHTSA considered a third verification option that is a variant of the Alliance Alternative A techniques, *Option STEP: Step Counting*.

The idea behind *Option STEP: Step Counting* is to first perform a detailed task analysis of the task under consideration on the device being studied. After the detailed task analysis has decomposed the task into elemental components, a number of "steps" are assigned to each elemental component. Tasks that require more than a set number of steps are considered to be too distracting to be performed by drivers while driving.

The Alliance Guideline's Alternative B reads:

> *Alternatively, the impact of a device-related visual or visual-manual task on driving safety can be assessed directly by measuring concurrent driving performance under dynamic conditions and relating it to driving performance under specified reference conditions. The influence of such a secondary task shall not be greater than that of a scientifically-accepted reference task in terms of:*
>
> *B1. Lateral position control: Number of lane exceedances observed during secondary task execution should not be higher than the number of lane exceedances observed while performing one or more reference tasks (e.g., manual radio tuning) under standard test conditions (e.g., same drivers, driving scenario) replicating routine driving tasks; and*
>
> *B2. Following headway: Car following headway variability observed during secondary task execution should not be worse than car following headway observed while performing one or more reference tasks under standard test conditions (e.g., same drivers, same driving scenario) replicating routine driving tasks. This measure is influenced by speed changes of preceding traffic or lane changes of other vehicles.*[79]

[79] Ibid, p. 39

For Alliance Principle 2.1 Alternative B, the recommended Alliance reference task is radio tuning. This task (which will be referred to as manual radio tuning) does not use a preset button to switch to a desired radio station. Manual radio tuning consists of first toggling betweens bands (AM to FM or vice versa) and then using the tuning controls to select a station at a specified frequency.

Alliance Principle 2.1 Alternative B consists of performing a task while driving either in a driving simulator, on the test track, or on an actual roadway using a standard driving scenario. However, for previously discussed reasons of safety, the NHTSA Guidelines research limit testing for this alternative to driving simulators.

NHTSA considered two test protocols and sets of acceptance criteria for determining whether a task is too distracting to be performed by drivers while driving that were based on Alliance Alternative B. These were *Option DS-BM: Driving Test Protocol with Benchmark* and *Option DS-FC: Driving Test Protocol with Fixed Acceptance Criteria*. *Option DS-BM* is based on the test protocols used by Alliance member companies when performing Alternative B testing and uses, as its name implies, radio tuning as its reference task.

One concern with Alliance's implementation of the radio tuning reference task is that it is insufficiently specific to prevent designers from developing radios that are more difficult for drivers to tune. While the Alliance has told NHTSA that they intended the reference radio to be representative of a 1980's production radio, the Guideline text lacks the detail needed to ensure a fixed-difficulty reference task. As a result, some designers may interpret the Alliance Guidelines to permit more complicated radios to be used, thereby increasing the difficulty of the reference task and allowing more complex secondary tasks to meet the benchmark acceptance criteria. To better achieve the goal of a fixed-difficulty reference task, NHTSA considered a similar option that instead uses fixed driving performance values for lane exceedances and headway variability. This testing option is called *Option DS-FC: Driving Test Protocol with Fixed Acceptance Criteria*.

Over the past few years, NHTSA has worked independently on the development of a test protocol and acceptance criteria for determining whether a secondary task is too distracting for drivers to perform while driving. This research is documented in a recently released NHTSA technical report.[80] The test protocol combines eye glance metrics similar to those of Alliance Alternative A, driving performance variability metrics similar to those of Alliance Alternative B, and target detection metrics to attain a comprehensive protocol that NHTSA believes is useable for both visual-manual and auditory-vocal driver interfaces.

In developing this protocol, NHTSA considered two existing test protocols and sets of acceptance criteria for determining whether a task is too distracting to be performed by drivers while driving that were based upon its research. These were *Option DFD-BM: Dynamic Following and Detection Protocol with Benchmark* and *Option DFD-FC: Dynamic Following and Detection Protocol with Fixed Acceptance Criteria*. *Option DFD-BM* uses route navigation system destination entry (entry of the full address including house number, street name, and city name) as a reference task. Unlike *Option DS-BM*, where the acceptance criteria are that the appropriate metric values should not be worse than radio tuning, for *Option DFD-BM* the acceptance criteria are that the appropriate metric values should be better than those associated with the destination entry reference task.

The use of a destination entry reference task gives NHTSA similar concerns as were noted for the radio tuning reference task. If a very detailed navigation system interface is not specified in the

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[80] Ranney, T.A., Baldwin, G.H.S., Parmer, E., Domeyer, J., Martin, J., and Mazzae, E. N., "Developing a Test to Measure Distraction Potential of In-Vehicle Information System Tasks in Production Vehicles," DOT HS 811 463, November 2011.

guidelines, the opportunity may be left for designers to create route navigation systems for which the destination entry task is more difficult. The result would be a non-fixed reference task that could be used to justify more complex secondary tasks as being suitable for performance while driving. To alleviate this concern, NHTSA also considered *Option DFD-FC: Dynamic Following and Detection Protocol with Fixed Acceptance Criteria*. *Option DFD-FC* is very similar to *Option DFD-BM* except that instead of using a reference task to determine acceptance, under *Option DFD-BM* fixed values for the metrics would be used.

Table 3 summarizes the seven test protocols and sets of acceptance criteria for determining whether a task is unreasonably distracting and should be locked out while driving.

TABLE 3 -- SUMMARY OF DISTRACTION TEST PROTOCOLS AND ACCEPTANCE CRITERIA CONSIDERED BY NHTSA

Option Letter	Test Name	Performance Measures	Acceptance Criteria	Testing Venue
EGDS	Eye Glance Testing Using a Driving Simulator	• Duration of individual eye glances away from forward road view • Sum of individual eye glance durations away from forward road view	• 85% of individual glance durations less than 2.0 seconds • Mean of individual glance durations less than 2.0 seconds • Sum of individual eye glance durations less than or equal to12.0 seconds	Driving Simulator
OCC	Occlusion Testing	• Sum of shutter open times	• Sum of shutter open times less than 9.0 seconds	Occlusion
STEP	Step Counting	• Number of steps required for task	• Less than 6 steps required for task	Task Analysis
DS-BM	Driving Test Protocol with Benchmark	• Standard deviation of headway • Lane exceedances	• Performance measures not greater than benchmark values	Driving Simulator
DS-FC	Driving Test Protocol with Fixed Acceptance Criteria	• Same as *Option DS-BM*	• Performance measures not greater than specified values	Driving Simulator
DFD-BM	Dynamic Following and Detection Protocol with Benchmark	• Duration of individual eye glances away from forward road view • Sum of individual eye glance durations away from forward road view • Standard deviation of lane position • Car following delay • Percent of visual targets detected • Visual detection response time	• *Option EGDS* eye glance acceptance criteria ***plus*** • Performance measures less than benchmark values	Driving Simulator
DFD-FC	Dynamic Following and Detection Protocol with Fixed Acceptance Criteria	• Same as *Option DFD-BM*	• *Option EGDS* eye glance acceptance criteria ***plus*** • Performance measures less than specified values	Driving Simulator

L. NHTSA's Preferred Tests for Determining What Tasks Should Be Accessible While Driving

NHTSA has thoroughly evaluated all seven of the candidate test protocols and acceptance criteria for determining what tasks should be accessible while driving listed in Table 3. The evaluation criteria used included:

- Test protocol discriminatory capability,
- Difficulty of performing test protocol, and
- Repeatability of test protocol.

NHTSA is not, at this time, removing any of the test protocols and acceptance criteria that are listed in Table 3 from consideration for use as a task acceptability test protocol(s) in the NHTSA Guidelines. However, the Agency is indicating that it prefers two of the Table 3 test protocols and that one, or both, of these test protocols are more likely to be selected. Following due consideration of comments received in response to this notice, NHTSA will select the test protocols and acceptance criteria for determining what visual-manual tasks should be accessible while driving.

NHTSA has decided that it prefers the following two test protocols and their associated acceptance criteria:

- *Option EGDS: Eye Glance Testing Using a Driving Simulator*, and
- *Option OCC: Occlusion Testing.*

The Agency's reasons for choosing these two options as its preferred test protocols and acceptance criteria are discussed in the remainder of this subsection.

Two of the test protocols and acceptance criteria that NHTSA considered, *Option DS-BM: Driving Test Protocol with Benchmark* and *Option DFD-BM: Dynamic Following and Detection Protocol with Benchmark*, include benchmark tasks. For *Option DS-BM*, the benchmark task is manual radio tuning while the benchmark task for *Option DFD-BM* is entering an address into a route navigation system.

The goal of using a benchmark task is to increase the discriminatory power of a test protocol by comparing the performance of test participants performing a task using a device against that for the benchmark task. Both theoretically, and in NHTSA's experimental testing, the use of a benchmark task reduces the impact of individual test participant differences on the outcome of testing.

However, NHTSA has decided that the drawbacks of using a benchmark task outweigh the advantages. The main drawbacks regarding the use of a benchmark task are:

- The determination as to what tasks may be performed by the driver while driving depends not just on the task and the device under consideration but also on the design of the device with which the reference task is performed. The level of detail of the benchmark task specification will affect the repeatability of test results. For example, if a reference task of manual radio tuning was specified with minimal radio interface specifications, then performing a task with a device might be deemed unsuitable for performance while driving in a vehicle that had a very easy to tune radio but suitable for performance while driving in a second vehicle that had a more difficult to tune radio. Testing recently performed for NHTSA by VTTI has found large vehicle-to-vehicle differences in driver performance during manual radio tuning so NHTSA knows that this concern is real and not just hypothetical.
- Not all vehicles have a suitable device for performing the benchmark task. While virtually all production vehicles have radios suitable for performing the manual radio tuning task, the Alliance Guidelines did consider it necessary to include specifications for simulating a built-in radio to bound the difficulty of the benchmark task. Many production vehicles do not have a built-in route navigation system. Again, specifications could be developed for simulating a built-in route navigation system. However, simulating the device used for the reference task increases testing complexity and cost while reducing the meaningfulness of a test.

Based upon its evaluation, NHTSA believes that two eye glance-related test protocols and acceptance criteria, *Option EGDS: Eye Glance Testing Using a Driving Simulator,* and *Option OCC: Occlusion Testing,* are both acceptable methods for determining which tasks should have lock outs during driving.

The eye glance-related test protocols have a number of advantages. These include:

- A clear relationship between eye glance-related metrics and driving safety exists. A driver's vigilant monitoring of the road and nearby vehicles is essential to safe driving.
- A substantial research base exists that verifies the correctness of the above statement and provides quantitative support for it. Based on analyses of past naturalistic data, we know that looking away from the forward roadway for up to 2.0 seconds has no statistically significant effect on the risk of a crash or near-crash event occurring. However, eyes-off-road times of greater than 2.0 seconds have been shown to increase risk at a statistically significant level. The risk of a crash or near-crash event increases rapidly as eyes-off-road time increases above 2.0 seconds.[81]
- An obvious relationship between visual-manual distraction and eye glance measures exists. Visual-manual distraction strongly implies that the driver is looking away from the forward road scene.
- Eyes-off-road time is measureable. While not easy to measure, researchers have been working for more than 30 years to develop better techniques for measuring driver eyes-off-road times. A

[81] Klauer, S.G., Dingus, T.A., Neale, V.L., Sudweeks, J.D., and Ramsey, D.J., "The Impact of Driver Inattention on Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data," DOT HS 810 594, April 2006.

large amount of effort has focused on such topics as the best ways to ensure coding reliability when reducing eye glance video and the development of automated eye trackers.

- Commercially available occlusion goggles allow occlusion testing to be performed without having to develop new hardware.
- ISO standards exist for both eye glance measurement (ISO 15007-1 and ISO 15007-2) and occlusion testing (ISO 16673). This allows us to take advantage of years of test development effort by the research community.

While both of these test protocols have some drawbacks, NHTSA generally considers these issues to be relatively minor.

Option EGDS: Eye Glance Testing Using a Driving Simulator suffers from two problems:

- The need for a driving simulator in which to perform testing. A driving simulator is an expensive piece of test equipment that typically requires special, highly trained staff to operate correctly. The driving simulator should be configured to model the dynamics of the vehicle being tested. *Option EGDS* is not alone in having this problem; *Options DS-BM, DS-FC, DFD-BM,* and *DFD-FC* also require a driving simulator.
- Difficulty in accurately measuring eye glance behavior from data collected during testing. There are two main methods for determining eye glance characteristics from test data: through the use of an eye tracker and by manually extracting eye glance locations and durations from video recorded data. There are substantial operational problems associated with both of these methods. For example, using an eye tracker requires extensive calibration for each test participant, which substantially adds to the time and expense of testing. Manually reducing video recorded data to obtain eye glance characteristics is highly labor intensive, time consuming, and expensive. While both methods can be used to determine the angle at which a participant's head is aimed

with respect to center, identifying the particular point of gaze (i.e., where the eyes are pointed, or eye glance location) is challenging. Both methods of measuring eye glance behavior are even more difficult for test participants who wear eye glasses, such that participants who require them to drive are at times avoided, substantially reducing the test participant pool (in NHTSA's experience, this is particularly a problem when trying to recruit older test participants).

Option OCC: Occlusion Testing avoids both of the drawbacks that are present for *Option EGDS: Eye Glance Testing Using a Driving Simulator*. Testing does not have to be performed in a driving simulator so the driving simulator related issues are avoided. The occlusion apparatus constrains when driver eye glances to the task device occur, so the eye glance analysis difficulties present for *Option EGDS* are not present for *Option OCC*.

NHTSA's proposed occlusion testing uses a field factor of 75 percent to relate shutter open time during occlusion testing to eyes-off-road time measured during driving simulator testing. The Alliance Guidelines and ISO International Standard 16673:2007(E), "Road Vehicles – Ergonomic Aspects of Transport Information and Control Systems – Occlusion Method to Assess Visual Demand due to the use of In-Vehicle Systems" also uses this 75 percent field factor. The JAMA Guidelines, however, use a field factor of 93.75 percent.

The theoretical rationale of a field factor is that every time a driver looks away from the forward roadway (for occlusion testing, each such eye glance is assumed to be 2.0-seconds long), the first 0.50 seconds is spent transitioning the driver's eyes from the roadway to the object being looked at (i.e., a saccade). As a result, only 1.5-seconds of a 2.0-second eye glance are available for actually looking at and manipulating the device interface. Therefore, occlusion testing is performed in 1.5-second shutter open time periods each corresponding to one 2.0-second eye glance focused away from the forward roadway.

NHTSA performed a small study to experimentally determine the most appropriate field factor.[82] NHTSA's testing produced a field factor of 78 percent for occlusion testing that was quite close to the field factor of 75 percent in the ISO Standard 16673. Since the NHTSA Guidelines occlusion test procedure is based on the ISO Standard 16673, the theoretical field factor of 75 percent is used instead of the experimentally determined field factor of 78 percent throughout the remainder of this document. Note that the use of the theoretical field factor is slightly conservative in the sense that it results in shorter viewing intervals; using the experimentally determined field factor would increase the viewing intervals from 1.50 seconds to 1.56 seconds.

However, *Option OCC* has one major drawback of its own. *Option OCC* does not really test for adherence to the criterion that single glance durations generally should not exceed 2.0 seconds. The use of an occlusion apparatus forcibly restricts single glance durations to be no more than 1.5 seconds long (which, with the 75 percent field factor being applied to occlusion testing, equates to a 2.0 second eye glance). If a test participant can complete a task using the occlusion protocol, it has been demonstrated that drivers **can** complete the task with sub-2.0 second eye glance durations. However, just because drivers can accomplish a task with sub-2.0 second eye glances does not mean that they actually will limit themselves to sub-2.0 second eye glance durations when not constrained by occlusion apparatus. *Option OCC* does not include any mechanism for ensuring that, during actual driving, drivers will limit themselves to sub-2.0 second eye glance durations while performing a given task.

Option STEP: Step Counting has a major advantage over all of the other test protocols and acceptance criteria considered by NHTSA in that it does not require human testing to determine whether

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[82] Ranney, T.A., Baldwin, G.H.S., Parmer, E., Domeyer, J., Martin, J., and Mazzae, E. N., "Developing a Test to Measure Distraction Potential of In-Vehicle Information System Tasks in Production Vehicles," DOT HS 811 463, November 2011.

a task is suitable for performing while driving. The task analysis that is performed for this method should be quite objective since it is generally quite clear how many button presses or other manual operations have to be performed in order to perform a task. The objectivity of *Option STEP* would be helpful if, at some future time, NHTSA decided to convert its NHTSA Guidelines into a Federal Motor Vehicle Safety Standard.

Since no human performance testing is actually performed, *Option STEP* also avoids both of the drawbacks that are present for *Option EGDS: Eye Glance Testing Using a Driving Simulator*.

While not having human performance testing gives *Option STEP* some major advantages, it is also the source of this option's major drawback. *Option STEP* is based on data using past and present vehicle designs about the eyes-off-road time required for drivers to perform common manual actions, such as button presses. However, there are no guarantees that the eyes-off-road time required to perform these actions will remain the same for future devices and in-vehicle tasks. NHTSA does not want to determine that tasks performed on future devices are safe to perform while driving without performing any human performance testing.

Another issue with *Option STEP* is determining exactly what constitutes a step in all situations. While it is fairly clear what a step is for pressing buttons, it is not clear for driver operation of such interface items as knobs or joysticks.

Based on recent NHTSA testing, the two test protocols and acceptance criteria that NHTSA considered which were based on just driving performance , *Option DS-BM: Driving Test Protocol with Benchmark* and *Option DS-FC: Driving Test Protocol with Fixed Acceptance Criteria*, both suffer from low statistical power when performed using an economically reasonable number of test participants. When testing of a task/device was performed using just 20 test participants, there were almost no statistically significant differences in driver performance, even between tasks that were found to be different by other testing protocols. In order to obtain the power necessary to provide the discriminatory capability needed to determine which tasks should require lock outs during driving, many more (on the order of 100) test participants would need to be tested. This would make this test protocol impractically time consuming and expensive to perform for the large number of tasks that will need to be screened.

One of the reasons for the low discriminatory capability of the *Options DS-BM* and *DS-FC* test protocols and acceptance criteria was due to their use of lane exceedances as a measure of test participant performance. Lane exceedances have the advantage of being a measure of driving performance that appears to generally relate directly to safety.[83] However, lane exceedances are low frequency events, particularly during straight line driving. Secondary tasks can be performed with no lane exceedances. The relative rarity of lane exceedances means that a large amount of testing has to be performed to obtain a statistically stable number of these events.

One possible alternative to using lane exceedances as a measure of test participant performance is to use the mean standard deviation of lane position during task performance as a substitute measure of test participant performance. This approach was used by the Dynamic Following and Detection Test Protocol to increase the statistical power of that test procedure.

The remaining two test protocols and acceptance criteria that NHTSA considered, *Option DFD-BM: Dynamic Following and Detection Protocol with Benchmark* and *Option DFD-FC: Dynamic Following and Detection Protocol with Fixed Acceptance Criteria*, were both based on the Dynamic Following and Detection (DFD) Test Protocol. This is a test protocol that has been developed by

[83] Research has indicated that one type of lane exceedance, specifically those due to "curve cutting," have no relationship to safety.

NHTSA[84] over the last few years in an attempt to combine the Alliance Guidelines' test protocols and acceptance criteria with the Peripheral Detection Task (PDT). This test protocol is a driving simulator based test protocol. Unlike the other test protocols evaluated, DFD results are based on a test participant performing the same task repeatedly for a 2.5-minute interval. The DFD also uses a complex lead vehicle speed profile that the test participant is supposed to follow as well as they can with a fixed headway. It has acceptance criteria based upon eye glance characteristics, measures of test participant driving performance, and test participant performance in performing the PDT concurrently with other secondary tasks.

Testing performed by NHTSA[85] has demonstrated that the DFD test protocol generally works well for determining whether a task is overly distracting and should be locked out while driving. Unfortunately, adding additional measures of test participant performance and additional acceptance criteria increase test procedure and data analysis complexity. While this increased analysis complexity may well be necessary when evaluating a device's auditory-vocal task interactions, it appears to be unnecessary when evaluating visual-manual device interfaces. A test protocol and acceptance criteria based only on eye glance characteristics appears to be adequate for visual-manual secondary tasks.

In summary, all of the candidate test protocols and acceptance criteria that NHTSA evaluated have both advantages and drawbacks. Therefore, NHTSA is not, at this time, removing any of the test protocols and acceptance criteria from consideration for being the test protocol(s) finally selected. However, NHTSA has concluded that the following two test protocols and associated criteria might be best suited for the visual-manual NHTSA Guidelines:

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[84] Ranney, T.A., Baldwin, G.H.S., Parmer, E., Domeyer, J., Martin, J., and Mazzae, E. N., "Developing a Test to Measure Distraction Potential of In-Vehicle Information System Tasks in Production Vehicles," DOT HS 811 463, November 2011.
[85] Ibid.

- *Option EGDS: Eye Glance Testing Using a Driving Simulator*, and
- *Option OCC: Occlusion Testing.*

Therefore, a detailed discussion of the basis for the proposed acceptance criteria will be given only for these two testing options.

M. Eye Glance Acceptance Criteria

The proposed acceptance criteria for *Option EGDS: Eye Glance Testing Using a Driving Simulator* are:

- For at least 21 of the 24 test participants, no more than 15 percent (rounded up) of the total number of eye glances away from the forward road scene should have durations of greater than 2.0 seconds while performing the secondary task, and
- For at least 21 of the 24 test participants, the mean duration of all eye glances away from the forward road scene should be less than 2.0 seconds while performing the secondary task, and
- For at least 21 of the 24 test participants, the sum of the durations of each individual participant's eye glances away from the forward road scene should be less than, or equal to, 12.0 seconds while performing the secondary task one time.

The rationale for the above acceptance criteria is discussed in the remainder of this subsection. First, NHTSA's reasons for choosing manual radio tuning as its reference task are explained. It is from the manual radio tuning reference task that NHTSA's acceptance criteria were developed. Next, this document will discuss the Alliance Guidelines' task acceptance criteria. Then, recent NHTSA research on driver distraction and performance during manual radio tuning is presented. Finally, results from the recent NHTSA research on manual radio tuning are used to develop acceptance criteria.

i. Selection of Manual Radio Tuning as the Reference Task

The above proposed acceptance criteria were developed based on the idea of a "reference" task. A reference task strategy is used because no general consensus exists as to the threshold at which an absolute level of distraction due to a driver performing a task becomes unacceptably high. However, methods for measuring distraction while performing a secondary task have been developed. Since there is no agreed upon absolute level at which distraction becomes unacceptably high, a relative limit can be developed by comparing the distraction level associated with a driver performing an "acceptable" reference task with the distraction level associated with a driver performing new tasks.

A reference task should be a commonly performed task that is societally acceptable for drivers to perform while driving. The idea is that any task that is more distracting than the selected reference task should be locked out while driving. Tasks that create less distraction than the selected reference task are suitable for the driver to perform while the vehicle is in motion.

NHTSA has chosen traditional, manual radio tuning as its recommended reference task. Manual radio tuning consists of first[86] toggling betweens frequency bands (AM to FM or vice versa) and then using the tuning controls (e.g., rotary knob or continuously-held push button) to select a station at a specified frequency. The prescribed manual radio tuning task does not use a preset button to tune to a desired radio station, which would be considered "automatic" radio tuning.

The Alliance Guidelines also use manual radio tuning as their reference task. The Alliance's rationale[87] for radio tuning as the reference task is that traditional, manual radio tuning:

- Is a distraction source that exists in the crash record[88,89] and so has established safety-relevance;

[86] In some cases, the first step is to switch to the radio function, or powering on the device.

[87] P. 40, Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC.

- Is a typical in-vehicle task that average drivers perform;
- Involves use of an in-vehicle device that has been present in motor vehicles for more than 80 years;
- Is an in-vehicle device task that is typical in terms of technological complexity, as well as in terms of impacts on driver performance; and
- Represents a plausible benchmark for driver distraction potential beyond which new devices, functions, and features should not go.

Vehicle radios/stereos have long been the most common original equipment system with functionality not directly related to driving. Driving a car with the radio on is an extremely common and widely accepted scenario for Americans. Given this fact, it seems reasonable to allow other tasks to be performed that require a similar degree of driver interaction and to discourage tasks that are more distracting than that level.

The specific reference task of manual radio tuning as defined by the Alliance involves a defined traditional radio design and two input steps: a single button press followed by a longer knob turn or button hold. Many of the most basic and common in-vehicle control inputs a driver may make require only a single, short duration input (e.g., turn on headlights, activate turn signal, adjust temperature). Considering this, manual radio tuning could be considered a worst case traditional task.

In recent years, multi-function in-vehicle information systems such as BMW's iDrive, Ford's SYNC, and several others have come available. These multi-function systems provide the driver with more than just music and can involve more complex inputs and/or more steps for the driver to

[88] Wang, J.S., Knipling, R.R., and Goodman, M.J., "The Role of Driver Inattention in Crashes: New Statistics from the 1995 Crashworthiness Data System," 40th Annual proceedings, Association for the Advancement of Automotive Medicine, Vancouver, British Columbia, Canada, October 1996.
[89] Singh, S., "Distracted Driving and Driver, Roadway, and Environmental Factors," DOT HS 811 380, September 2010.

accomplish tasks. Comparing newer, more complex tasks to the historical standard of worst-case non-driving tasks allows a perspective on relative safety to be ascertained.

Past research efforts have identified crashes that are believed to be caused by driver distraction due to vehicle radio use. A 1996 study by Wang, Knipling, and Goodman[90] analyzed data collected during 1995 by NASS-CDS. This analysis found that distraction due to driver radio, cassette player, or CD player usage was present in 2.1 percent of all crashes. There were also 2.6 percent of crashes for which the source of distraction was unknown. Distributing crashes with an unknown source of distraction proportionately among the other identified sources of distraction, the percentage of crashes with distraction due to driver radio, cassette player, or CD player usage increases to 2.6 percent.

A more recent study by Singh[91] analyzed data from NHTSA's National Motor Vehicle Crash Causation Survey (NMVCCS) to estimate the incidence of crashes due to radios and CD players (cassette players in vehicles are a disappearing technology). This analysis found that distraction due to driver radio or CD player usage was present in 1.2 percent of all crashes.

NMVCCS is NHTSA's most recent, nationally representative, detailed survey of the causes of light motor vehicle crashes (essentially an updated version of the Indiana Tri-Level Study of the Causes of Traffic Accidents[92] that was conducted in the 1970s). For NMVCCS driver (including distraction- and inattention-related information), vehicle, and environment data were collected during a three-year period (January 2005 to December 2007). A total of 6,949 crashes met the specified criteria for

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[90] Wang, J.S., Knipling, R.R., and Goodman, M.J., "The Role of Driver Inattention in Crashes: New Statistics from the 1995 Crashworthiness Data System," 40th Annual proceedings, Association for the Advancement of Automotive Medicine, Vancouver, British Columbia, Canada, October 1996.

[91] P. 5, Singh, S., "Distracted Driving and Driver, Roadway, and Environmental Factors," DOT HS 811 380, September 2010.

[92] Treat, J.R., Tumbas, N.S., McDonald, S.T., Shinar, D., Hume, R.D., Mayer, R.E., Stansifer, T.L., and Castellan, N.J., "Tri-Level Study of the Causes of Traffic Accidents: Final Report. Executive Summary," DOT HS 805 099, May 1979.

inclusion in NMVCCS. Due to specific requirements that must be met by crashes for inclusion in NMVCCS, the NMVCCS data differs from other crash databases such as NASS-CDS or NASS-GES.

Unfortunately, there is no way to determine with the data currently available to NHTSA (i.e., Singh[93]; Wang, Knipling, and Goodman[94]) the fraction of the observed crashes due solely to radio usage (or due to radio tuning specifically).

Making the further assumption that fatality, injury, and property damage only crashes all have the same percentage of distraction due to driver radio, cassette player, or CD player usage gives the estimates shown in Table 4.

TABLE 4 -- ESTIMATED NUMBER OF FATALITIES, INJURIES, AND PROPERTY DAMAGE ONLY CRASHES IN 2009 DUE TO RADIO, CASSETTE, OR CD PLAYER USE

	Singh Estimate	Wang, Knipling, and Goodman Estimate
Percentage	1.2 %	2.6 %
Fatalities	406	869
Injuries	27,000	57,000
Property Damage Only	66,000	142,000

As stated above, NHTSA accepts the use of manual radio tuning as a reference task for indicating a driver distraction magnitude beyond which new devices, functions, features, and tasks should not exceed. NHTSA agrees with the Alliance rationale for using manual radio tuning as the

93 Singh, S., "Distracted Driving and Driver, Roadway, and Environmental Factors," DOT HS 811 380, September 2010.
94 Wang, J.S., Knipling, R.R., and Goodman, M.J., "The Role of Driver Inattention in Crashes: New Statistics from the 1995 Crashworthiness Data System," 40th Annual proceedings, Association for the Advancement of Automotive Medicine, Vancouver, British Columbia, Canada, October 1996.

reference task and considers it suitable for use as a standard to which new in-vehicle tasks may be compared.

ii. The Alliance Guidelines Acceptance Criteria

The Alliance Guidelines include three verification options for their Alternative A: *Eye Tracker Measurement*, *Video Recording of Test Participant's Eyes/Face*, and *Testing using Occlusion*. Two of these verification options, *Eye Tracker Measurement* and *Video Recording of Test Participant's Eyes/Face*, require the determination of test participant eye glances. Both of these verification options are covered by NHTSA *Option EGDS: Eye Glance Testing Using a Driving Simulator*. The third Alliance Guidelines verification option, *Testing using Occlusion*, is covered by NHTSA *Option OCC: Occlusion Testing.* The development of acceptance criteria for *Option OCC* is discussed in a subsequent subsection.

As discussed above, the Alliance Guidelines use manual radio tuning as their reference task. The Alliance Guidelines acceptance criteria were developed based on this reference task.

The Alliance Guidelines acceptance criteria were based upon the 85^{th} percentile of driver eye glance performance during manual radio tuning. As the Alliance points out, the 85^{th} percentile response characteristics or capability are a common design standard in traffic engineering. For example, according to the Federal Highway Administration, all states and most localities use the 85^{th} percentile speed of free flowing traffic as a basic factor in establishing speed limits.[95]

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[95] Institute of Transportation Engineers, "Speed Zoning Information," March 2004, retrieved in August 2011.

The eye glance acceptance criteria times that are in the Alliance Guidelines are based on a 1987 study by Dingus[96] and a 1988 study by Rockwell.[97] However, neither of these studies actually measured the total eyes-off-road time associated with manual radio tuning. The Rockwell study determined that approximately 85 percent of driver eye glances away from the forward road scene had durations of 1.90 seconds or less. This value of 1.90 seconds was rounded up by the Alliance to get their 2.0-second criterion. The Dingus study determined that the 85th percentile for the number of driver eye glances away from the forward road scene was 9.4 glances. The 9.4 glances value was rounded up by the Alliance to get 10 glances. The Alliance then multiplied the 10 glances by 2.0 seconds per glance to determine their acceptance criteria of 20.0 seconds of total glance time.[98]

Based on these studies, the Alliance Guideline's Alternative A have two acceptance criteria:

> *A1. Single glance durations generally should not exceed 2 seconds; and*
>
> *A2. Task completion should require no more than 20 seconds of total glance time to display(s) and controls.*[99]

For both of the eye glance verification options, the Alliance Guidelines operationalize the A1 and A2 acceptance criteria as follows:

> *A task will be considered to meet criterion A1 if the mean of the average glance durations to perform a task is ≤ 2.0 sec for 85% of the test sample. A task will be considered to meet criterion A2 if the mean total glance time to perform a task is ≤ 20 sec for 85% of the sample of test participants.*[100]

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[96] Dingus, T.A., *Attentional Demand Evaluation for an Automobile Moving-Map Navigation System*, unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA, 1987.
[97] Rockwell, T.H., "Spare Visual Capacity in Driving Revisited: New Empirical Results for an Old Idea," in A. G. Gale et al (editors), *Vision in Vehicles II* (pp. 317-324, Amsterdam: Elsevier, 1988.
[98] When performing this determination, the Alliance is treating total glance time to the task as being the same as total eyes-off-road time.
[99] P. 39, Driver Focus-Telematics Working Group, "Statement of Principles, Criteria and Verification Procedures on Driver-Interactions with Advanced In-Vehicle Information and Communication Systems," June 26, 2006 version, Alliance of Automobile Manufacturers, Washington, DC.
[100] Ibid, P. 53.

NHTSA has a concern with these Alliance-developed acceptance criteria because neither of the studies used as a basis for the criteria actually measured the total eyes-off-road time associated with manual radio tuning. Rather, the Alliance estimated it from the data available in the Dingus and Rockwell studies. NHTSA's concern is with the way in which the estimate was developed. If 85 percent of driver eye glances away from the road last for less than 2.0 seconds, the probability of 10 glances away from the road each having an average length of 2.0 seconds or greater is very small. As a result, due to rounding up of both the guideline-recommended length of driver eye glances and the number of driver eye glances during manual radio tuning, the Alliance total glance time criterion of 20.0 seconds is not the 85th percentile value that the Alliance advocates, but instead a value that approximates the 100th percentile value for manual radio tuning.

iii. Recent NHTSA Research on Manual Radio Tuning

To obtain data about driver performance during manual radio tuning, NHTSA has recently sponsored two experimental studies, one with testing performed by NHTSA[101] and one with testing performed by VTTI.

The NHTSA study[102] tested 90 test participants performing 541 instances of manual radio tuning in a 2010 Toyota Prius (trim level V) connected to a personal computer-based driving simulator. Driving the simulator required the test participant to follow a lead vehicle moving at a varying rate of speed. Table 5 presents summary data from the first (of, typically, 6) manual radio tuning trial for all 90 test participants. The last two columns represent the respective percentile values from distributions of

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[101] This study had multiple objectives; a better understanding of manual radio tuning was just one of the objectives.
[102] Ranney, T. A., Baldwin, G. H. S., Parmer, E., Martin, J., and Mazzae, E. N., "Distraction Effects of Number and Text Entry Using the Alliance of Automotive Manufacturers' Principle 2.1B Verification Procedure," NHTSA Technical Report number TBD, November 2011.

each subject's proportion of glances longer than 1.5 and 2.0 seconds, respectively. The glance data were computed from eye tracker data. (Comparable data reduced manually from video footage was also collected for these trials; this found similar glance durations.)

TABLE 5 -- SUMMARY OF EYE GLANCE MEASURES DURING THE FIRST MANUAL RADIO TUNING PERFORMED BY TEST PARTICIPANTS IN A 2010 TOYOTA PRIUS ON THE NHTSA DRIVING SIMULATOR (N = 90)

Measure or Percentile	Total Eyes-Off-Road Time (seconds)	Number of Glances From Road	Mean Glance Duration (seconds)	Percent of Glances > 1.5 Seconds	Percent of Glances > 2.0 Seconds
Mean	7.11	8.04	0.89	20%	3%
Median	7.25	8	0.85	0%	0%
85th	10.50	12	1.14	25%	0%
95th	12.70	15	1.39	40%	29%
100th	16.86	16	2.11	80%	50%

Items of relevance from Table 5 for NHTSA's determination of its acceptance criteria include:

- The 85th percentile total eyes-off-road time (TEORT) based on the first radio tuning trial by each test participant was 10.50 seconds.
- None of the first radio tuning trials by test participants had a TEORT that exceeded 20.00 seconds. The longest initial radio tuning trial took 16.86 seconds.
- The 85th percentile mean glance duration (MGD) was 1.14 seconds. For only 1 out of 90 test participants was the mean glance duration greater than 2.00 seconds during their first trial.
- The 85th percentile proportion of glances longer than 2.00 seconds was zero percent. This means that 85 percent of test participants performed their first radio tuning trial with no glances away from the forward roadway of duration longer than 2.0 seconds.

The NHTSA data collection protocol had test participants perform the manual radio tuning task multiple times. Table 6 presents the same data as Table 5 except that Table 6 is based on data from all of each test participants' radio tuning trials.   The first trial data were analyzed separately, as presented above, since repeatedly performing the same task was expected to speed up test participant performance of the task.

TABLE 6 -- SUMMARY OF EYE GLANCE MEASURES DURING ALL MANUAL RADIO TUNING PERFORMED BY TEST PARTICIPANTS IN A 2010 TOYOTA PRIUS ON THE NHTSA DRIVING SIMULATOR (N = 541)

Measure or Percentile	Total Eyes-Off-Road Time (seconds)	Number of Glances From Road	Mean Glance Duration (seconds)	Percent of Glances > 1.5 Seconds	Percent of Glances > 2.0 Seconds
Mean	6.49	7.54	0.87	10%	3%
Median	6.38	7	0.84	0%	0%
85^{th}	9.61	11	1.15	25%	0%
95^{th}	11.97	14	1.39	40%	22%
100^{th}	20.50	21	2.11	80%	50%

Differences between the first trial and all trial data are minor. What differences do exist suggest that radio tuning performance improves slightly with repeated performance. However, it is important to note that, while the large number of trials included in Table 6 provides more precision in the estimation of the various metrics, the construction of this distribution is not formally suitable for use with inferential statistics, which require independence among all of the individual data items. In this collection, the use of multiple data points from each subject is not consistent with the independence requirement. Items of relevance from Table 6 for NHTSA's determination of its acceptance criteria include:

- The 85^{th} percentile TEORT value for repeatedly performing radio tuning was 9.61 seconds. (Reduced from the 10.50 seconds found for the first trial data.)

- Only 1 out of 541 total radio tuning trials had a TEORT value greater than 20.00 seconds. The second longest TEORT value was 17.28 seconds.
- The 85th percentile mean glance duration was 1.15 seconds. For only 1 out of 541 trials was the mean glance duration greater than 2.00 seconds. The second longest mean glance duration was 1.85 seconds.
- The 85th percentile proportion of glances longer than 2.00 seconds was zero percent. Although not shown in Table 6, the 90th percentile value for this metric was 14 percent. This means that 90 percent of 541 radio tuning trials were accomplished with no more than 14 percent of the glances away from the forward roadway being longer than 2.00 seconds.

The VTTI radio tuning study had two testing phases. During Phase I, test participants drove each of four vehicles on the VTTI Smart Road while following a lead vehicle traveling at a constant speed of 45 mph. One vehicle was tested using both of its two available methods for tuning the radio, resulting in a total of five test conditions. The five vehicles/configuration conditions tested were:

1. 2005 Mercedes R350
2. 2006 Cadillac STS
3. 2006 Infiniti M35
4. 2010 Chevrolet Impala with rotary knob tuning
5. 2010 Chevrolet Impala with push button tuning

During Phase II, test participants drove each of two vehicles on the VTTI Smart Road while following a lead vehicle traveling during one lap at a constant speed of 45 mph and during another lap at a variable speed.[103] One vehicle was again tested using both of its two available methods for manually tuning the radio resulting in a total of three test conditions. The three vehicles/configuration conditions tested were:

1. 2010 Chevrolet Impala with rotary knob tuning
2. 2010 Chevrolet Impala with knob/button tuning
3. 2010 Toyota Prius (exact same vehicle as tested by NHTSA)

A total of 43 participants between the ages of 45 and 65 took part in this study. This participant sample was comprised of two separate participant groups, as data collection occurred in phases listed above. Invalid data points were removed, yielding at least 20 participants with complete data for each phase as well as some participants with missing data.

Data were analyzed for the longest duration manual radio tuning trial for each test participant for each vehicle/configuration. Data for a total of 228 manual radio tuning trials were obtained and analyzed.

Table 7 summarizes the eye glance measures that were calculated by VTTI for the manual radio tuning trial of longest duration performed by each test participant in each of the vehicles/tuning methods/lead vehicle speed profile conditions. The values shown for Total Glance Time to Task, Total Eyes-Off-Road Time, and Average Duration of Individual Glances to Device are all 85th percentile values. The Duration of Longest Glance to Device values are the longest glances to the device that were

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[103] The variable speed profile of the lead vehicle for this second lap was similar to the one used by NHTSA during testing on their driving simulator. There were two differences. First, slowing down the lead vehicle on the NHTSA driving simulator was accomplished by having the driver remove his/her foot from the throttle pedal and allowing the vehicle to coast. However, due to the vertical profile of the VTTI Smart Road, when going downhill, the lead vehicle driver had to brake to produce the desired speed variation. The resulting brake lights are likely to have impacted the test participants' following behavior/performance. Second, the speed reduction profile was more step-wise than the one used in the simulator, since the lead vehicle speed was controlled by a trained driver, not by automated means.

made for that vehicle/tuning method/lead vehicle speed profile for any of the radio tuning trials that were analyzed.

TABLE 7 -- 85TH PERCENTILES OF EYE GLANCE MEASURES DURING MANUAL RADIO TUNING TRIALS PERFORMED BY IN VARIOUS VEHICLES TEST PARTICIPANTS ON THE VTTI SMART ROAD (N = 228)

(Duration of Longest Glance to Device and Total Number of Data Points are not 85th percentiles)

Vehicle, Tuning Method, and Lead Vehicle Speed Profile	Total Glance Time to Task (sec.)	Total Eyes-Off-Road Time (sec.)	Mean Glance Duration (sec.)	Duration of Longest Glance to Device (sec.)	Total Number of Data Points (--)
Cadillac STS-Knob Tuning-Constant Speed	15.9	16.3	1.7	2.9	21
Chevrolet Impala-Button Tuning-Constant Speed	13.2	13.9	1.3	2.4	41
Chevrolet Impala-Knob Tuning-Constant Speed	7.8	8.1	1.4	2.2	41
Chevrolet Impala-Button Tuning-Varied Speed	11.5	12.3	1.2	2.3	20
Chevrolet Impala-Knob Tuning-Varied Speed	8.4	8.5	1.4	2.4	20
Infiniti M35-Button Tuning-Constant Speed	17.6	17.6	1.7	4.5	21
Mercedes R350-Button Tuning-Constant Speed	15.4	16.6	1.4	2.6	22
Toyota Prius-Knob Tuning-Constant Speed	10.3	11.1	1.4	2.4	21
Toyota Prius-Knob Tuning-Varied Speed	11.3	11.3	1.6	2.7	21
All VTTI Data	11.6	11.8	1.5	2.5	228

Items of relevance from Table 7 for NHTSA's determination of its acceptance criteria include:

- The 85th percentile Total Glance Time to Task (TGT) for performing manual radio tuning varied from 7.8 to 17.6 seconds depending upon the vehicle, tuning method, and lead vehicle speed profile. The 85th percentile TGT for all of the VTTI radio tuning data was 11.6 seconds.
- The 85th percentile Total Eyes-Off-Road Time (TEORT) for performing manual radio tuning varied from 8.1 to 17.6 seconds depending upon the vehicle, tuning method, and lead vehicle

speed profile. The 85th percentile TEORT for all of the VTTI radio tuning data was 11.8 seconds.

- The 85th percentile TEORT exceeded the 85th percentile TGT times by 0.0 to 1.2 seconds with an average increase of 0.2 seconds
- The 85th percentile mean glance durations ranged from 1.2 to 1.7 seconds depending upon the vehicle, tuning method, and lead vehicle speed profile.

iv. Development of NHTSA's Eye Glance Acceptance Criteria

NHTSA proposes to base the acceptance criteria in these Guidelines on test participants' Eyes-Off-Road Time (EORT) during task performance. This differs from existing Alliance and JAMA Guidelines which assess task-related eye glance behavior based upon just those eye glances to the device upon which the task is being performed.[104]

NHTSA proposes to use EORT because we would like to use eye tracker data to determine whether a task meets the eye glance criteria. However, based upon the experiences of NHTSA, eye tracker data do not have quite enough accuracy to reliably characterize whether eye glances are focused toward the device upon which the task is being performed or toward some other in-vehicle location.[105]

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[104] However, the Alliance Guidelines do not consistently distinguish between test participant glances to the device being tested and test participant eye glances away from the forward roadway and, in places, appear to treat the two as interchangeable. For example, in the discussion on p. 42 of the Alliance Guidelines on the basis for the Alliances A2 acceptance criterion of 20 seconds, the phrase "mean number of glances away from the road scene" is used. However, this is equated to test participant glances to the device being tested to develop the 20 seconds acceptance criterion.

[105] Ranney, T.A., Baldwin, G.H.S., Vasko, S.M., and Mazzae, E.N., "Measuring Distraction Potential of Operating In-Vehicle Devices," DOT HS 811 231, December 2009. NHTSA's eye glance measurement technology has been upgraded since this report was written but the specific eye position limitation noted in that report continues to be a problem. The report "Developing a Test to Measure Distraction Potential of In-Vehicle Information System Tasks in Production Vehicles" by Ranney, T.A., Baldwin, G.H.S., Parmer, E., Domeyer, J., Martin, J., and Mazzae, E. N., DOT HS 811 463, November 2011, discusses NHTSA's most recent work to upgrade its eye glance measurement technology.

Eye tracker data do have sufficient accuracy to accurately characterize test participant eye glances focused away from the forward roadway.

Total EORT, or the cumulative duration of eye glances away from the roadway during task performance, will always equal or exceed the Total Glance Time to Task (TGT). For the VTTI testing, the 85th percentile of this difference ranged from 0.0 to 1.2 seconds with an average increase of 0.2 seconds. Therefore, basing the test acceptance criteria on TEORT instead of TGT gives a slight increase in test stringency. However, this is partially compensated for by NHTSA's use of a reference task to determine overall test stringency.

NHTSA finds reasonable the Alliance's technique of using the 85th percentile of driver eye glance measures while performing manual radio tuning as a way to set acceptance criteria for testing to determine if a task is unreasonably distracting. As the Alliance points out, the 85th percentile response characteristics or capability are a common design standard in traffic engineering. Other existing guidelines do not appear to use this reference task technique for determining acceptance criteria.

Occlusion testing (discussed in greater detail in a subsequent subsection) involves unoccluded vision durations of 1.5 seconds. Using the previously discussed 75 percent field factor for occlusion testing versus driving simulator eyes-off-road time, each 1.5-second unoccluded period corresponds to 2.0 seconds of driving simulator eyes-off-road time. Therefore, specified acceptance criteria involving eyes-off-road time should be a multiple of 2.0 seconds.

The NHTSA and VTTI manual radio tuning testing summarized in Tables 5 through 7 found 85th percentile Mean Glance Durations (MGD) that ranged from 1.1 to 1.7 seconds depending upon the vehicle, tuning method, test venue, and lead vehicle speed profile. All of these values round to 2.0 seconds (equivalent to a shutter open time of 1.5 seconds during occlusion testing). Therefore one proposed NHTSA acceptance criterion is that, for 85 percent of test participants, the mean duration of all individual eye glances away from the forward road scene should be less than 2.0 seconds while performing the secondary task. Since NHTSA is proposing to test a sample of 24 subjects, for at least 21 of the 24 test participants (85 percent rounded up to the next whole number of test participants), the mean of all eye glances away from the forward road scene should be less than 2.0 seconds while performing the secondary task. The proposed NHTSA mean eye glance duration criterion then is:

- For at least 21 of the 24 test participants, the mean duration of all individual eye glances away from the forward road scene should be less than 2.0 seconds while performing the secondary task.

The above acceptance criterion only constrains the mean of the eye glance distribution. This is necessary but, NHTSA believes, not sufficient. As pointed out by Horrey and Wickens:

> *In general, the unsafe conditions that are likely to produce a motor vehicle crash reside not at the mean of a given distribution (in other words, under typical conditions), but rather in the tails of the distribution.*[106]

To ensure safety, it is also necessary to have another acceptance criterion that minimizes the above 2.0-seconds tail of the eye glance distribution.

The acceptance criterion that NHTSA is proposing is designed to directly limit the tail of the eye glance distribution. The proposed eye glance distribution tail-limiting criterion, for 85 percent of test participants, limits the percentage of their long (more than 2.0 seconds) eye glances away from the forward road scene while performing the secondary task to no more than 15 percent of their total number of eye glances away from the road.

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[106] Horrey, W.J., and Wickens, C.D., "In-Vehicle Glance Duration: Distributions, Tails, and Model of Crash Risk," *Transportation Research Record, Journal of the Transportation Research Board,* No. 2018, Transportation Research Board of the National Academies, pp. 22-28, Washington, DC, 2007.

Typically, the number of eye glances away the forward road scene will be fairly low for any task, function, or feature that passes all of the eye glance criteria. For example, if the average eye glance duration is 1.5 seconds, a task can have a maximum of eight eye glances away the forward road scene and meet the TEORT acceptance criterion (discussed below). Therefore, the method used for rounding when calculating the 15 percent of eye glances value is important.

NHTSA has tentatively decided that, for any task that requires at least two[107] eye glances away from the forward road scene, it should be acceptable for at least one of these eye glances to exceed 2.0 seconds in duration (of course, the other two acceptance criteria would also have to be met). This can be accomplished by always rounding up when calculating the guideline-recommended number of eye glances exceeding 2.0 seconds in duration. The proposed NHTSA eye glance distribution tail limiting criterion then is:

- For at least 21 of the 24 test participants, no more than 15 percent (rounded up) of the total number of eye glances away from the forward road scene should have durations of greater than 2.0 seconds while performing the secondary task.

The NHTSA and VTTI manual radio tuning testing summarized in Tables 5 through 7 found 85th percentile Total Eyes-Off-Road Times (TEORT) values that ranged from 8.1 to 17.6 seconds depending upon the vehicle, tuning method, test venue, trial, and lead vehicle speed profile.

NHTSA is proposing to perform driver eye glance measurement in conjunction with a driving simulator protocol. For test participants driving a 2010 Toyota Prius, NHTSA measured a 85th percentile TEORT value of 10.5 seconds for the first manual radio tuning trial performed and 9.6

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[107] For a task that only requires one glance away from the forward roadway, the mean glance duration criterion cannot be met unless that glance is less than 2.0 seconds long. Therefore, the proposed NHTSA eye glance distribution tail limiting criterion does not need to have a special case for one glance tasks.

seconds using data from all trials. It is not clear which of these values best typifies normal driving since drivers are generally familiar with their own vehicle's radio, and have tuned it many times but generally not consecutively.

The VTTI data collected under conditions that most closely match the NHTSA experimental conditions for testing are those collected on VTTI's Smart Road using a 2010 Toyota Prius (VTTI tested the exact same vehicle) following a lead vehicle with varying speed. The VTTI measured 85th percentile TEORT for this condition is 11.3 seconds (versus NHTSA's 10.5 seconds). From this data, it appears that driving simulator measured TEORT values may be slightly shorter than ones measured while driving on the Smart Road. However, the two studies' results are similar enough (considering the variability present in testing of this sort) that it is reasonable to analyze both sets of results together and determine an overall TEORT.

The 85th percentile from the consolidated NHTSA and VTTI manual radio tuning data is 11.3 seconds. For compatibility with occlusion testing, the maximum TEORT needs to be a multiple of 2.0 seconds. The nearest multiple of 2.0 seconds to 11.3 seconds is 12.0 seconds. Therefore NHTSA is proposing that the acceptance limit for TEORT for *Option EGDS: Eye Glance Testing Using a Driving Simulator* be 12.0 seconds. In other words, tasks with an 85th percentile TEORT greater than 12.0 seconds should not be accessible by the driver while driving.[108]

As has been mentioned, the Alliance Guidelines include a TEORT acceptance limit of 20.0 seconds for Principle 2.1, Alternative A. The JAMA Guidelines include a TEORT acceptance limit of 8.0 seconds. NHTSA's value of 12.0 seconds is between these two values. NHTSA prefers the 12.0

[108] For the purposes of these NHTSA Guidelines, "while driving" is defined as any time the vehicle's engine is turned on and its transmission is not in "Park" (for automatic transmission vehicles; for manual transmission vehicles change this to the transmission is not in "Neutral" with the parking brake engaged).

second limit to either of the other two guidelines' values because the NHTSA value is based on more recent, more thorough, research.

Since NHTSA is proposing to test a sample of 24 test participants, for at least 21 of the 24 test participants (85 percent rounded up to the next whole number of test participants), the TEORT should be less than 12.0 seconds while performing the secondary task. The proposed NHTSA total eye glance duration criterion then is:

- For at least 21 of the 24 test participants, the sum of the durations of each individual participant's eye glances away from the forward road scene should be less than, or equal to, 12.0 seconds while performing the secondary task one time.

N. Human Subject Selection for Guideline Testing

The NHTSA Guidelines suggest that the following test participant sample composition criteria be used for testing performed to determine whether a device should be locked out under the NHTSA Guidelines:

1. To ensure that in-vehicle device secondary tasks can be performed by virtually the entire range of drivers without being unreasonably distracting, the recommended age range for test participants is 18 years and older. NHTSA research has shown that restricting test participant age range can improve test repeatability.[109] The lower limit, 18 years of age, is due to concerns about testing with minors. There is no upper limit, however, organizations may set an upper age

[109] Ranney, T. A., Baldwin, G. H. S., Parmer, E., Martin, J., and Mazzae, E. N., "Distraction Effects of Number and Text Entry Using the Alliance of Automotive Manufacturers' Principle 2.1B Verification Procedure," NHTSA Technical Report number TBD, November 2011.

limit (such as 65 years old) for their testing if they can easily find the needed test participants and they have health concerns about testing with elderly test participants.

2. Continuing with NHTSA's goal of ensuring that in-vehicle device tasks can be performed by the entire age range of drivers without being unreasonably distracting, the NHTSA Guidelines recommend that out of each group of 24 test participants used for testing, there should be

- Six test participants 18 through 24 years old, inclusive, and
- Six test participants 25 through 39 years old, inclusive, and
- Six test participants 40 through 54 years old, inclusive, and
- Six test participants 55 or more years old.

This should ensure adequate representation by a broad age range of test participants in each sample of subjects.

The above age ranges are partially based on the age distribution of drivers in the United States. NHTSA is focusing on the age distribution of drivers rather than the age distribution of drivers involved in fatal crashes because:

- The age distribution of drivers involved in fatal crashes due to electronic device distraction is not necessarily the same as the age distribution of drivers in involved in all fatal crashes. NHTSA currently does not know the age distribution of drivers involved in fatal crashes due to electronic device distraction.
- The age distribution of drivers involved in fatal crashes due to electronic device distraction may change in the future as new electronic devices are introduced into service.

Table 8 shows the percentage of United States drivers 18 years of age and older in each of the four test participant age ranges.

TABLE 8 -- PERCENT OF UNITED STATES DRIVERS 18 YEARS OF AGE AND OLDER IN EACH AGE RANGE[110]

Age Range	Percent of United States Drivers in Age Range
18 – 24	11.4 %
25 – 39	26.8 %
40 – 54	29.7 %
55 and older	32.1 %

The 18 through 24 years old, inclusive, age range is overrepresented in test samples relative to their numbers in the general driving population. There are two reasons for this. First, drivers in the 18 through 24 age range have a higher rate of fatalities (per 100,000 drivers in that age range[111] or per 100 million vehicle miles traveled[112]) than do drivers that are 25 years of age or older. Second, at least anecdotally, younger drivers are more frequent user of electronic technology than are older drivers. Therefore, NHTSA believes that this age range should be overrepresented in each test participant sample.

The 55 years and older age range is underrepresented in test samples relative to their numbers in the general driving population. While NHTSA considers it important that advanced electronic device tasks be tested using drivers in this age range, as mentioned above, older drivers are less frequent users of electronic technology than are younger drivers. Therefore, NHTSA is proposing to underweight this age range with six test participants rather than the eight called for by their numbers in the general driving population.

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[110] http://www.fhwa.dot.gov/policyinformation/statistics/2009/dl20.cfm
[111] National Highway Traffic Safety Administration, "Traffic Safety Facts 2008," NHTSA Technical Report DOT HS 811 170, 2010.
[112] United States Government Accountability Office, "Older Driver Safety, Knowledge Sharing Should Help States Prepare for Increase in Older Driver Population," Report to the Special Committee on Aging of the United States Senate, GAO-07-413, April 2007.

NHTSA solicits comments on the age range and distribution of test participants that are recommended to be in each test participant sample. We could use the age distribution of drivers involved in fatal crashes as the primary factor in determining the age range and distribution of test participants. This would result in somewhat different age ranges and distributions than are listed above. Would this be better for ensuring safety while driving and using electronic devices?

3. NHTSA also wishes to ensure that drivers of both genders be able to safely utilize in-vehicle devices. The United States driver population is 49.7 percent male and 50.3 percent female. For the relatively small test participant samples used for distraction testing, this implies that test participant samples should be evenly divided between men and women (i.e., each sample of 24 test participants should be balanced in gender overall and within each age range).

4. Another of NHTSA's concerns relates to ensuring that test participants are impartial with regard to the testing. To ensure fairness, test participants should not have any direct interest, financial or otherwise, in whether or not any of the devices being tested meets or does not meet the acceptance criteria. Therefore, NHTSA has added test participant impartiality criteria to its NHTSA Guidelines.

While auto manufacturers may have multiple categories of employees that are not involved in vehicle systems or component development, NHTSA believes that automaker employees will tend to be generally more knowledgeable about vehicles and their current features than the average member of the public. With this additional knowledge of vehicles and their latest features, the employees may perform better in testing due to this exposure to the automotive industry. Therefore we feel that this impartiality criterion is essential to ensure that test results represent the performance of average U.S. drivers. We welcome comments on any available strategies that automakers may implement to ensure impartial test participation by employees.

O. Occlusion Test Protocol

NHTSA is proposing that its *Option OCC: Occlusion Testing* test protocol be the same as that specified in ISO 16673:2007.[113] ISO 16673:2007 specifies a viewing interval (shutter open time) of 1.5 seconds followed by an occlusion interval (shutter closed time) of 1.5 seconds. NHTSA has selected the use of the ISO test protocol for its occlusion test protocol in the interests of promoting international regulatory harmonization.

NHTSA's past occlusion testing was performed with a viewing interval (shutter open time) of 1.5 seconds followed by an occlusion interval (shutter closed time) of 1.0 second. NHTSA is performing a study during the summer of 2011 to examine what effects, if any, this change to the length of the occlusion interval has on the results of occlusion testing. This study will also ensure that there are no unforeseen difficulties in performing occlusion testing using the ISO 16673:2007 test protocol.

ISO 16673:2007 states that occlusion testing results need to be corrected for system response delays that are greater than 1.5 seconds.[114] However, since the NHTSA Guidelines specify that the maximum device response time for a device input should not exceed 0.25 second, no correction is needed for occlusion testing performed under the NHTSA Guidelines.

NHTSA is proposing to set the maximum recommended total viewing interval (total shutter open time) for a task to be accessible to the driver while driving at 9.0 seconds. As was previously discussed, NHTSA is proposing to set the maximum recommended total glance time (time during which the driver's eyes are looking at the device upon which the task is being performed) for a task to be accessible to the driver while driving for *Option EGDS: Eye Glance Testing Using a Driving Simulator*

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[113] International Standard 16673:2007, "Road Vehicles – Ergonomic Aspects of Transport Information and Control Systems – Occlusion Method to Assess Visual Demand due to the use of In-Vehicle Systems."
[114] Ibid, P. 13.

at 12.0 seconds of total eyes-off-road time. The acceptance criteria for *Option OCC: Occlusion Testing* should be consistent with the *Option EGDS* acceptance criteria. Applying the earlier explained field factor of 75 percent to the 12.0 seconds of total eyes-off-road time criteria that NHTSA is proposing for *Option EGDS: Eye Glance Testing Using a Driving Simulator* gives a maximum permitted total shutter open time for the NHTSA Guidelines *Option OCC: Occlusion Testing* of 9.0 seconds.

P. Task Performance Errors During Testing

Reaching the desired end state of a secondary task is generally only possible if the driver follows the correct steps to complete the task and makes no mistakes. If the driver presses the wrong button or inputs an incorrect character, a correction typically must be made in order to reach the desired end state. An interface associated with frequent input errors by the driver could reasonably be considered a greater source of distraction than one for which task performance is performed without errors. Therefore, for the purposes of these NHTSA Guidelines only data from "error-free" test trials performed by test participants should be used for determining whether a task is suitable for performance while driving. Using only data from error-free test trials improves testing repeatability.

The precise definition of an error during device testing is difficult to develop. NHTSA proposes that an error would be considered to have occurred during a test trial if the test participant has to backtrack or delete already entered inputs. If the device can accommodate an incorrect entry without requiring backtracking and extra inputs beyond those necessary to reach the desired end state of the task, then no error would be deemed to have occurred. For example, suppose that a task on a device could be accomplished either by pressing Button "A" or by pressing first Button "B" and then Button "C." If a test participant were asked to perform this task, either pressing Button "A" or pressing first Button "B" and then Button "C" would result in a valid trial. If however, the test participant first pressed Button "B," then reset the device, and then pressed Button "A" an error would have occurred.

A record should be kept during testing as to whether one or more errors occurred during each test trial. If errors occur during more than 50 percent of test trials while testing a sample of test participants, then that task is deemed an "unreasonably difficult task." Unreasonably difficult tasks are not recommended for performance while driving and should be locked out. (Note that in order to check NHTSA's acceptance criteria; it is necessary for 24 test participants to successfully complete each task. This may require testing more than 24 subjects.)

Q. Limited NHTSA Guidelines for Passenger Operated Equipment

The NHTSA Guidelines are appropriate primarily for devices that are intended to be operated by the vehicle driver. For the sake of clarity, NHTSA believes it necessary to make a few general statements about passenger operated equipment.

The NHTSA Guidelines should be appropriate for any devices that the driver can easily see and/or reach. For any in-vehicle device that is within sight and reach of the driver (even if it is intended for use solely by passengers), any task that has associated with its performance an unacceptable level of distraction should be locked out whenever the vehicle's engine is on and its transmission is not in "Park" (the vehicle's transmission in "Neutral" and parking brake engaged for manual transmission vehicles).

The NHTSA Guidelines are not appropriate for any device that is located fully behind the front seat of the vehicle. Similarly, the NHTSA Guidelines are not appropriate for any front-seat device that cannot reasonably be reached or seen by the driver.

VII. Implementation Considerations for the NHTSA Guidelines

A. Current Vehicles That Meet the NHTSA Guidelines

All members of the Alliance of Automobile Manufacturers have committed themselves to producing vehicles that meet the Alliance Guidelines. Five years have passed since the current version of the Alliance Guidelines was issued and NHTSA expects that most current vehicle models produced by Alliance members meet the Alliance Guidelines. However, this is an expectation based on statements by the Alliance's members and is not based on any NHTSA testing of recently designed vehicle models.

Some automobile manufacturers that are not members of the Alliance (e.g., Honda) have also committed to producing vehicles that meet the Alliance Guidelines. However, this commitment was made in 2010; therefore, most of their vehicles may not yet meet the Alliance Guidelines' recommendations.

Given the many common elements and details between the NHTSA Guidelines and the Alliance Guidelines, NHTSA believes that many in-vehicle device tasks will either meet the recommendations of these proposed NHTSA Guidelines or be close to doing so. The changes to existing devices and/or vehicles that already meet the Alliance Guidelines so as to make them meet the NHTSA Guidelines are expected to be minor.

There is no time frame in which vehicle manufacturers are expected to produce vehicles that meet these guidelines; meeting them is strictly voluntary. However, NHTSA believes that manufacturers will take the initiative to implement these guidelines in an effort to improve safety. Manufacturers choosing to implement these guidelines for existing vehicle models would likely make any necessary changes to meet the guidelines when a vehicle model undergoes a major revision. Typically, major revisions occur on about a five-year cycle for passenger cars and less frequently for light trucks. NHTSA believes that it would be feasible for manufacturers to make the necessary changes implementing these guidelines for existing vehicle models that undergo major revisions two or more years after the final issuance of these guidelines. Likewise, NHTSA believes it would be feasible for new vehicle models that come onto the market two or more years after the final issuance of these guidelines to meet them.

B. Expected Effects of the NHTSA Guidelines

The main effects that NHTSA hopes to achieve through its NHTSA Guidelines are better designed vehicles and integrated electronic device interfaces, neither of which exceeds a reasonable level of complexity for visual-manual secondary tasks. This will be accomplished through multiple recommendations that will discourage device interfaces that lack evidence of sound human factors principles in their designs. One important recommendation recommends a limit for allowable total eyes-off-road time for any one task. The NHTSA Guidelines would discourage the introduction of egregiously distracting integrated devices and non-driving tasks.

The NHTSA Guidelines recommend against designing in-vehicle electronic systems that allow drivers to perform the following activities while the vehicle is "moving":[115]

- Visual-manual text messaging,
- Visual-manual internet browsing,
- Visual-manual social media browsing,
- Visual-manual navigation system destination entry by address, and
- Visual-manual 10-digit phone dialing

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[115] More specifically, the NHTSA Driver Distraction Guidelines recommend disabling unreasonably distracting tasks/device unless either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles).

The NHTSA Guidelines are expected to have little impact on current vehicle designs. For many current vehicles, the only integrated electronic device that is not required for driving is the stereo system (radio and CD player). Based on the research that was performed in support of the development these NHTSA Guidelines, integrated stereo systems would either already meet, or be easily modifiable to meet, these NHTSA Guidelines. For integrated electronic devices other than the stereo system, if such devices are incorporated into vehicles built by Alliance member companies (as well as some non-Alliance vehicle manufacturers), then they are already covered by that organization's guidelines. Since the NHTSA Guidelines share many common elements with the Alliance Guidelines, NHTSA believes that many devices/vehicles would either meet the recommendations of its NHTSA Guidelines or be close to doing so.

The NHTSA Guidelines are expected to have a larger impact on future devices that are integrated into vehicles. For future integrated original equipment devices, these NHTSA Guidelines are expected to encourage simple visual-manual driver interfaces. They should also help encourage the introduction of visual-manual non-driving tasks into the vehicle that are not unreasonably distracting. Research by Ford Motor Company[116] and VTTI[117] has shown reductions in Total Eyes-Off-Road Time through the use of an auditory-vocal driver-vehicle interface. As a result, NHTSA anticipates that manufacturers may consider relying more on auditory-vocal interactions for task performance in future device designs.

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[116] Shutko, J., Mayer, K., Laansoo, E., and Tijerina, L., "Driver Workload Effects of Cell Phone, Music Player, and Text Messaging Tasks with the Ford SYNC Voice Interface versus Handheld Visual-Manual Interfaces," Ford Motor Company, SAE Paper 2009-01-0786, 2009.

[117] Owens, J. M., McLaughlin, S. B., and Sudweeks, J., "On-Road Comparison of Driving Performance Measures When Using Handheld and Voice-Control Interfaces for Mobile Phones and Portable Music Players," Virginia Tech Transportation Institute, SAE Paper 2010-0101036, April 2010.

The goal of the NHTSA Guidelines is not to prevent drivers from performing activities that they wish to perform while driving; instead, the goal is to improve vehicle safety. These NHTSA Guidelines identify only a few, clearly safety-detrimental tasks as ones that should not be accessible to a driver while operating a vehicle. NHTSA believes that, with thoughtful interface engineering and appropriate application of well designed auditory-vocal interfaces, drivers can continue to perform most of the activities that they wish to perform while driving and also have improved vehicle safety.

As previously stated, for many current vehicles, the only integrated electronic device that is not required for driving is the stereo system (radio and CD player). Based on the research that was performed in support of the development the NHTSA Guidelines, many current integrated stereo systems already meet the recommendations of the NHTSA Guidelines. Other stereos would need to be modified so as to reduce their Total Eyes-Off-Road Time (TEORT) to perform a manual radio tuning to meet these NHTSA Guidelines. NHTSA does not know what percentage of existing integrated stereo systems would need to be redesigned. Nor do we know by how much the recommended stereo system modifications should improve safety. However, the recommended changes to existing integrated electronic devices would be expected to have a small but positive impact on vehicle safety.

For integrated electronic devices other than the stereo system (when they exist), if such devices are installed into vehicles built by Alliance member companies (as well as some non-Alliance vehicle manufacturers), then they are already covered by that organization's guidelines. Since the NHTSA Guidelines share many common elements with the Alliance Guidelines, many existing in-vehicle devices already either meet the recommendations of the NHTSA Guidelines or would be close to doing so. As a result, the NHTSA Guidelines are expected to encourage only minimal revisions to existing, integrated, original equipment devices. Therefore, the

NHTSA Guidelines are expected to have only small benefits for many current, integrated, in-vehicle advanced electronic devices.

The NHTSA Guidelines could have a larger impact on future devices that are integrated into vehicles. For future integrated original equipment devices, these NHTSA Guidelines encourage simpler visual-manual driver interfaces and task performance. They should also help encourage the introduction of visual-manual non-driving tasks into the vehicle that are not unreasonably distracting. As a result, NHTSA anticipates that future device designs may rely more on auditory-vocal interactions for task performance.

NHTSA does not know the safety effects of the NHTSA Guidelines expected impact on future devices that are integrated into vehicles. The problem is one of trying to estimate the safety benefits of unknown future systems that meet the NHTSA Guidelines versus unknown future systems that do not meet the NHTSA Guidelines and which will, due to the influence of the NHTSA Guidelines, never be developed. For these future systems, we do not know what they will do, their market share, how often drivers will want to use them, or how much of a reduction in TEORT would result from the NHTSA Guidelines. The numerous unknown factors make it impossible to calculate meaningful estimates of benefits. However, the resulting impact is expected to have a positive impact on vehicle safety.

There are certain non-driving tasks that are obviously inappropriate to perform while driving, such as the driver watching television. Many other in-vehicle device tasks are more reasonable to perform while driving but, when equipped with a visual-manual driver-vehicle interface, would be considered unreasonably distracting by the NHTSA Guidelines (and, therefore, a manufacturer choosing to apply the NHTSA Guidelines would lock out those tasks. However, research by Ford Motor Company[118] and VTTI[119] has shown that through the use of an auditory-vocal driver-vehicle interface reductions in Total Eyes-Off-Road Time can be attained. As a result, NHTSA believes that many of these in-vehicle device tasks may be suitable for performance by the driver while driving if performed via an auditory-vocal interface.

Since most in-vehicle device tasks that are reasonable to perform while driving will still be performable while meeting the NHTSA Guidelines, NHTSA does not expect to affect the overall size of the in-vehicle device market with its NHTSA Guidelines. The goal of the NHTSA Guidelines is not to prevent drivers from performing reasonable tasks while driving but to enable them to perform such tasks in a minimally-distracting and safe manner.

C. NHTSA Monitoring to Determine Whether Vehicles Meet Guideline Recommendations

Since our voluntary NHTSA Guidelines are not a Federal Motor Vehicle Safety Standard, the degree to which in-vehicle devices meet the specified criteria would not be assessed in the context of a formal compliance program. However, NHTSA does intend to monitor whether vehicles meet these NHTSA Guidelines to help determine their effectiveness and sufficiency. NHTSA has not determined the nature of the monitoring it might adopt. At a minimum, some spot checking of vehicles is likely.

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[118] Shutko, J., Mayer, K., Laansoo, E., and Tijerina, L., “Driver Workload Effects of Cell Phone, Music Player, and Text Messaging Tasks with the Ford SYNC Voice Interface versus Handheld Visual-Manual Interfaces,” Ford Motor Company, SAE Paper 2009-01-0786, 2009.
[119] Owens, J. M., McLaughlin, S. B., and Sudweeks, J., “On-Road Comparison of Driving Performance Measures When Using Handheld and Voice-Control Interfaces for Mobile Phones and Portable Music Players,” Virginia Tech Transportation Institute, SAE Paper 2010-0101036, April 2010.

NHTSA seeks comment as to how best to monitor manufacturers' voluntary implementation of the recommendations contained in the NHTSA Guidelines. In particular, NHTSA requests input from commenters in response to the following questions:

- Are these NHTSA Guidelines reasonable and applicable for meeting their intended goals?
- How likely are vehicle manufacturers to adopt these NHTSA Guidelines?
- How likely are equipment suppliers to adopt these NHTSA Guidelines?
- How should NHTSA monitor adoption of these NHTSA Guidelines in order to evaluate their effectiveness? How should it make public the results of that monitoring?

NHTSA will announce its plan for monitoring the adoption of these guidelines as part of the final notice for Phase 1 of the NHTSA Guidelines.

VIII. Public Participation

How do I prepare and submit comments?

Your comments must be written and in English. To ensure that your comments are correctly filed in the Docket, please include the docket number of this document in your comments.

Your comments must not be more than 15 pages long. (See 49 CFR 553.21.) We established this limit to encourage you to write your primary comments in a concise fashion. However, you may attach necessary additional documents to your comments. There is no limit on the length of the attachments.

Comments may be submitted to the docket electronically by logging onto the Docket Management System website at http://www.regulations.gov. Follow the online instructions for submitting comments.

You may also submit two copies of your comments, including the attachments, to Docket Management at the address given above under ADDRESSES.

Please note that pursuant to the Data Quality Act, in order for substantive data to be relied upon and used by the agency, it must meet the information quality standards set forth in the Office of Management and Budget (OMB) and DOT Data Quality Act guidelines. Accordingly, we encourage you to consult the guidelines in preparing your comments. OMB's guidelines may be accessed athttp://www.whitehouse.gov/omb/fedreg/reproducible.html. DOT's guidelines may be accessed at http://dms.dot.gov.

How can I be sure that my comments were received?

If you wish Docket Management to notify you upon its receipt of your comments, enclose a self-addressed, stamped postcard in the envelope containing your comments. Upon receiving your comments, Docket Management will return the postcard by mail.

How do I submit confidential business information?

If you wish to submit any information under a claim of confidentiality, you should submit three copies of your complete submission, including the information you claim to be confidential business information, to the Chief Counsel, NHTSA, at the address given above under FOR FURTHER INFORMATION CONTACT. In addition, you should submit two copies, from which you have deleted the claimed confidential business information, to Docket Management at the address given above under ADDRESSES. When you send a comment containing information claimed to be confidential business information, you should include a cover letter setting forth the information specified in our confidential business information regulation. (See 49 CFR Part 512.)

Will the agency consider late comments?

We will consider all comments received before the close of business on the comment closing date indicated above under DATES. To the extent possible, we will also consider comments that are received after that date. If a comment is received too late for us to consider in developing any final guidelines, we will consider that comment as an informal suggestion for future guidelines.

How can I read the comments submitted by other people?

You may read the comments received by Docket Management at the address given above under ADDRESSES. The hours of the Docket are indicated above in the same location. You may also see the comments on the Internet. To read the comments on the Internet, go to http://www.regulations.gov. Follow the online instructions for accessing the dockets.

Please note that even after the comment closing date, we will continue to file relevant information in the Docket as it becomes available. Further, some people may submit late comments. Accordingly, we recommend that you periodically check the Docket for new material.

IX. National Technology Transfer and Advancement Act

Under the National Technology Transfer and Advancement Act of 1995 (NTTAA) (Public Law 104-113), "all Federal agencies and departments shall use technical standards that are developed or adopted by voluntary consensus standards bodies, using such technical standards as a means to carry out policy objectives or activities determined by the agencies and departments." Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies, such as SAE. The NTTAA directs us to provide Congress, through OMB, explanations when we decide not to use available and applicable voluntary consensus standards.

The agency is not aware of any applicable voluntary consensus standards that are appropriate for driver distraction stemming from driver interactions with in-vehicle electronic devices. However, industry-developed standards do exist. These standards were reviewed and formed the basis for the NHTSA Guidelines outlined herein.

In view of all of the research and analysis discussed above, NHTSA proposes the following voluntary NHTSA Guidelines for in-vehicle devices.

X. Guidelines for Reducing Visual-Manual Driver Distraction During Interactions with In-Vehicle Devices

I. Purpose. The purpose of these guidelines is to reduce the number of motor vehicle crashes and the resulting deaths and injuries that occur due to a driver being distracted from the primary driving task while performing non-driving activities with an integrated-into-the-vehicle electronic device. The guidelines are presented as an aid to manufacturers in designing in-vehicle devices so as to avoid unsafe driver distraction resulting from use of the devices. Manufacturers that choose to adhere to these guidelines do so voluntarily and compliance with them is not required.

I.1 Protection Against Unreasonable Risks to Safety. Due to the rapid rate of development of electronic in-vehicle devices, the National Highway Traffic Safety

Administration (NHTSA) cannot possibly evaluate the safety implications of every new device before it is introduced into vehicles. However, because they have obligations to recall and remedy vehicles or motor vehicle equipment they manufacture that present an unreasonable risk to safety (45 U.S.C. §§ 30118-20), manufacturers bear such obligations with regard to integrated-into-the-vehicle electronic devices that create unreasonable risks to the driving public.

I.2 Driver Responsibilities. Drivers are still responsible for the safety of people and property while driving and interacting with integrated-into-the-vehicle electronic devices. Drivers retain the primary responsibility for ensuring the safe operation of the vehicle under all operating conditions.

II. Scope. These guidelines are appropriate for driver interfaces of original equipment electronic devices for performing non-driving activities that are built into a vehicle when it is manufactured. They are not appropriate for driving controls, driver safety warning systems, any other electronic device that is necessary to drive a motor vehicle, or any other electronic device that has a driver interface that is specified by a Federal Motor Vehicle Safety Standard. Table 1 contains a non-exhaustive list of the types of devices for which these guidelines are appropriate.

TABLE 9 -- TYPES OF DEVICES AND TASKS FOR WHICH THESE GUIDELINES ARE APPROPRIATE

Vehicle Information	Vehicle Information Center Emissions Controls Fuel Economy Information
Navigation	Destination Entry Route Following Real-Time Traffic Advisory Trip Computer Information
Communications	Caller Identification Incoming Call Management Initiating and Terminating Telephone Calls Conference Telephoning Walkie-Talkie-Like Services Paging E-mail Reminders Instant Messaging Text Messaging
Entertainment	AM Radio FM Radio Satellite Radio Pre-recorded Music Players, All Formats Television Video Displays Advertising Address Book Internet Searching Internet Content News Directory Services

II.1 Guidelines Intended for Driver Interfaces. These guidelines are appropriate primarily for driver interfaces of devices. They are appropriate to a limited extent (see Section VII) for devices intended for use by front seat passengers. They are not appropriate for devices that are located solely rearwards of the front seat of a vehicle.

II.2 Only Driver Interfaces Covered. These guidelines are not appropriate for any aspect of covered devices other than their driver interfaces. Specifically, they do not cover a device's electrical characteristics, material properties, or performance.

II.3 Aftermarket and Portable Devices Not Covered. These guidelines are only appropriate for devices that are installed in a vehicle by the original manufacturer of the vehicle.

II.4 Auditory-Vocal Interfaces Not Covered. These guidelines are not appropriate for devices having solely auditory-vocal interfaces or to the auditory-vocal portions of device's interfaces that contain both auditory-vocal and visual-manual elements.

II.5 Intended Vehicle Types. These guidelines are appropriate for all passenger cars, multipurpose passenger vehicles, and trucks and buses with a GVWR of not more than 10,000 pounds.

III. Standards Included by Reference.

III.1 International Standards Organization Standards.

III.1.a ISO International Standard 16673:2007(E), "Road Vehicles – Ergonomic Aspects of Transport Information and Control Systems – Occlusion Method to Assess Visual Demand due to the use of In-Vehicle Systems."

III.2 SAE Standards.

III.2.a SAE Surface Vehicle Recommended Practice J941 MAR 2010, "Motor Vehicle Drivers' Eye Locations."

IV. Definitions.

IV.1 General Definitions.

IV.1.a Active Display Area means the portion of a display that is being used. It excludes unused display surface and any area containing physically-manipulatable controls.

IV.1.b Device means all components that a driver uses to perform secondary tasks (i.e., tasks other than their primary task of driving); whether stand-alone or integrated into another device.

IV.1.c Distraction means the diversion of a driver's attention from activities critical for safe driving to a competing activity. This diversion of attention may be due to non-driving related tasks or to driving related tasks involving information presented in an inefficient manner or demanding unnecessarily complex inputs by a driver. Driver distraction is accompanied by an approximately proportional decrease in driving performance that can vary based on driver characteristics and roadway environment.

IV.1.d Downward Viewing Angle means the angle by which a driver has to look down from the horizontal to directly look at a device's visual display. Both three-dimensional downward viewing angle and a two-dimensional approximation are used in these guidelines.

IV.1.e Driver's Field of View means the forward view directly through the windshield, rear and side views through the other vehicle windows, as well as the indirect side and rear view provided by the vehicle mirror system.

IV.1.f Driving means any condition in which the vehicle's engine is running **unless** the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles).

IV.1.g Driving-Related Task means an activity performed by a driver that is essential to the operation and safe control of the vehicle.

IV.1.h Function means an individual action that a device can perform. A device may have one or more functions.

IV.1.j Glance means a single ocular fixation by a driver. When using eye tracker equipment that cannot distinguish different nearby locations of individual fixations, glance may also be used to refer to multiple fixations to a single area that the eye tracker treats as one ocular fixation.

IV.1.k Glance Duration means the time from the moment at which the direction of gaze moves towards a target to the moment it moves away from that target. It should be noted that glance duration includes the transition time to a target and the dwell time on the target.

IV.1.l Interaction means a transaction between a driver and a device. Interactions include control inputs (defined later) and data inputs (information that a driver sends or receives from the device that is not intended to control the device). Depending on the type of task and the goal, interactions may be elementary or more complex. For the visual-manual interfaces covered by this version of the NHTSA Driver Distraction Guidelines (NHTSA Guidelines), interactions are restricted to physical (manual or visual) actions.

IV.1.m Lock Out means the disabling of one or more functions or features of a device **unless** either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles).

IV.1.n Nominal Driver Eye Point means the X_C and Z_C coordinates of the Cyclopean eye point as given by Equations (2) and (5), respectively, of SAE Surface Vehicle Recommended Practice J941 MAR 2010, Motor Vehicle Drivers' Eye Locations.

IV.1.o Subtend means, in a geometrical sense, to be opposite to and delimit (an angle or side).

IV.2 Task-Related Definitions.

IV.2.a Control Input means a transaction between a driver and a device that is intended to affect the state of a device. Control inputs may be initiated either by a driver or as a response to displayed information initiated by a device itself. For the visual-manual interfaces covered by this version of the NHTSA Guidelines, control inputs are restricted to manual control actions.

IV.2.b Dependent Task means a task that cannot be initiated until another task (referred to as the antecedent task) is first completed. Their start state is thus dependent upon the end state of another, antecedent, task.

An antecedent task that is followed by a dependent task can be distinguished from a task that contains two subtasks by examining the end states of both the antecedent task and the dependent task. For the antecedent task-dependent task case, both tasks will end with the achievement of a driver goal (i.e., two driver goals will be achieved, one for the antecedent task and one for the dependent task). In contrast, for a task composed of two subtasks, only one driver goal will be achieved.

For example, after choosing a restaurant from a navigation system's point-of-interest list (antecedent task), a driver is offered an internet function option of making a reservation at the restaurant (dependent task). The dependent task of making a reservation can only be initiated following the task of selecting a restaurant from within the navigation system.

IV.2.c End of Data Collection means the time at which a test participant tells the experimenter "done" (or, by some means, indicates non-verbally the same thing). Test participant eye glances and vehicle driving performance are **not** examined after the end of data collection. If a test participant eye glance was in progress at the end of data collection, only the portion of it before the end of data collection is used. If the end of data collection occurs when the device is at the desired end state for a testable task, then a test participant has successfully completed the testable task.

IV.2.d End State for a Testable Task means the pre-defined device state sought by a test participant to achieve the goal of that testable task.

IV.2.e Error means that a test participant has made an incorrect input when performing a requested task during a test trial. An error has occurred if the test participant has to backtrack during performance of the task or delete already entered inputs. If the device can accommodate an incorrect entry without requiring backtracking and extra inputs beyond those necessary to reach the desired end state of the task, then no error is deemed to have occurred.

IV.2.f Error-Free Trial means a test trial in which no errors are made by the test participant while completing the task.

IV.2.g Goal means a device state sought by a driver. Goal achievement is defined as achieving a device state that meets the driver's intended state, independent of the particular device being executed or method of execution.

IV.2.h Secondary Task means, in these guidelines, any interaction a driver has with an in-vehicle device that is not directly related to the primary task of driving. These tasks may relate to driver comfort, convenience, communications, entertainment, information gain, or navigation.

IV.2.i Start of Data Collection means the time at which the experimenter tells a test participant "begin" (or, by some means, issues a non-verbal command indicating the same thing). Test participant eye glances and vehicle driving performance are examined only after the start of data collection. If a test participant eye glance was in progress at the start of data collection, only the portion of it after the start of data collection is used. The start of data collection should occur when the device is at the start state for a testable task.

IV.2.j Start State for a Testable Task means the pre-defined device state from which testing of a testable task always begins. This is frequently the "home" screen, default visual display state, or other default driver interface state from which a driver initiates performance of the testable task. For dependent tasks, the start state would be the end state of the previous testable task.

For a testable task for which there is only one point (e.g., screen, visual prompt, step) screen from which the task can be initiated, that point would correspond to the start state. For a testable task which can be initiated from more than one point, one of these options is selected as the start state. (The desire here is to reduce the amount of testing needed to ensure adherence with these guidelines. It is generally not necessary to test all possible transitions into a testable task.)

IV.2.k Sub-goal means an intermediate state on the path to the goal toward which a driver is working. It is often distinguishable from a goal in two ways: (1) it is usually not a state at which a driver would be satisfied stopping; and (2) it may vary in its characteristics and/or ordering with other sub-goals across hardware/interface functions, and thus is system dependent.

IV.2.l Subtask means a sub-sequence of control operations that is part of a larger testable task sequence – and which leads to a sub-goal that represents an intermediate state in the path to the larger goal toward which a driver is working.

*Subtasks should **not** be treated as separate dependent tasks. For example, entering the street name as part of navigation destination entry is not a separate task from entering the street number; rather, these are subtasks of the same task.*

IV.2.m Successful Task Completion means that a test participant has performed a testable task without substantial deviations from the correct sequence(s) of control inputs and achieved the desired end state for a testable task.

IV.2.n Testable Task means a sequence of control operations performed using a specific method leading to a goal toward which a driver will normally persist until the goal is reached. A testable task begins with the device at a previously defined start state and proceeds, if the testable task is successfully completed, until the device attains a previously defined end state.

A testable task is a secondary task that is performed using an electronic device with a specified sequence of control operations leading to a goal and a defined start state and end state. It is called a testable task because it is a secondary task that can be tested for adherence with these guidelines. While performing a testable task during testing to determine if a task causes an unacceptable level of distraction, data collection begins at start of data collection and continues until end of data collection.

IV.3 Task-Related Explanatory Material.

IV.3.a Testable tasks should be completely defined prior to any testing to determine whether they are suitable to perform while driving under these guidelines.

IV.3.b For testable tasks that have a variety of possible inputs of different lengths (e.g., city names for navigation systems), a typical or average length input should be used. Precise averages need not be used and there may be some variation in length from input-to-input. For example, for the input of city names into a navigation system, a length restriction of 9 through 12 letters might be used.

V. Device Interface Recommendations. Each device's driver interface should meet the recommendations specified in Section V under the test procedures specified in Section VI of these guidelines.

V.1 No Obstruction of View.

V.1.a No part of the physical device should, when mounted in the manner intended by the manufacturer, obstruct a driver's field of view.

V.1.b No part of the physical device should, when mounted in the manner intended by the manufacturer, obstruct a driver's view of any vehicle controls or displays required for the driving task.

V.2 Easy to See and Reach. The mounting location for a device should not be in a location that is difficult to see and/or reach (as appropriate) while driving.

V.3 Maximum Display Downward Angle. Each device's display(s) should be mounted in a position where the downward viewing angle, measured at the geometric center of each active display area and determined as explained in Subsection VI.1, is less than at least one of the following two angles:

- The 2D Maximum Downward Angle, or
- The 3D Maximum Downward Angle.

When the 2D Maximum Downward Angle is used, the downward viewing angle is determined as explained in Subsection VI.1.a. When the 3D Maximum Downward Angle is used, the downward viewing angle is determined as discussed in Subsection VI.1.b.

V.3.a The 2D Maximum Downward Angle is equal to 30.00 degrees for a vehicle with the height above the ground of the nominal driver eye point less than or equal to 1700 millimeters above the ground.

V.3.b The 2D Maximum Downward Angle is given by the following equation for nominal driver eye point heights greater than 1700 millimeters above the ground:

$$\theta_{2DMax} = 0.01303\, h_{Eye} + 15.07$$

where

θ_{2DMax} is the 2D Maximum Downward Angle, and

h_{Eye} is the height above the ground of the nominal driver eye point.

V.3.c The 3D Maximum Downward Angle is equal to 28.16 degrees for a vehicle with the height above the ground of the nominal driver eye point less than or equal to 1146.2 millimeters above the ground.

V.4.d The 3D Maximum Downward Angle is given by the following equation for nominal driver eye point heights greater than 1146.2 millimeters above the ground:

$$\theta_{sDMax} = 57.2958 \tan^{-1}[0.829722 \tan(0.263021 + 0.000227416\, h_{Eye})]$$

where

θ_{sDMax} is the 3D Maximum Downward Angle, and

h_{Eye} is the height above the ground of the nominal driver eye point.

V.3.e Visual displays that present information highly relevant to the driving task and/or visually-intensive information should have downward viewing angles that are as close as practicable to a driver's forward line of sight. Visual displays that present information less relevant to the driving task should have lower priority, when it comes to locating them to minimize their downward viewing angles, than displays that present information highly relevant to the driving task.

V.4 Lateral Display Position. Visual displays that present information relevant to the driving task and/or visually-intensive information should be laterally positioned as close as practicable to a driver's forward line of sight.

V.5 *Per se* Lock Outs. The following in-vehicle device tasks should always be locked out **unless** either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles):

V.5.a Displaying dynamic or static visual photographic or graphical images not related to driving including, but not limited to:

V.5.a.i Video-based entertainment in view of the driver; and

V.5.a.ii Video-based communications including video phone calls and other forms of video communication.

V.5.b Dynamic map displays. The display of either static or quasi-static maps (quasi-static maps are static maps that are updated frequently, perhaps as often as every few seconds, but are **not** continuously moving) for the purpose of providing driving directions is acceptable. Dynamic, continuously-moving maps are **not** recommended.

V.5.c The display of rearview images for the purposes of aiding a driver in performing a backing maneuver should not be locked out when presented in accordance with the allowable circumstances specified in FMVSS No. 111.

V.5.d Displaying static photographic or graphical images not related to driving. However, displaying driving-related images including icons, line drawings, and either static or quasi-static maps is acceptable.

V.5.e Automatically scrolling text. The display of continuously moving text is **not** recommended. The visual presentation of limited amounts of static or quasi-static text is acceptable

V.5.f Manual text entry. A driver should not enter more than six button or key presses during a single task. This would include drafting text messages and keyboard-based text entry.

V.5.g Reading more than 30 characters (not counting punctuation marks, counting each number, no matter how many digits it contains, as one character, and counting units such as mph as just one character) of visually presented text.

V.5.h The *per se* lock outs listed above are intended to specifically prohibit a driver from performing the following while driving:

- Watching video footage,
- Visual-manual text messaging,
- Visual-manual internet browsing, and
- Visual-manual social media browsing.

V.6 Task Lock Outs. Any secondary task that draws a driver's attention from the primary driving task to the point where safety is reduced, as determined by the test procedure contained in Subsection VI.2, should be locked out **unless** either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles).

V.7 Sound Level. Devices should not produce uncontrollable sound levels liable to mask warnings from within the vehicle or outside or to cause distraction or irritation.

V.8 Single-Handed Operation. Devices should allow a driver to leave at least one hand on the vehicle's steering control. All tasks that require manual control inputs (and can be done with the device while the vehicle is in motion) should be executable by a driver in a way that meets all of the following criteria:

V.8.a When manual device controls are placed in locations other than on the steering control, no more than one hand should be required for manual input to the device at any given time during driving.

V.8.b When device controls are located on the steering wheel and both hands are on the steering wheel, no device tasks should require simultaneous manual inputs from both hands.

V.8.c A driver's reach to the device's controls should allow one hand to remain on the steering control at all times.

V.8.d Reach of the whole hand through steering wheel openings should not be required for operation of any device controls.

V.9 Interruptability. Devices should not require uninterruptible sequences of visual-manual interactions by a driver. A driver should be able to resume an operator-interrupted sequence of visual-manual interactions with a device at the point of interruption or at another logical point in the sequence. This subsection, including all of its following sub-parts, is not appropriate for device output of dynamically changing data.

V.9.a Except as stated in Subsection V.9.e, no device-initiated loss of partial driver input (either data or command inputs) should occur automatically.

V.9.b Drivers may initiate commands that erase driver inputs.

V.9.c A visual display of previously-entered data or current device state should be provided to remind a driver of where the task was left off.

V.9.d If feasible, necessary, and appropriate, the device should offer to aid a driver in finding the point to resume the input sequence or in determining the next action to be taken. Possible aids include, but are not limited to:

- A visually displayed indication of where a driver left off,
- A visually displayed indication of input required to complete the task, or
- An indication to aid a driver in finding where to resume the task.

V.9.e Devices may revert automatically to a previous or default state without the necessity of further driver input after a device defined time-out period, provided:

- It is a low priority device state (one that does not affect safety-related functions or way finding), and
- The state being left can be reached again with low driver effort. In this context, low driver effort is defined as either a single driver input or not more than four presses of one button.

V.10 Response Time. A device's response (e.g., feedback, confirmation) following driver input should be timely and clearly perceptible. The maximum device response time to a device input should not exceed 0.25 second. If device response time exceeds 0.25 second, a clearly perceptible indication should be given indicating that the device is responding.

V.11 Disablement. Devices providing dynamic (i.e., moving) non-safety-related visual information should provide a means by which that information is not seen by a driver. A device visually presenting dynamic non-safety-related information should make the information not seen by a driver through at least one of the following mechanisms:

- Dimming the displayed information,
- Turning off or blanking the displayed information,
- Changing the state of the display so that the dynamic, non-safety-related information cannot be seen by a driver while driving, or
- Positioning or moving the display so that the dynamic, non-safety-related information cannot be seen while driving.

V.12 Lock Out Functions not Intended for Driving Use. Device functions not intended to be used by a driver while driving should be locked out (i.e., made inoperable **unless** either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles).

V.13 Distinguish Devices not Intended for Driving Use. Devices should clearly distinguish between those aspects of a device which are intended for use by a driver while driving, and those aspects (e.g., specific functions, menus, etc) that are not intended to be used while driving.

V.14 Device Status. Information about current status, and any detected malfunction, within the device that is likely to have an adverse impact on safety should be presented to the driver.

VI. Recommended Test Procedures.

VI.1 Determination of Downward Viewing Angle. The downward viewing angle of each display is determined in two ways, two dimensionally (the 2D Downward Viewing Angle; Subsection VI.1.a explains how to calculate) and three dimensionally (the 3D Downward Viewing Angle; Subsection VI.1.b discusses how to calculate). As discussed in Subsection V.3, the downward viewing angle of each display should be less than at least one of the following two angles:

- The 2D Maximum Downward Angle, or
- The 3D Maximum Downward Angle.

VI.1.a Determination of 2D Downward Viewing Angle. Create a fore-and-aft plane (Plane FA) through the nominal driver eye point as determined using the March 2010 revision of SAE Surface Vehicle Recommended Practice J941 "Motor Vehicle Drivers' Eye Locations." Project the position of the geometric center of a display for which this angle is being determined laterally (while maintaining the same fore-and aft and vertical coordinates) onto Plane FA. Generate two lines in Plane FA, Line 1 and Line 2. Line 1 is a horizontal line (i.e., maintaining the same vertical coordinate) going through the nominal driver eye point. Line 2 goes through the nominal driver eye point and the projected onto Plane FA geometric center of the display. The downward viewing angle is the angle from Line 1 to Line 2.

VI.1.b Determination of 3D Downward Viewing Angle. Generate two lines, Line 3 and Line 4. Line 3 is a horizontal line (i.e., maintaining the same vertical coordinate) going through the nominal driver eye point, as determined using the March 2010 revision of SAE Surface Vehicle Recommended Practice J941 "Motor Vehicle Drivers' Eye Locations," and a point vertically above or at the geometric center of the display for which the angle is being determined. Line 4 goes through the nominal driver eye point and the geometric center of the display. The downward viewing angle is the angle from Line 3 to Line 4.

VI.2 Driving Simulator Recommendations. A driving simulator is used for most of the proposed test options (*Options C, F, G, H,* and *J*, below) for determining whether driver operation of a device while performing a secondary task produces an unacceptable level of distraction. The driving simulator used for distraction testing should conform to the recommendations in the following subsections.

VI.2.a The driving simulator should be capable of testing using a substantial portion (the entire area that can be reached by a driver) of a full-size production vehicle cab. To set up this portion of a vehicle cab for testing, no modifications should be made to the dashboard or driver interface other than the addition of sensors to determine steering wheel angle, brake pedal position, and throttle pedal position, driver gaze location, headway (distance from the subject vehicle to a lead vehicle if one is present), lane position, and other desired data. The portion of the actual production vehicle cab being used for testing should be easily changeable.

VI.2.b The driving simulator should use information collected by the steering wheel angle, brake pedal position, and throttle pedal position sensors, along with an appropriate vehicle dynamics simulation, to predict vehicle orientation and position, angular and linear velocities, and angular and linear accelerations.

VI.2.c The driving simulator should record the following data channels at a minimum of 30 times per second: steering wheel angle, brake pedal position, throttle pedal position, vehicle orientation and position, lane position, headway, vehicle speed, and vehicle lateral and longitudinal accelerations. Each of the above listed channels should be either be calculated or measured with a sensor having an accuracy of ±2 percent of full scale or better. The simulator should also have a means of determining the exact time of the start and end of each secondary task that is performed.

VI.2.d For test paradigms that require the determination of eye glance location, the driving simulator should determine them in one of two ways: (1) through the use of an eye tracker or (2) by collecting full motion video of each test participant's face and, subsequent to testing, a human data reducer determines from this video the direction of a test participant's gaze at each instant in time.

VI.2.e The driving simulator should generate and display color (16 bit minimum color depth), computer generated imagery of the forward road scene. This imagery should be projected onto a large area screen in front of the vehicle. The portion of the projection screen on which computer generated imagery is displayed should have an area of at least 2083±25 mm wide by at least 1372±25 mm tall. The projection screen should be placed 4700±125 mm in front of the nominal driver eye point. The computer generated image should contain at least 880 by 500 pixels and should be updated at least 30 times per second. The time lag to calculate the computer generated imagery should not be more than 0.10 second.

VI.2.f For test paradigms that require the performance of a visual detection task, the driving simulator should be capable of displaying the target to be detected.

VI.2.f.i The target to be detected consists of a filled-in, red circle. The target should be sized such that it subtends a visual angle of 1.0±0.2 degrees. It may be displayed in any one of six positions. These positions are: vertically – all approximately at horizon height, and horizontally, with respect to the driver's head position – 9±1, 5±5, and 1±1 to the left of straight ahead, and 10±1, 14±5, and 17±1 degrees to the right of straight ahead.

VI.2.f.ii The target is displayed in one position at a time. The target is displayed in a particular, randomly-selected (via a pick from a uniform probability distribution) position for 1.5 seconds or until the participant responds. The target disappears if a test participant responds (via the micro-switch discussed in Subsection VI.2.g) while it is displayed or within 0.5 seconds after the target disappears. After the target disappears, it is not displayed for a period of time that varies randomly (via a pick from a uniform probability distribution) from 3.0 to 5.0 seconds.

VI.2.g For test paradigms that require the performance of a visual detection task, the driving simulator should be capable of recording both the time at which each target begins to be displayed and the time when a test participant's responds.

VI.2.g.i Test participant responses are recorded based on the wirelessly-transmitted output of a finger-mounted button micro-switch. The button micro-switch should be mounted, if feasible, on the index finger of a test participant's left hand in such a way that a test participant can easily momentarily depress the micro-switch button when he or she sees a target displayed.

VI.2.g.ii If it is not feasible to mount the button micro-switch on the index finger of a test participant's left hand, mount the button micro-switch in a convenient location such that it can be easily pressed while driving.

VI.2.g.iii If a test participant starts pressing the micro-switch button either while the target is displayed or within 0.5 seconds of the completion of a target display, it is counted as a correct response.

VI.2.g.iv For correct responses only, the Visual Detection Task Response Time is equal to the time from the beginning of the target display to the start of the micro-switch button press. This measure cannot be calculated for incorrect responses.

VI.2.h The driving simulator should display the vehicle's speed to a driver.

VI.2.j The driving simulator should be capable of simulating the driving scenarios described elsewhere in this document.

VI.3 Recommended Driving Simulator Scenario.

VI.3.a The road being simulated should:

VI.3.a.i Be undivided and four lanes wide,

VI.3.a.ii Have a solid double yellow line down the center,

VI.3.a.iii Have solid white lines on the outside edges,

VI.3.a.iv Have dashed white lines separating the two lanes that go in each direction,

VI.3.a.v Be flat (no grade or road crown), and

VI.3.a.vi Have a speed limit of 55 mph.

VI.3.a.vii All test data collection is performed on straight road segments. However, the road being simulated may, if desired, contain occasional curved segments not in the area used for data collection.

VI.3.b The driving scenario should proceed as follows:

VI.3.b.i The subject vehicle begins motionless in the right lane of the road.

VI.3.b.ii Test participant accelerates vehicle up to approximately the speed limit.

VI.3.b.iii After approximately 360 meters of travel, the lead vehicle, which is initially traveling at the speed limit, appears in the travel lane in front of the subject vehicle at the desired following distance.

VI.3.b.iv The subject vehicle then follows the lead vehicle for the remainder of the test. This is defined as the car following portion of the test.

VI.3.c All testing is performed while driving in the right lane of the simulated road

VI.3.d A test participant should begin performing secondary tasks as soon as feasible after the start of the car following portion of the test.

VI.3.e The speed of the lead vehicle, as a function of time, will be specified for each test. Each of the test options, below, that use a driving simulator (*Options EGDS, DS-BM, DS-FC, DFD-BM,* and *DFD-FC*) state the lead vehicle speed as a function of time.

VI.3.f Once the subject vehicle is following the lead vehicle, oncoming or adjacent lane traffic may begin to appear. The oncoming or adjacent lane traffic that is present is specified for each of the test options, below, that use a driving simulator (*Options EGDS, DS-BM, DS-FC, DFD-BM,* and *DFD-FC*).

VI.4 Test Participant Recommendations.

VI.4.a General Criteria*.* Each test participant should meet the following general criteria:

VI.4.a.i Be in good general health,

VI.4.a.ii Be an active driver with a valid driver's license,

VI.4.a.iii Drive a minimum of 7,000 miles per year,

VI.4.a.iv Be in the age range of 18 through 75 years of age, inclusive,

VI.4.a.v Have experience using a wireless phone while driving,

VI.4.a.vi Be comfortable communicating via text messages, and

VI.4.a.vii Be unfamiliar with the device(s) being tested.

VI.4.b Mix of Ages in Each Test Participant Sample*.* Out of each group of twenty-four test participants used for testing a particular in-vehicle device task, there should be:

VI.4.b.i Six test participants 18 through 24 years old, inclusive,

VI.4.b.ii Six test participants 25 through 39 years old, inclusive,

VI.4.b.iii Six test participants 40 through 54 years old, inclusive, and

VI.4.b.iv Six test participants 55 years old or older.

VI.4.c Even Mix of Genders in Each Test Participant Sample. Each sample of twenty-four test participants used for testing a particular in-vehicle device task, should contain:

VI.4.c.i Twelve men and twelve women overall, and

VI.4.c.ii An equal balance of men and women in each of the age ranges 18 through 24 years old, 25 through 39 years old, 40 through 54 years old, and 55 years old and older.

VI.4.d Test Participant Impartiality. Test participants should be impartial with regard to the testing. To ensure fairness, test participants should not have any direct interest, financial or otherwise, in whether or not any of the devices being tested meets or does not meet the acceptance criteria. (While auto manufacturers may have multiple categories of employees that are not involved in vehicle systems or component development, NHTSA believes that automaker employees will tend to be generally more knowledgeable about vehicles and their current features than the average member of the public. With this additional knowledge of vehicles and their latest features, the employees may perform better in testing due to this exposure to the automotive industry. Therefore, their use as test participants is discouraged.)

VI.5 Test Participant Device Training Recommendations. Each test participant should be given training as to how to operate the driving simulator (if one is being used) and how to perform each of the desired secondary tasks using the devices being evaluated.

VI.5.a Test instruction should be standardized and be presented either orally or in writing. The display and controls of the interface should be visible during instruction. An instruction may be repeated at the request of a test participant.

VI.5.b Each test participant should have the vehicle's controls and displays explained to them, and shown how to adjust the seat. Since the vehicle's mirrors are not used during this testing, there is no need to explain to test participants how to adjust them.

VI.5.c Each test participant should be given instructions on the driving scenario that they are to perform. These should include:

VI.5.c.i That he or she should drive in the right lane, and

VI.5.c.ii That, as a driver, their primary responsibility is to drive safely at all times.

VI.5.d Test participants should be told the speed at which they are to drive prior to the beginning of car following. Test participants should be told that, once in car following mode, they should follow the lead vehicle at as close to a constant following distance as they can manage.

VI.5.e Test participants should be given specific detailed instructions and practice as to how to perform each secondary task of interest on each device being studied before that particular driving trial.

VI.5.f Test participants should practice each secondary task of interest on each device being studied with the driving simulator with the vehicle parked. This practice may also be performed in a separate parked vehicle. A test participant should practice a task as many times as needed until they think that they have become comfortable in performing the task.

VI.6 Eye Glance Measurement. While driving the simulator and performing the secondary task, the length of each test participants eye glances away from the forward roadway should be recorded and determined.

VI.6.a Eye glance durations should be determined in one of two ways: (1) through the use of an eye tracker or (2) by collecting full motion video of each test participant's face and, subsequent to testing, a data reducer determines from this video the direction of a test participant's gaze at each instant in time.

VI.6.b The length of an individual glance is determined as the time associated with any eye glances away from the forward roadway. Due to the driving scenario, eye glances to the side of the roadway or to the vehicle's mirrors are expected to be minimal.

VI.6.c Ensuring eye tracker accuracy and repeatability. If an eye tracker is used, the testing organization should have a procedure for ensuring the accuracy and repeatability of eye glance locations. This will require collecting full motion video of a small sample of test participant's faces and having data reducer determine from this video the direction of a test participant's gaze at each instant in time. The testing organization should also have a written procedure for setting up and calibrating the eye tracker.

VI.6.d Ensuring Full Motion Video Reduction Accuracy and Repeatability. If full motion video is used, the testing organization should have a procedure for ensuring the accuracy and repeatability of eye glance locations. This will involve having multiple data reducers analyze the same, relatively short segment(s) of full motion video and checking that they obtained the same glance locations. The testing organization should also have a written procedure for instructing and training data reducers as to how to determine eye glance locations. To the extent possible, data reducers should not have an interest as to whether a secondary task/device being tested meets the acceptance criteria. Data reducers should not be closely involved with the development of a device.

VI.7 Task Performance Errors During Testing.

VI.7.a "Error-Free" Performance During Testing. During testing, only data from "error-free" test trials performed by test participants should be used for determining whether a task is suitable for performance while driving.

VI.7.b Unreasonably Difficult Tasks. A record should be kept during testing as to whether one or more errors occurred during each test trial. If errors occur during more than 50 percent of test trials while testing a sample of 24 test participants, then that task is deemed an "unreasonably difficult task" for performance by a driver while driving. Unreasonably difficult tasks are not recommended for performance while driving and should be locked out.

VI.8 Determination That a Task Should be Locked Out. Any task that draws a driver's attention from the primary driving task to the point where it does not comply with the Subsection VI.8 test procedures, should either be located and oriented so that it cannot be seen by a driver unless either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles). The following table summarizes the test procedures that are currently being considered to determine which tasks should be locked out.

TABLE 10 -- SUMMARY OF DISTRACTION TEST PROTOCOLS AND ACCEPTANCE CRITERIA CONSIDERED BY NHTSA

Option Letter	Test Name	Performance Measures	Acceptance Criteria	Testing Venue
EGDS	Eye Glance Testing Using a Driving Simulator	• Duration of individual eye glances away from forward road view • Sum of individual eye glance durations away from forward road view	• 85% of individual glance durations less than 2.0 seconds • Mean of individual glance durations less than 2.0 seconds • Sum of individual eye glance durations less than or equal to 12.0 seconds	Driving Simulator
OCC	Occlusion Testing	• Sum of shutter open times	• Sum of shutter open times less than 9.0 seconds	Occlusion
STEP	Step Counting	• Number of steps required for task	• Less than 6 steps required for task	Task Analysis
DS-BM	Driving Test Protocol with Benchmark	• Standard deviation of headway • Lane exceedances	• Performance measures not greater than benchmark values	Driving Simulator
DS-FC	Driving Test Protocol with Fixed Acceptance Criteria	• Same as *Option DS-BM*	• Performance measures not greater than specified values	Driving Simulator
DFD-BM	Dynamic Following and Detection Protocol with Benchmark	• Duration of individual eye glances away from forward road view • Sum of individual eye glance durations away from forward road view • Standard deviation of lane position • Car following delay • Percent of visual targets detected • Visual detection response time	• *Option EGDS* eye glance acceptance criteria ***plus*** • Performance measures less than benchmark values	Driving Simulator
DFD-FC	Dynamic Following and Detection Protocol with Fixed Acceptance Criteria	• Same as *Option DFD-FC*	• *Option EGDS* eye glance acceptance criteria ***plus*** • Performance measures less than specified values	Driving Simulator

Note: Manufacturers are free to use any testing protocol that they desire to ensure that their products adhere to the NHTSA Guidelines.

<u>Option EGDS: Eye Glance Testing Using a Driving Simulator.</u>

EGDS.1 Test Apparatus. Testing should be performed using a driving simulator that meets the recommendations contained in Subsection VI.2 using the driving scenario described in Subsection VI.3.

EGDS.2 Lead Vehicle Speed. For this testing, the lead vehicle should travel at a constant speed of 50 mph.

EGDS.3 Test Device. The device under investigation should be operational and fitted to a vehicle or simulator buck.

EGDS.4 Test Participants.

EGDS.4.a Twenty-four test participants should be enrolled using the procedures described in Subsection VI.4.

EGDS.4.b Test participants initially should be unfamiliar with the device being tested. As part of the test protocol, they should be trained in the use of the device(s) that are being tested using the procedures described in Subsection VI.5.

EGDS.5 Test Instructions. Test instruction should be standardized and be presented either in oral or written format. The display and controls of the interface should be visible during instruction. An instruction may be repeated at the request of a test participant.

EGDS.6 Number of Trials. Each test participant should drive the driving scenario two times, one time not performing any secondary task (the Familiarization Trial), and a second time performing the secondary task being studied (the Data Trial).

EGDS.7 Eye Glance Determination. Eye glances are determined for each test participant while performing each secondary task using the techniques described in Subsection VI.6.

EGDS.8 Acceptance Criteria. A task should not be allowed to be performed by drivers unless either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles), or (3) the following three criteria are all met:

EGDS.8.a For any of the test participants, no more than fifteen percent (rounded up) of the total number of eye glances away from the forward road scene should last for more than 2.0 seconds while performing the secondary task one time.

EGDS.8.b For at least twenty-one of the twenty-four test participants, the mean of all eye glances away from the forward road scene should be less than 2.0 seconds while performing the secondary task one time.

EGDS.8.c For at least twenty-one of the twenty-four test participants, the sum of the durations of each individual participant's eye glances away from the forward road scene should be less than, or equal to, 12.0 seconds while performing the secondary task one time.

EGDS.9 Multiple Trials. To improve testing efficiency, multiple Data Trials should be allowed to be made by the same subject. Only one Familiarization Trial needs to be performed, prior to any desired number of Data Trials. Also, multiple secondary tasks can be tested, one after another, during the same Data Trial.

Option OCC: Occlusion Testing

OCC.1 Test Apparatus. Intermittent viewing of a device interface can be provided by various means such as commercially-available occlusion goggles, a shutter in front of the interface, or some other means.

OCC.1.a Either the occlusion goggles, the shutter in front of the interface, or other means used should be transparent during the viewing interval and opaque during the occlusion interval.

OCC.1.b During the occlusion interval, neither the interface displays nor controls should be visible to a test participant.

OCC.1.c During the occlusion interval, operation of the device controls by a test participant should be permitted.

OCC.1.d The switching process between the viewing interval and the occlusion interval should occur in less than twenty (20) milliseconds and vice versa.

OCC.1.e Either the occlusion goggles, the shutter in front of the interface, or the other means of allowing/blocking a test participant's vision should be electronically controlled.

OCC.1.f The illumination levels during the viewing and occlusion intervals should be comparable so that dark/light adaptation of test participants' eyes is not necessary during the procedure.

OCC.2 Test Device. The device under investigation should be operational and fitted to a vehicle, simulator buck, or vehicle mock-up in a design which duplicates the intended location of the interface in the vehicle (i.e., the viewing angle and control placement relationships should be maintained).

OCC.3 Test Participants.

OCC.3.a Twenty-four test participants should be enrolled using the procedures described in Subsection VI.4.

OCC.3.b Test participants initially should be unfamiliar with the device being tested. As part of the test protocol, they should be trained in the use of the device(s) that are being tested using the procedures described in Subsection VI.5.

OCC.4 Test Instructions. Test instruction should be standardized and be presented either in oral or written format. The display and controls of the interface should be visible during instruction. An instruction may be repeated at the request of a test participant.

OCC.5 Test Procedure. Testing is performed in accordance with ISO International Standard 16673:2007, "Road Vehicles – Ergonomic Aspects of Transport Information and Control Systems – Occlusion Method to Assess Visual Demand due to the use of In-Vehicle Systems" with the exception that where the ISO Standard states that at least ten participants are to be tested, the current guidelines have fixed this number at twenty-four participants to be tested.

OCC.5.a The viewing interval (shutter open time) should be 1.5 seconds. This should be followed by a 1.5-second occlusion interval (shutter closed time). The sequence of viewing interval followed by occlusion interval should occur automatically without interruption until the task is completed or the trial is terminated.

OCC.5.b The initial condition for testing is occlusion in which a test participant cannot see the device interface.

OCC.5.c Task stimuli (e.g., addresses, phone numbers, etc.) are provided to a test participant prior to the start of testing. When the task stimuli are given to a test participant, the device should be occluded (i.e., a test participant cannot see the device interface) and it should remain occluded until after testing has begun.

OCC.5.d Testing starts when a test participant tells the experimenter that he or she is ready to begin. The experimenter then triggers the alternating sequence of viewing intervals followed by occlusion intervals. A test participant starts performing the task at the beginning of the first viewing interval.

OCC.5.e When a test participant has completed the task, he or she tells the experimenter that the task has been completed. The experimenter stops the shutter operation.

OCC.5.f There should be an automatic means of recording the number of shutter open intervals required to complete the task.

OCC.6 Acceptance Criterion. A task should not be allowed to be performed by drivers unless either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles), or (3) the following criterion is met:

OCC.6.a For at least twenty-one of the twenty-four test participants, the task was successfully completed during six or fewer viewing intervals (i.e., a maximum of 9.0 seconds of shutter open time).

OCC.7 Multiple Trials. To improve testing efficiency, multiple Data Trials should be allowed to be made by the same subject. Only one Familiarization Trial needs to be performed, prior to any desired number of Data Trials. Also, multiple secondary tasks can be tested, one after another, during the same Data Trial.

Option STEP: Step Counting

STEP.1 Task analysis. A task analysis is performed to decompose the secondary task being performed into an ordered sequence of its elemental components that a driver would perform in order to successfully complete a task. The elemental components of a task would include such driver actions as:

- Pressing a single button,
- Glancing at a device display,
- Choosing an entry from a list,
- Picking up an object, or
- Putting down an object.

STEP.2 Step Assignment. Each elemental component that constitutes a secondary task is assigned a number of steps as follows:

STEP.2.a Each time that a driver presses a single button, one step is assigned except that if a driver is pressing the same button multiple times in rapid succession (e.g., pressing the "3" button on a telephone three times to indicate an "f"), all of the multiple button presses are assigned one step.

STEP.2.b Each time that a driver looks at the device display, one step is assigned.

STEP.2.c Each time that a driver chooses from an entry in a list, a variable number of steps are assigned. The number of steps assigned depends upon the length of the list as follows:

STEP.2.c.i If there are one through five entries in the list, then five steps are assigned.

STEP.2.c.ii If there are six through nine entries in the list, then seven steps are assigned.

STEP.2.c.iii If there are ten or more entries in the list, then nine steps are assigned.

STEP.2.d Each time a driver picks up an object, three steps are assigned.

STEP.2.e Each time a driver puts down an object, one step is assigned.

STEP.3 Add Steps Together. All of the steps that have been assigned from all of the elemental components that constitute a secondary task are added together. The resulting number is the number of steps to perform that secondary task.

STEP.4 Acceptance Criterion. A task should not be allowed to be performed by drivers unless either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles), or (3) the following criterion is met:

STEP.4.a The number of steps to successfully complete the task is six or less.

<u>Option DS-BM: Driving Test Protocol with Benchmark</u>

DS-BM.1 Test Apparatus. Testing should be performed using a driving simulator that meets the recommendations contained in Subsection VI.2 using the driving scenario described in Subsection VI.3.

DS-BM.2 Lead Vehicle Speed. For this testing, the lead vehicle should travel at a constant speed of 50 mph.

DS-BM.3 Test Device. The device under investigation should be operational and fitted to a vehicle or simulator buck.

DS-BM.4 Test Participants.

DS-BM.4.a Twenty-four test participants should be enrolled using the procedures described in Subsection VI.4.

DS-BM.4.b Test participants initially should be unfamiliar with the device being tested. As part of the test protocol, they should be trained in the use of the device(s) that are being tested using the procedures described in Subsection VI.5.

DS-BM.5 Test Instructions. Test instruction should be standardized and be presented either in oral or written format. The display and controls of the interface should be visible during instruction. An instruction may be repeated at the request of a test participant.

DS-BM.6 Number of Trials. Each test participant should drive the driving scenario six (6) times, one time not performing any secondary task (the Familiarization Trial), and five more times performing the secondary task being studied (the Data Trials).

DS-BM.7 Reference Task. During each Data Trial, in addition to the secondary tasks that are being evaluated, a test participant should perform one additional secondary task, Manual Radio Tuning. This Manual Radio Tuning task serves as a reference task that is used to determine whether the acceptance criteria listed in Subsection DS-BM.9, below, are met.

DS-BM.7.a The Manual Radio Tuning task should be performed as follows:

DS-BM.7.a.i Prior to the commencement of the Manual Radio Tuning task, a test participant is told the frequency of the station to which the radio is to be tuned.

DS-BM.7.a.ii Initially the radio is "On." If the radio controls are part of an integrated vehicle display, the integrated display should be set so that the radio controls are not active.

DS-BM.7.a.iii If the radio controls are part of an integrated vehicle display, a test participant performs the action(s) necessary to make the radio controls active.

DS-BM.7.a.iv A test participant changes the radio band selection from AM to FM (or vice versa). The station that the radio is tuned to immediately after this band selection is made should be referred to as the Initial Station.

DS-BM.7.a.v A test participant uses the radio tuning control to tune the radio to the desired, new, station (referred to as the Final Station) that is approximately one-third of the AM or FM (as appropriate) band away from the Initial Station.

DS-BM.7.a.vi The Manual Radio Tuning has been completed when the radio has been successfully tuned to the Final Station.

DS-BM.8 Metric Computation. Metric values should be determined based on data recorded by the driving simulator from the start of a secondary task to the end of a secondary task.

DS-BM.8.a Based on the recorded lane position data, determine how many lane exceedances occurred during each secondary task. A lane exceedance occurs whenever either:

DS-BM.8.a.i The right front or right rear tire of the vehicle is totally to the right of the right lane edge line, or

DS-BM.8.a.ii The left front or left rear tire of the vehicle is totally to the left of the left lane edge line.

DS-BM.8.a.iii No distinction is made between right and left side lane exceedances. Similarly, no distinction is made as to whether only the front tire, only the rear tire, or both tires have crossed the lane edge line.

DS-BM.8.b Based on the recorded data for headway (distance from the subject vehicle to a lead vehicle), the time headway (headway divided by the nominal travel speed of 50 mph) is calculated as a function of time. The standard deviation of time headway during the secondary task is calculated.

DS-BM.9 Acceptance Criteria. A task should not be allowed to be performed by drivers unless either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles), or (3) both of the following criteria are met:

DS-BM.9.a The number of lane exceedances occurring while the secondary task is being performed is not statistically significantly greater, at the 95 percent confidence level, than the number of lane exceedances occurring while the manual radio tuning task is being performed.

DS-BM.9.b The standard deviation of headway while the secondary task is being performed is not statistically significantly greater, at the 95 percent confidence level, than the standard deviation of headway while the manual radio tuning is being performed.

DS-BM.9.c Data from all five Data Trials is used when making the statistical significance calculations required by DS-BM.9.a and DS-BM.9.b.

Option DS-FC: Driving Test Protocol with Fixed Acceptance Criteria

DS-FC.1 Test Apparatus. Testing should be performed using a driving simulator that meets the recommendations contained in Subsection VI.2 using the driving scenario described in Subsection VI.3.

DS-FC.2 Lead Vehicle Speed. For this testing, the lead vehicle should travel at a constant speed of 50 mph.

DS-FC.3 Test Device. The device under investigation should be operational and fitted to a vehicle or simulator buck.

DS-FC.4 Test Participants.

DS-FC.4.a Twenty-four test participants should be enrolled using the procedures described in Subsection VI.4.

DS-FC.4.b Test participants initially should be unfamiliar with the device being tested. As part of the test protocol, they should be trained in the use of the device(s) that are being tested using the procedures described in Subsection VI.5.

DS-FC.5 Test Instructions. Test instruction should be standardized and be presented either in oral or written format. The display and controls of the interface should be visible during instruction. An instruction may be repeated at the request of a test participant.

DS-FC.6 Number of Trials. Each test participant should drive the driving scenario six (6) times, one time not performing any secondary task (the Familiarization Trial), and five more times performing the secondary task being studied (the Data Trials).

DS-FC.7 Metric Computation. Metric values should be determined based on data recorded by the driving simulator from the start of a secondary task to the end of a secondary task.

DS-FC.7.a Based on the recorded lane position data, determine how many lane exceedances occurred during each secondary task. A lane exceedance occurs whenever either:

DS-FC.7.a.i The right front or right rear tire of the vehicle is totally to the right of the right lane edge line, or

DS-FC.7.a.ii The left front or left rear tire of the vehicle is totally to the left of the left lane edge line.

DS-FC.7.a.iii No distinction is made between right and left side lane exceedances. Similarly, no distinction is made as to whether only the front tire, only the rear tire, or both tires have crossed the lane edge line.

DS-FC.7.b Based on the recorded data for headway (distance from the subject vehicle to a lead vehicle), the time headway (headway divided by the nominal travel speed of 50 mph) is calculated as a function of time. The standard deviation of time headway during the secondary task is calculated.

DS-FC.8 Acceptance Criteria. A task should not be allowed to be performed by drivers unless either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles), or (3) both of the following criteria are met:

DS-FC.8.a The number of lane exceedances occurring while the secondary task is being performed is not statistically significantly greater, at the 95 percent confidence level, than 0.06 lane exceedances per secondary task performed.

DS-FC.8.b The standard deviation of headway while the secondary task is being performed is not statistically significantly greater, at the 95 percent confidence level, than 0.35 seconds while a secondary task is being performed.

DS-FC.8.c Data from all five Data Trials is used when making the statistical significance calculations required by DS-FC.8.a and DS-FC.8.b.

Option DFD-BM: Dynamic Following and Detection Protocol with Benchmark

DFD-BM.1 Test Apparatus. Testing should be performed using a driving simulator that meets the recommendations contained in Subsection VI.2 using the driving scenario described in Subsection VI.3.

DFD-BM.1.a For this testing, the vehicle being tested should contain a route navigation system. If the vehicle does not have an integrated route navigation system, a portable one may be used.

DFD-BM.2 Lead Vehicle Speed. For this testing, the lead vehicle should travel at a continually varying speed that is determined by linear interpolation from a table of lead vehicle speed values versus time. Multiple lead vehicle speed tables are used, with a different one being used each time a test participant drives the simulator. Electronic copies of these tables, in the form of Microsoft Excel files, can be obtained from NHTSA.

DFD-BM.3 Test Device. The device under investigation should be operational and fitted to a vehicle or simulator buck.

DFD-BM.4 Test Participants.

DFD-BM.4.a Twenty-four test participants should be enrolled using the procedures described in Subsection VI.4.

DFD-BM.4.b Test participants initially should be unfamiliar with the device being tested. As part of the test protocol, they should be trained in the use of the device(s) that are being tested using the procedures described in Subsection VI.5.

DFD-BM.5 Test Instructions. Test instruction should be standardized and be presented either in oral or written format. The display and controls of the interface should be visible during instruction. An instruction may be repeated at the request of a test participant.

DFD-BM.6 Number of Trials. Each test participant should drive the driving scenario two times, one time not performing any secondary task (the Familiarization Trial), and a second time performing the secondary task being studied (the Data Trial).

DFD-BM.7 Eye Glance Determination. Eye glances are determined for each test participant while performing each secondary task using the techniques described in Subsection VI.6.

DFD-BM.8 Reference Task. During each Data Trial, in addition to the secondary tasks that are being evaluated, a test participant should perform one additional secondary task, route navigation system destination entry. This Destination Entry task serves as a reference task that is used to determine whether the acceptance criteria listed in Subsection DFD-BM.12, below, are met.

DFD-BM.8.a The Destination Entry task should be performed as follows:

DFD-BM.8.a.i Initially the route navigation system is "On." If the route navigation system controls are part of an integrated vehicle display, the integrated display should be set so that the route navigation system controls are active.

DFD-BM.8.a.ii A test participant enters a complete address (house number, street name, city name, and state abbreviation) into the route navigation system. Choosing from an entry in a list of either previously entered destinations or landmarks is not acceptable.

DFD-BM.8.a.iii The Destination Entry task has been completed when the final button on the route navigation system is pressed to have the system find the route to the address.

DFD-BM.8.b Addresses chosen for testing should have a three or four digit house number, and a nine through twelve character street name (see details in DFD-BM.8.c), have a seven through ten character city name (see details in DFD-BM.8.d), and have a two character state abbreviation.

DFD-BM.8.c The nine through twelve character street name should always be two words with a space between them. The first word will be the actual name, while the second word will be an abbreviation for the type of street (Blvd, Ct, Rd, St, etc.). When determining the number of characters in the street name, all characters of both the actual name and the abbreviation as well as one character for the space in between are counted.

DFD-BM.8.c.i The route navigation system may use an auto-complete feature after a portion of the street name has been entered. Having a test participant choose from a list generated by an auto-complete feature is acceptable.

DFD-BM.8.d The seven through ten character city name should always be one word.

DFD-BM.8.d.i The route navigation system may use an auto-complete feature after a portion of the city name has been entered. Having a test participant choose from a list generated by an auto-complete feature is acceptable. The auto-complete feature may make it unnecessary for a test participant to enter the two character state abbreviation.

DFD-BM.8.e The route navigation system may have a test participant enter a five-digit ZIP code instead of the city name and state abbreviation.

DFD-BM.9 Continuous Task Performance. Each secondary task is continuously performed for 3 minutes during the car following portion of the test (see Subsection VI.3.b.iv).

DFD-BM.10 Visual Detection Task. During the car following portion of the test, simultaneously with performing each secondary task, a test participant also continuously performs the visual detection task that is described below.

DFD-BM.10.a As explained in Subsections VI.2.f and VI.2.g, for the visual detection task, the driving simulator should display a series of targets to be detected. Each target consists of a filled-in, solid, red circle that is displayed in any one of six positions. Target dimensions and positions are described in VI.2.f. When a test participant sees a target appear, he or she should respond as quickly as possible by pressing the micro-switch typically attached to their left index finger.

DFD-BM.10.b Outputs from the visual detection task consist of:

DFD-BM.10.b.i The number of visual targets displayed during the car following portion of the test.

DFD-BM.10.b.ii The number of correctly identified visual targets during the car following portion of the test (see Subsection VI.2.g.iii for details on how to determine).

DFD-BM.10.b.iii The Visual Detection Task Response Time, defined as the time when the test participant pressed the micro-switch minus the time when each visual target begins to display on the projection screen, is calculated for each time that a test participant's response was correct(see Subsection VI.2.g.iv for details on how to determine).

DFD-BM.11 Metric Computation. Glance-by-glance Eyes-Off-Road Times, Standard Deviation of Lane Position, Car Following Delay, Percent Correctly Detected, and Visual Detection Task Response Time metrics should be determined based on data recorded by the driving simulator from the start of the 3 minutes of secondary task performance to the end of the 3 minutes (the Data Interval). The following measures of test participant performance are determined for each Data Interval:

DFD-BM.11.a Glance-by-glance Eyes-Off-Road Times. The lengths of eye glances away from the forward road scene are determined for each test participant for each Data Interval using the techniques described in Subsection VI.6.

DFD-BM.11.b Standard Deviation of Lane Position. Based on the recorded data for lane position, the Standard Deviation of Lane Position during the Data Interval is determined.

DFD-BM.11.c Car Following Delay. The Car Following Delay for each Data Interval is calculated as follows:

DFD-BM.11.c.i The mean value of the subject vehicle speed, s_{SV}, over the Data Interval is calculated and subtracted from each value of s_{SV} during the Data Interval. This generates the zero-mean, adjusted, subject vehicle speed channel, $\bar{s}_{SV}$.

DFD-BM.11.c.ii The mean value of the lead vehicle speed, s_{LV}, over the Data Interval is calculated and subtracted from each value of s_{LV} during the Data Interval. This generates the zero-mean, adjusted, lead vehicle speed channel, $\bar{s}_{LV}$.

DFD-BM.11.c.iii The cross correlation is calculated between the zero-mean, adjusted, subject vehicle speed channel, $\bar{s}_{SV}$, and the zero-mean lead vehicle speed channel, $\bar{s}_{LV}$. Mathematically, this is done using the equation:

$$F(\varphi) = \sum_{j=0}^{n} \bar{s}_{SV}(j)\bar{s}_{LV}(j + \varphi)$$

where:

$F(\varphi)$ is the cross correlation as a function of the delay in samples,

φ is the delay in samples,

j is the sample index, and

n is the number of samples.

DFD-BM.11.c.iv The delay in samples, φ, should be negative (i.e., the subject vehicle response should lag the lead vehicle response). Furthermore, φ multiplied by the time interval between data points should not be less than -15.0 seconds.

DFD-BM.11.c.v Practically, this calculation is made using the Matlab function “xcorr.”

DFD-BM.11.c.v1 The value of φ at which $F(\varphi)$ has its largest magnitude multiplied by the time interval between data points is used to calculate the Car Following Delay.

DFD-BM.11.d Percent Correctly Detected. For each Data Interval, the Percent Correctly Detected is equal to the percentage obtained by dividing the number of a test participant’s correct responses by the total number of targets displayed during a trial.

DFD-BM.11.e Visual Detection Task Response Time. As explained in Subsection VI.2.g.iii, the Visual Detection Task Response Time is calculated for each target that is displayed during a Data Interval for which a test participant gave a correct response.

DFD-BM.12 Acceptance Criteria. A task should not be allowed to be performed by drivers unless either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles), or (3) both of the recommendations DFD-BM.12.a and DFD-BM.12.b are met:

DFD-BM.12.a A secondary task meets the recommendations of DFD-BM.12.a if it satisfies all three of the following criteria:

DFD-BM.12.a.i For at least 21 of the 24 test participants, no more than 15 percent (rounded up) of the total number of eye glances away from the forward road scene should have durations of greater than 2.0 seconds while performing the secondary task.

DFD-BM.12.a.ii For at least 21 of the 24 test participants, the mean of all eye glances away from the forward road scene should be less than 2.0 seconds while performing the secondary task.

DFD-BM.12.a.iii For at least 21 of the 24 test participants, the sum of the durations of each individual participant's eye glances away from the forward road scene should be less than, or equal to, 12.0 seconds while performing the secondary task one time.

DFD-BM.12.b A secondary task meets the recommendations of DFD-BM.12.b if it satisfies at least three of the following four criteria:

DFD-BM.12.b.i The Standard Deviation of Lane Position during the Data Intervals is statistically significantly less, at the 95 percent confidence level, than the Standard Deviation of Lane Position during the Data Intervals for the Destination Entry task.

DFD-BM.12.b.ii The Car Following Delay during the Data Intervals is statistically significantly less, at the 95 percent confidence level, than the Car Following Delay during the Data Intervals for the Destination Entry task.

DFD-BM.12.b.iii The Percent Correctly Detected during the Data Intervals is statistically significantly greater, at the 95 percent confidence level, than the Percent Correctly Detected during the Data Intervals for the Destination Entry task.

DFD-BM.12.b.iv The Visual Detection Task Response Time during the Data Intervals is statistically significantly less, at the 95 percent confidence level, than the Visual Detection Task Response Time during the Data Intervals for the Destination Entry task.

DFD-BM.13 Testing Procedure Items.

DFD-BM.13.a To prevent familiarity with the lead vehicle's speed profile from becoming an issue, a different speed profile should be used for each test participant drive on the driving simulator.

DFD-BM.13.b It is acceptable for each test participant to perform multiple secondary tasks in a single test participation session. However, a test participant should not be tested performing more than six secondary tasks in a single session.

DFD-BM.13.c Each test participant should only be tested for one 3-minute interval while performing the same secondary task.

DFD-BM.14 Multiple Trials. To improve testing efficiency, multiple Data Trials should be allowed to be made by the same subject. Only one Familiarization Trial needs to be performed, prior to any desired number of Data Trials. Also, multiple secondary tasks can be tested, one after another, during the same Data Trial.

Option DFD-FC: Dynamic Following and Detection Protocol with Fixed Acceptance Criteria

DFD-FC.1 Test Apparatus. Testing should be performed using a driving simulator that meets the recommendations contained in Subsection VI.2 using the driving scenario described in Subsection VI.3.

DFD-FC.1.a For this testing, the vehicle being tested should contain a route navigation system. If the vehicle does not have an integrated route navigation system, a portable one may be used.

DFD-FC.2 Lead Vehicle Speed. For this testing, the lead vehicle should travel at a continually varying speed that is determined by linear interpolation from a table of lead vehicle speed values versus time. Multiple lead vehicle speed tables are used, with a different one being used each time a test participant drives the simulator. Electronic copies of these tables, in the form of Microsoft Excel files, can be obtained from NHTSA.

DFD-FC.3 Test Device. The device under investigation should be operational and fitted to a vehicle or simulator buck.

DFD-FC.4 Test Participants.

DFD-FC.4.a Twenty-four test participants should be enrolled using the procedures described in Subsection VI.4.

DFD-FC.4.b Test participants initially should be unfamiliar with the device being tested. As part of the test protocol, they should be trained in the use of the device(s) that are being tested using the procedures described in Subsection VI.5.

DFD-FC.5 Test Instructions. Test instruction should be standardized and be presented either in oral or written format. The display and controls of the interface should be visible during instruction. An instruction may be repeated at the request of a test participant.

DFD-FC.6 Number of Trials. Each test participant should drive the driving scenario two times, one time not performing any secondary task (the Familiarization Trial), and a second time performing the secondary task being studied (the Data Trial).

DFD-FC.7 Eye Glance Determination. Eye glances are determined for each test participant while performing each secondary task using the techniques described in Subsection VI.6.

DFD-FC.8 Continuous Task Performance. Each secondary task is continuously performed for 3 minutes during the car following portion of the test (see Subsection VI.3.b.iv).

DFD-FC.9 Visual Detection Task. During the car following portion of the test, simultaneously with performing each secondary task, a test participant also continuously performs the visual detection task that is described below.

DFD-FC.9.a As explained in Subsections VI.2.f and VI.2.g, for the visual detection task, the driving simulator should display a series of targets to be detected. Each target consists of a filled-in, solid, red circle that is displayed in any one of six positions. Target dimensions and positions are described in VI.2.f. When a test participant sees a target appear, he or she should respond as quickly as possible by pressing the micro-switch typically attached to their left index finger.

DFD-FC.9.b Outputs from the visual detection task consist of:

DFD-FC.9.b.i The number of visual targets displayed during the car following portion of the test.

DFD-FC.9.b.ii The number of correctly identified visual targets during the car following portion of the test (see Subsection VI.2.g.iii for details on how to determine).

DFD-FC.9.b.iii The Visual Detection Task Response Time, defined as the time when the test participant pressed the micro-switch minus the time when each target begins to display on the projection screen, is calculated for each time that a test participant's response was correct(see Subsection VI.2.g.iv for details on how to determine).

DFD-FC.10 Metric Computation. Glance-by-glance Eyes-Off-Road Times, Standard Deviation of Lane Position, Car Following Delay, Percent Correctly Detected, and Visual Detection Task Response Time metrics should be determined based on data recorded by the driving simulator from the start of the 3 minutes of secondary task performance to the end of the 3 minutes (the Data Interval). The following measures of test participant performance are determined for each Data Interval:

DFD-FC.10.a Glance-by-glance Eyes-Off-Road Times. The lengths of eye glances away from the forward road scene are determined for each test participant for each Data Interval using the techniques described in Subsection VI.6.

DFD-FC.10.b Standard Deviation of Lane Position. Based on the recorded data for lane position, the Standard Deviation of Lane Position during the Data Interval is determined.

DFD-FC.10.c Car Following Delay. The Car Following Delay for each Data Interval is calculated as follows:

DFD-FC.10.c.i The mean value of the subject vehicle speed, s_{SV}, over the Data Interval is calculated and subtracted from each value of s_{SV} during the Data Interval. This generates the zero-mean, adjusted, subject vehicle speed channel, $\bar{s}_{SV}$.

DFD-FC.10.c.ii The mean value of the lead vehicle speed, s_{LV}, over the Data Interval is calculated and subtracted from each value of s_{LV} during the Data Interval. This generates the zero-mean, adjusted, lead vehicle speed channel, $\tilde{s}_{LV}$.

DFD-FC.10.c.iii The cross correlation is calculated between the zero-mean, adjusted, subject vehicle speed channel, $\tilde{s}_{SV}$, and the zero-mean lead vehicle speed channel, $\tilde{s}_{LV}$. Mathematically, this is done using the equation:

$$F(\varphi) = \sum_{j=0}^{n} \tilde{s}_{SV}(j)\,\tilde{s}_{LV}(j+\varphi)$$

where:

$F(\varphi)$ is the cross correlation as a function of the delay in samples,

φ is the delay in samples,

j is the sample index, and

n is the number of samples.

DFD-FC.10.c.iv The delay in samples, φ, should be negative (i.e., the subject vehicle response should lag the lead vehicle response). Furthermore, φ multiplied by the time interval between data points should not be less than -15.0 seconds.

DFD-FC.10.c.v Practically, this calculation is made using the Matlab function “xcorr.”

DFD-FC.10.c.v1 The value of φ at which $F(\varphi)$ has its largest magnitude multiplied by the time interval between data points is used to calculate the Car Following Delay.

DFD-FC.10.d Percent Correctly Detected. For each Data Interval, the Percent Correctly Detected is equal to the percentage obtained by dividing the number of a test participant’s correct responses by the total number of targets displayed on the screen during the trial.DFD-FC.10.e

Visual Detection Task Response Time. As explained in Subsection VI.2.g.iii, the Visual Detection Task Response Time is calculated for each target that is displayed during a Data Interval for which a test participant gave a correct response.

DFD-FC.11 Acceptance Criteria. A task should not be allowed to be performed by drivers unless either (1) the vehicle's engine is not running, or (2) the vehicle's transmission is in "Park" (automatic transmission vehicles) or the vehicle's transmission is in "Neutral" and the parking brake is on (manual transmission vehicles), or (3) both of the recommendations DFD-FC.11.a and DFD-FC.11.b are met:

DFD-FC.11.a A secondary task meets the recommendations of DFD-FC.11.a if it satisfies all three of the following criteria:

DFD-FC.11.a.i For at least 21 of the 24 test participants, no more than 15 percent (rounded up) of the total number of eye glances away from the forward road scene should have durations of greater than 2.0 seconds while performing the secondary task.

DFD-FC.11.a.ii For at least 21 of the 24 test participants, the mean of all eye glances away from the forward road scene should be less than 2.0 seconds while performing the secondary task.

DFD-FC.11.a.iii For at least 21 of the 24 test participants, the sum of the durations of each individual participant's eye glances away from the forward road scene should be less than, or equal to, 12.0 seconds while performing the secondary task one time.

DFD-FC.11.b A secondary task meets the recommendations of DFD-FC.11.b if it satisfies at least three of the following four criteria:

DFD-FC.11.b.i The Standard Deviation of Lane Position during the Data Intervals is not statistically significantly greater, at the 95 percent confidence level, than 1.0 feet.

DFD-FC.11.b.ii The mean Car Following Delay during the Data Intervals is not statistically significantly greater, at the 95 percent confidence level, than 4.6 seconds.

DFD-FC.11.b.iii The mean Percent Detected during the Data Intervals is statistically significantly greater, at the 95 percent confidence level, than 80 percent.

J11.b.iv The mean Visual Detection Task Response Time during the Data Intervals is not statistically significantly greater, at the 95 percent confidence level, than 1.0 second.

DFD-FC.12 Testing Procedure Items.

DFD-FC.12.a To prevent familiarity with the lead vehicle's speed profile from becoming an issue, a different speed profile should be used for each test participant drive on the driving simulator.

DFD-FC.12.b It is acceptable for each test participant to perform multiple secondary tasks in a single test participation session. However, a test participant should not be tested performing more than six secondary tasks in a single session.

DFD-FC.12.c Each test participant should only be tested for one 3-minute interval while performing the same secondary task.

DFD-FC.13 Multiple Trials. To improve testing efficiency, multiple Data Trials should be allowed to be made by the same subject. Only one Familiarization Trial needs to be performed, prior to any desired number of Data Trials. Also, multiple secondary tasks can be tested, one after another, during the same Data Trial.

VII. Recommendations for Passenger Operated Devices. These guidelines primarily are appropriate for driver interfaces of devices intended for use by a driver. They are appropriate to a limited extent for devices intended for use by front seat passengers.

VII.1 Apply if Within Reach or View of Driver. These guidelines are appropriate for devices that can reasonably be reached and seen by a driver even if they are intended for use solely by front seat passengers.

VII.2 Not for Rear Seat Devices. These guidelines are not appropriate for devices that are located solely behind the front seat of the vehicle.

VIII. Recommendations for Aftermarket and Portable Devices.

VIII.1 Aftermarket and Portable Device Guidelines in Future. NHTSA intends, in the future, to extend its NHTSA Guidelines to cover aftermarket and portable devices. At that time, NHTSA may revise the metrics contained in the current guidelines or introduce new metrics.

VIII.2 Unreasonable Risks with Aftermarket and Portable Devices. NHTSA reminds manufacturers that they are responsible for ensuring that aftermarket and portable devices they produce which may reasonably be expected to be used by vehicle drivers do not create unreasonable risks to the driving public.

IX. Recommendations for Voice Interfaces.

IX.1 Auditory-Vocal Interface Guidelines (Future). NHTSA intends, in the future, to extend its NHTSA Guidelines to cover the auditory-vocal aspects of device interfaces. For now, only devices with tasks performed through visual-manual interfaces and/or a combination of visual-manual and auditory-vocal means are covered by the recommendations that are contained in these guidelines.

IX.2 Unreasonable Risks with Auditory-Vocal Interfaces. NHTSA reminds manufacturers that they are responsible for ensuring that devices they produce which have auditory-vocal portions of their interfaces do not create unreasonable risks to the driving public.

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David L. Strickland
Administrator

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