



U.S. Department of Transportation  
National Highway Traffic Safety  
Administration



# NHTSA Drowsy Driving Research and Program Plan



*Safer drivers. Safer cars. Safer roads.*

This Drowsy Driving Research and Program Plan was developed to guide the efforts of the National Highway Traffic Safety Administration (NHTSA) over the next several years. This is the first time that NHTSA has developed an initiative directed at curtailing drowsy driving. The plan includes Background and Overview sections and it addresses six broad focus areas: Measurement and Problem Identification, Public Awareness and Education, Policy Development, High-Risk Populations, Vehicle Technology, and Infrastructure. A total of 10 projects are included under these focus areas. Each project will be underway by late 2016. Some have short-term outcomes, whereas others will be long-term. This plan is an initial effort by NHTSA to enhance the science and program initiatives around drowsy driving.

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## Introduction

Sleepiness is an inescapable biological phenomenon that has drastic effects on the mind and body. Whether sleepiness is caused by sleep restriction due to a baby crying all night, a late shift at work, a teenager staying up all night with friends, health issues such as sleep apnea and medications, or our natural circadian rhythm – the negative outcomes can be the same. Most importantly, the longer someone remains awake, the more probable the negative outcomes become. Sleepiness, without fail, results in cognitive and behavioral changes that can contribute to diverse negative outcomes including automobile crashes, poor school performance, accidents at work, and other long-term physical and mental health consequences. NHTSA is concerned with this issue and is working with a number of other Federal agencies, including other U.S. Department of Transportation agencies, as well as the Centers for Disease Control and Prevention (CDC) and the National Institutes for Health (NIH), toward eliminating drowsy driving. Recently the National Transportation Safety Board (NTSB) declared that reducing fatigue-related accidents was one of its most wanted transportation safety improvements for 2016.<sup>1</sup>

This document outlines a comprehensive program for NHTSA to reduce the problem of drowsy driving. The program uses a number of approaches and techniques that are familiar to NHTSA and therefore somewhat predictable in feasibility and effectiveness.

The underlying premise of this initiative is that drowsy driving is a controllable behavior that drivers will modify if given sufficient information and motivation. The primary source of behavior-change motivation would be similar to that used in other successful programs such as *Click It or Ticket* and *Drive Sober or Get Pulled Over* – the use of evidence-based public policy to change individual perception of community expectations. Since drowsiness is inherently more challenging to observe and enforce than other risky behaviors, more emphasis will be placed on strategies such as education and policy development, along with environmental countermeasures including vehicle warning systems and roadway rumble strips.

The proposed program includes a number of tangible milestones over the coming years and is also intended to establish a strong evidence-based foundation on which an ongoing drowsy driving program would be built. The initiative is designed to mobilize traditional NHTSA partners and constituents – State Highway Safety Offices, policymakers, law enforcement officials, vehicle researchers and Federal Highway Administration partners – and is based on the assumption that few drowsy- or fatigued-driving programs are now in operation.

## Overview of the Problem

Drowsy driving is not just falling asleep at the wheel – it is a profound impairment that mimics alcohol-impaired driving in many ways. Drowsiness leads to slower reaction times, and impaired attention, mental processing, judgment, and decision making.<sup>2</sup> Drowsiness can occur from accumulating sleep debt (typically <6 hours a night) across multiple nights, or from only one night of not sleeping.

Drowsy driving crashes can happen any time, but most consistently occur late at night, in the early pre-dawn hours, or in the mid-afternoon.<sup>3</sup> Furthermore, age also plays a significant factor. Research conducted in 2012 by the AAA Foundation for Traffic Safety shows that crash-involved drivers ages 16-24 were nearly twice as likely to be drowsy at the time of their crash in comparison to drivers ages 40-59. Drivers age 24 and younger were most likely to report having fallen asleep at the wheel in the past year, and they were least likely to report having never fallen asleep at the wheel. This is consistent with other studies that have found younger drivers to have a higher risk of falling asleep at the wheel.<sup>4</sup>

Precise counts of crashes caused by drowsy driving are not yet possible. Crash investigators can look for certain clues that drowsiness was likely to have contributed to a driver error, but these clues are not always identifiable or conclusive. In lieu of consistent and conclusive evidence, researchers have used various methods to estimate the overall number of crashes or crash fatalities caused by driver drowsiness. These methods range from counts of crash reports where police-reports indicate drowsiness as a contributing factor, to statistical estimates based on crash reports and surveys of self-report crashes or driving experience.

<sup>1</sup> 2016 Most Wanted List: Reduce Fatigue-Related Accidents. Washington, DC: National Transportation Safety Board. Retrieved from [www.nts.gov/safety/mwl/Pages/mwl1-2016.aspx](http://www.nts.gov/safety/mwl/Pages/mwl1-2016.aspx).

<sup>2</sup> Goel, N., Rao, H., Durmer, J. S., & Dinges, D. F. (2009). Neurocognitive consequences of sleep deprivation. *Seminars in Neurology*, 29(4), 320-39. doi: 10.1055/s-0029-1237117

<sup>3</sup> NCSDR/NHTSA Expert Panel on Driver Fatigue and Sleepiness. (1998). *Drowsy Driving and Automobile Crashes* (pp. 1-39). Washington, DC. Retrieved from [www.nhtsa.gov/staticfiles/nti/pdf/808707.pdf](http://www.nhtsa.gov/staticfiles/nti/pdf/808707.pdf)

<sup>4</sup> 2012 Traffic Safety Culture Index: Motorists Admit to Driving Drowsy, Fact Sheet. Washington, DC: AAA Foundation for Traffic Safety. Retrieved from [www.aaafoundation.org/sites/default/files/2012%20DDPW%20Fact%20Sheet%20%282%29.pdf](http://www.aaafoundation.org/sites/default/files/2012%20DDPW%20Fact%20Sheet%20%282%29.pdf)

Current estimates range from 2 percent to 20 percent of annual traffic deaths attributable to driver drowsiness.<sup>5</sup> According to NHTSA, annually on average from 2009 to 2013, there were over 72,000 police-reported crashes involving drowsy drivers, injuring more than an estimated 41,000 people, and killing more than 800, as measured by NHTSA's Fatality Analysis Reporting System (FARS) and National Automotive Sampling System (NASS) General Estimates System (GES).<sup>6</sup> FARS is a census of all fatal crashes that occur on the Nation's roadways. NASS GES contains data from a nationally representative sample of police-reported crashes that result in fatality, injury, or property damage.

Researchers have inferred the existence of additional drowsy-driving crashes by looking for correlations with related factors such as the number of passengers in the vehicle, crash time and day of week, driver sex and crash type. One such study was conducted by the AAA Foundation for Traffic Safety and analyzed data from NHTSA's NASS Crashworthiness Data System (CDS).<sup>7</sup> By using a multiple imputation methodology they estimated that 7 percent of all crashes and 16.5 percent of fatal crashes involved a drowsy driver. This estimate suggests that more than 5,000 people died in drowsy-driving-related motor vehicle crashes across the United States last year.

Although numbers and percentages differ, most experts agree that drowsy driving is an important traffic safety issue, and the public agrees. In a 2002 NHTSA-sponsored Gallup survey, 95 percent of the driving population considered drowsy driving by other people to be a major threat to their safety. Just over a third (37%) of drivers reported that they had nodded off or fallen asleep at least once since they began driving.<sup>8</sup>

AAA's 2014 Traffic Safety Culture Index also showed that virtually all (96.2%) of the sampled drivers consider it unacceptable for someone to drive when they are so sleepy that they have a hard time keeping their eyes open (81.3% completely unacceptable), and most (90.7%) believe that most other people where they live consider it unacceptable. Despite these findings, more than 1 in 4 drivers (29.4%) reported having driven when they were so tired that they had a hard time keeping their eyes open in the past 30 days. One in five (19.8%) reported having done this more than once, and 2.4 percent reported having done this fairly often or regularly.<sup>9</sup>

## Building Momentum to End Drowsy Driving

### *Measurement and Problem Identification*

Drowsy driving is an elusive behavior which is difficult to measure objectively. However, the success of conventional behavior-change methods depends largely on objective evidence on the extent to which a problem behavior exists and on the response of that behavior to countermeasures.

Police crash reports are the traditional source of information on crash-related behaviors. In lieu of an objective measure of pre-crash drowsiness, investigating officers can only report testimony from the driver or passenger, or circumstantial evidence that is suggestive of drowsiness or fatigue. As a result of this uncertainty, drowsiness and fatigue are likely to be significantly underreported.

#### **PROJECT: Quantifying Drowsy Driving**

NHTSA uses imputation methods to predict the values of missing alcohol data based upon characteristics of existing data. In the case of alcohol use by drivers, objective measures (chemical tests or their equivalent) are available for many cases, and these known values can be used as a basis for imputing missing data. In the case of driver fatigue, objective data are not available, so other methodological and statistical approaches need to be developed to gain a greater understanding of the risks of drowsy driving and incidence of related crashes. By combining multiple methods (experimental, naturalistic, survey, and epidemiological among others) of determining driver drowsiness and measuring related factors, we will explore the potential of utilizing methods such as those used in alcohol data imputation to generate sound estimates and cross-validate drowsy driving.

<sup>5</sup> Remarks: 2015 Lifesavers National Conference on Highway Safety Priorities, Mark R. Rosekind, Ph.D., Administrator, NHTSA (March 16, 2015). Retrieved from [www.nhtsa.gov/About+NHTSA/Speeches,+Press+Events+&+Testimonies/remarks-mr-lifesavers-03162015](http://www.nhtsa.gov/About+NHTSA/Speeches,+Press+Events+&+Testimonies/remarks-mr-lifesavers-03162015)

<sup>6</sup> National Center for Statistics and Analysis. (2011, March). Traffic Safety Fact Crash\*Stats: Drowsy Driving. (DOT HS 811 449). Washington, DC: NHTSA. Retrieved from [www-nrd.nhtsa.dot.gov/pubs/811449.pdf](http://www-nrd.nhtsa.dot.gov/pubs/811449.pdf)

<sup>7</sup> Tefft, B. C. (2012). Prevalence of motor vehicle crashes involving drowsy drivers, United States, 1999-2008. *Accident Analysis & Prevention*, 45(1): 180-186. See also Tefft, B. C. (2014, November) Prevalence of Motor Vehicle Crashes Involving Drowsy Drivers, United States, 2009-2013. Washington, DC: AAA Foundation. Retrieved from [www.aaafoundation.org/sites/default/files/AAAFoundation-DrowsyDriving-Nov2014.pdf](http://www.aaafoundation.org/sites/default/files/AAAFoundation-DrowsyDriving-Nov2014.pdf)

<sup>8</sup> Royal, D. (2003, April). *Volume I: Findings National Survey of Distracted and Drowsy Driving Attitudes and Behavior: 2002*. Washington, DC: National Highway Traffic Safety Administration.

<sup>9</sup> 2014 Traffic Safety Culture Index (January 2015). Washington, DC: AAA Foundation for Traffic Safety. Retrieved from [www.aaafoundation.org/sites/default/files/2014TSCireport.pdf](http://www.aaafoundation.org/sites/default/files/2014TSCireport.pdf)

A number of datasets are currently available that lend themselves to exploring crash numbers and the driving risks associated with drowsy driving. One of the most promising datasets for exploring drowsy driving is from the 2nd Strategic Highway Research Program (SHRP 2) naturalistic study.<sup>10</sup> By exploring and linking variables and estimates in the SHRP2 dataset and others, such as FARS, NASS, NMVCCS, and others, NHTSA hopes to create new statistical models and cross-validate findings in order to establish more reliable and valid estimates of drowsy driving crash risks and incidence.

This project was started in FY 2015 and is ongoing.

**PROJECT: National Survey of Drowsy Driving Knowledge, Attitudes, and Behaviors**

In the United States a number of surveys have asked drivers if they have fallen asleep while driving, and the survey results have shown which demographic characteristics are predictive of falling asleep while driving. These surveys have also shown that the public sees drowsy drivers as a dangerous risk on the roads. In recent years there have been a number of drowsy driving laws proposed throughout the United States. Laws were recently passed in New Jersey and Arkansas. Unfortunately not much is known about drowsy driving knowledge or attitudes, or how laws may impact these characteristics. To better understand public knowledge, attitudes, and drowsy driving behaviors, NHTSA will conduct a survey that will provide national estimates as well as State-level estimates for New Jersey and Arkansas. Repetition of this survey could enable measurement of changes in drowsy driving awareness and behaviors to assess the effectiveness of campaigns or programs.

Understanding the public's attitudes and knowledge is an important step in designing and deploying education and other countermeasures that will impact the incidence of drowsy driving across the United States.

This project is expected to begin in FY2016.

**PROJECT: Drowsy Driving Data Collection and Reporting**

There is little information on whether and how law enforcement officers identify drowsy drivers, or how often they may encounter a drowsy driver while on patrol. This information would be useful both in estimating the magnitude of the problem and in developing reporting protocols and training for law enforcement. To supplement ongoing data-collection initiatives, NHTSA will work with law enforcement officials at selected sites to gauge the proportion of apparently drowsy drivers encountered during routine contacts (stops, assists, crashes, etc.) with drivers over a period of time. A reporting protocol for drowsy driving and training may be developed as well.

This project will begin in FY2016.

**Public Awareness and Education**

Public education regarding drowsy and fatigued driving is essential to support a comprehensive program. While experience with other safety behaviors, including seat belt use, drinking and driving and driver distraction, indicates that awareness alone will not yield significant behavior change, public education has proven to be essential for supporting other program components such as policy development and enforcement.

NHTSA will raise awareness about drowsy driving through presentations at various meetings and conferences, through publication of the proceedings of the November 2015 "Asleep at the Wheel" forum, and through collaboration with other public and private organizations.<sup>11</sup> In addition, NHTSA will undertake a project to develop recommended messaging to address drowsy driving.

**PROJECT: Develop Evidence-Based Awareness and Educational Messages**

Public information would be evidence-based and utilize message strategies that prove effective in focus group testing. Public information would address:

- Why drowsy driving is risky;
- How motorists can prevent drowsy driving;

<sup>10</sup>For more information about SHRP2, see [www.trb.org/StrategicHighwayResearchProgram2SHRP2/Blank2.aspx/](http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Blank2.aspx/)

<sup>11</sup>For more information about NHTSA's drowsy driving event, *Asleep at the Wheel*, please see [www.nhtsa.gov/nhtsa/symposiums/november2015/index.html](http://www.nhtsa.gov/nhtsa/symposiums/november2015/index.html).

- Signs and symptoms of drowsy driving; and
- Strategies for dealing with drowsiness as a driver while on a trip.

Formulation and testing of public awareness and education messages will begin in FY 2016. Message content will be based on scientific literature and on the findings of the November 2015 NHTSA Drowsy Driving (“Asleep at the Wheel”) Forum. Focus groups on messaging will be conducted in the second quarter of FY 2016. Based on this information, material incorporating these messages would be ready for use by State and local constituents in mid-summer of 2016.



### ***Policy Development***

While we intend to look at every opportunity, experience with other driver risk behaviors suggests that the establishment of clear policies is necessary to motivate widespread behavior change. Policies regarding driving in a sleep-deprived condition can communicate the implications of this behavior on public safety and express intolerance for irresponsible driver decisions. We plan to investigate both legislation and corporate/organizational policies regarding drowsy driving.

#### **PROJECT: Investigate Drowsy Driving Legislation and Potential for Changing Awareness and Attitudes Regarding Drowsy Driving**

Two States have enacted laws specifically addressing drowsy and fatigued driving, and others have successfully used broader statutes as a means for controlling this behavior. Current limitations in measurement and data collection create challenges for assessing the potential impact of such laws on crashes, but the effectiveness of such policies on interim outcomes such as public awareness and attitudes could be investigated.

With respect to the two States (Arkansas and New Jersey) with laws addressing drowsy driving, NHTSA will ascertain the degree to which the laws are enforced, as well as public knowledge and awareness of the laws (see National Survey listed under Measurement and Problem Identification). NHTSA will explore the potential of conducting specific awareness programs in these States and measuring the effect of such programs on knowledge of the laws, and associated attitudes and self-report behaviors. In addition, NHTSA will investigate drowsy-driving legislative activity in other States, and document successes or obstacles encountered. Other State legislatures continue to show interest in drowsy driving, with New York State introducing legislation in early 2016.

This project will begin in FY2016.

#### **PROJECT: Develop Highway Safety Program Guidelines for Drowsy Driving**

Highway Safety Program Guidelines provide direction to State Highway Safety Offices for formulating their highway safety plans regarding efforts to be supported with section 402 and other grant funds. The guidelines provide a framework for developing a balanced highway safety program and serve as a tool with which States can assess the effectiveness of their own programs. Program Guidelines have been developed for a range of highway safety programs such as impaired driving, occupant protection, pedestrian and bicycle safety, speed management, and emergency medical services, among others. However, program guidelines do not exist for distracted or drowsy driving. NHTSA will develop a joint guideline addressing both distracted and drowsy driving.

This project will begin in calendar year 2016.

## **PROJECT: Network of Employers for Traffic Safety Toolkit**

Through policies, awareness and information, employers are able to reach a large portion of the driving population in the United States, and even more when the outreach includes family members and community members. Each year, the Network of Employers for Traffic Safety (NETS) sponsors *Drive Safely Work Week* and produces a toolkit on a specific theme for the week. In 2016, NETS will develop a *Drive Safely Work Week* toolkit focusing on the dangers of drowsy driving.

This project will begin in calendar year 2016; the toolkit will be completed by October 2016.

## **High-Risk Populations**

Drowsy drivers come from every race and ethnicity, sex, age, income level, education, and employment status. While some groups are more frequent drowsy drivers than others, once sleep-deprived they all experience similar crash risks. Developing and testing policies and programs targeting high-risk populations is an important aspect of the NHTSA drowsy driving plan. There are many groups at elevated risk of drowsy driving, including younger drivers, people with untreated sleep disorders, and shift-workers. One group of particular concern is public safety personnel like paramedics and emergency medical technicians (EMTs).

## **PROJECT: Evidence-Based Fatigue Risk Management Guidelines for Emergency Medical Services**

Emergency Medical Services (EMS) are required 24 hours per day and 365 days a year. This necessity often leads to a situation in which a critical workforce is not getting an appropriate amount of sleep and is required to work during dips in their circadian rhythm. Recent research demonstrates that more than half of EMS clinicians report being fatigued at work, get less than six hours of sleep per night, and rate their sleep quality as poor. Given these circumstances, there is a great need for fatigue risk management guidelines and resources for the EMS community.

Voluntary evidence-based fatigue risk management guidelines for the EMS community will be developed by an interdisciplinary team of sleep and fatigue scientists, Evidence Based Guideline (EBG) development specialists, and experts in emergency medicine and EMS. This project will also develop performance measures for EMS systems to evaluate the effectiveness of adopting a fatigue risk management program, dissemination of the guidelines to the community, and optional project tasks focused on guideline evaluation and creation of a free workforce scheduling tool for the EMS community based on a bio-mathematical model of fatigue in EMS.

This project began in FY 2015 and is ongoing.

## **Vehicle Technology**

A number of vehicle manufacturers have installed original equipment that detects characteristic variations in driver performance and provides a drowsiness warning. Recent NHTSA research indicates that algorithms based on driver performance measures can detect drowsiness and predict lane departures.<sup>12</sup> Improved understanding is needed of human factors issues regarding such devices, especially driver response to various types of warning signals and analysis of the effectiveness of such devices in leading to an appropriate driver actions and prevention (e.g., getting needed rest before continuing trip).

## **PROJECT: Foundations of Drowsy Driver Feedback**

To understand the current state of drowsiness detection and alerting systems as well as the future of these systems, NHTSA recently began work on a project that is exploring currently available drowsy detection and alerting systems. We are working with original equipment manufacturers (OEMs), suppliers, and aftermarket producers to discuss the function, testing, and future of drowsy driving detection systems. Additionally we are working to develop a methodology to help determine what vehicle warnings and messages can be effective in preventing drowsy driving. Currently, OEM drowsy driving detection systems alert drivers that they are drowsy with simple warnings (e.g., a red coffee cup icon). It is unclear whether these cues are sufficient to affect an

<sup>12</sup> Brown, T., Lee, J., Schwarz, C., Fiorentino, D., & McDonald, A. (2014, February). Assessing the feasibility of vehicle-based sensors to detect drowsy driving. (Report No. DOT HS 811 886). Washington, DC: National Highway Traffic Safety Administration. See also Office of Vehicle Safety Research (2104 February). Traffic Safety Facts Vehicle Safety Research Notes: Advanced Countermeasures for Multiple Impairments (DOT HS 811 887). Washington, DC: National Highway Traffic Safety Administration.

immediate remedy (e.g., stopping to rest) or longer-term behavior change (e.g., adoption of an adequate sleep pattern). To determine what type of alerting strategy is most effective, we are developing a methodology that will allow in-vehicle alerts and messages to be tested in motivationally and emotionally valid environments (e.g., the driver on the way home after a long drive).

This project began in FY 2015 and is ongoing.

## Infrastructure

Roadway rumble strips have proven to be particularly cost-effective in reducing crash types that are associated with drowsy and fatigued driving. Installation of rumble strips is inexpensive compared to other infrastructure improvements (about \$1,000-5,000 per mile). Evaluations indicate that rumble strips can reduce lane departure crashes by 50 percent or more depending on location. A nexus exists between NHTSA programs and rumble strip installation through our Section 154 and 164 transfer programs and the eligibility of these funds for Hazard Elimination infrastructure projects.

### PROJECT: Promote Widespread Adoption of Rumble Strip Technology

Together with the Federal Highway Administration, NHTSA will disseminate information and increase awareness among roadway and traffic safety decision-makers of the potential role of rumble strips in addressing drowsy driving risks. NHTSA and FHWA officials will coordinate at the national, regional and State levels to encourage further adoption of rumble strips consistent with state problem identification and planning processes.

This project will begin in FY2016.



## Conclusions

This research and program plan is an initial NHTSA effort designed to enhance the science around drowsy driving through evidence-based research. The projects described are both short term and longer term projects which can engage a variety of partners—scientists, policy makers, employers, government, as well as the public—to end drowsy driving. Clearly, there is more to be done to bring together highway safety stakeholders with the sleep medicine and science communities to further address strategies for eliminating drowsy driving. A more comprehensive plan (or blue print) will be developed to engage the participation of diverse stakeholders, such as those who attended the November 2015 “Asleep at the Wheel” forum,<sup>13</sup> to address drowsy driving over the long term.

<sup>13</sup> For more information about NHTSA's drowsy driving event, *Asleep at the Wheel*, please see [www.nhtsa.gov/nhtsa/symposiums/november2015/index.html](http://www.nhtsa.gov/nhtsa/symposiums/november2015/index.html).