VOLUME 14

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

REPORT 500

Guidance for Implementation of the AASHTO Strategic Highway Safety Plan

Volume 14: A Guide for Reducing Crashes Involving Drowsy and Distracted Drivers

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NCHRP REPORT 500

Guidance for Implementation of the AASHTO Strategic Highway Safety Plan

Volume 14: A Guide for Reducing Crashes Involving Drowsy and Distracted Drivers

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

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The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration, U.S. Department of Transportation.

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FOREWORD

By Charles W. Niessner
Staff Officer
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The goal of the AASHTO Strategic Highway Safety Plan is to reduce annual highway fatalities to 1.0 fatality per 100 million vehicle miles of travel. This goal can be achieved through the widespread application of low-cost, proven countermeasures that reduce the number of crashes on the nation's highways. This fourteenth volume of *NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan* provides strategies that can be employed to reduce the number of crashes involving drowsy and distracted drivers. The report will be of particular interest to safety practitioners with responsibility for implementing programs to reduce injuries and fatalities on the highway system.

In 1998, AASHTO approved its Strategic Highway Safety Plan, which was developed by the AASHTO Standing Committee for Highway Traffic Safety with the assistance of the Federal Highway Administration, the National Highway Traffic Safety Administration, and the Transportation Research Board Committee on Transportation Safety Management. The plan includes strategies in 22 key emphasis areas that affect highway safety. The plan's goal is to reduce the annual number of highway deaths by 9,000 by 2008. Each of the 22 emphasis areas includes strategies and an outline of what is needed to implement each strategy.

NCHRP Project 17-18(3) is developing a series of guides to assist state and local agencies in reducing injuries and fatalities in targeted areas. The guides correspond to the emphasis areas outlined in the AASHTO Strategic Highway Safety Plan. Each guide includes a brief introduction, a general description of the problem, the strategies/countermeasures to address the problem, and a model implementation process.

This is the fourteenth volume of *NCHRP Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan*, a series in which relevant information is assembled into single concise volumes, each pertaining to specific types of highway crashes (e.g., run-off-the-road, head-on) or contributing factors (e.g., aggressive driving). An expanded version of each volume with additional reference material and links to other information sources is available on the AASHTO Web site at http://safety.transportation.org. Future volumes of the report will be published and linked to the Web site as they are completed.

While each volume includes countermeasures for dealing with particular crash emphasis areas, *NCHRP Report 501: Integrated Management Process to Reduce Highway Injuries and Fatalities Statewide* provides an overall framework for coordinating a safety program. The integrated management process comprises the necessary steps for advancing from crash data to integrated action plans. The process includes methodologies to aid the practitioner in problem identification, resource optimization, and performance measurements. Together, the management process and the guides provide a comprehensive set of tools for managing a coordinated highway safety program.

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This volume of *NCHRP Report 500* was developed under NCHRP Project 17-18(3), the product of which is a series of implementation guides addressing the emphasis areas of AASHTO's Strategic Highway Safety Plan. The project was managed by CH2M HILL, and the co-principal investigators were Kevin Slack of CH2M HILL and Ron Pfefer. Timothy Neuman of CH2M HILL served as the overall project director for the team. Kelly Hardy, also of CH2M HILL, served as a technical specialist on the development of the guides.

The project team was organized around the specialized technical content contained in each guide, and the overall team included nationally recognized experts from many organizations. The following team of experts, selected based on their knowledge of this emphasis area, served as lead authors for the drowsy and distracted drivers guide:

- Jane Stutts
  University of North Carolina Highway Safety Research Center
- Ronald R. Knipling
  Virginia Tech Transportation Institute

Development of the volumes of *NCHRP Report 500* used the resources and expertise of many professionals from around the country and overseas. Through research, workshops, and actual demonstration of the guides by agencies, the resulting documents represent best practices in each emphasis area. The project team is grateful to the following people and their agencies for supporting the project by providing materials, participating in workshops and meetings, and providing input during the development of the drowsy and distracted drivers guide:

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SECTION I

Summary

Introduction

The American Association of State Highway and Transportation Officials' (AASHTO's) Strategic Highway Safety Plan identified 22 goals to pursue in order to significantly reduce highway crash fatalities. One of the plan's hallmarks is to comprehensively approach safety problems through a series of guides. The range of strategies available in the guides will ultimately cover various aspects of the road user, the highway, the vehicle, the environment, and the management system. The guides strongly encourage the user to develop a program to tackle a particular emphasis area from each perspective in a coordinated manner.

AASHTO's overall goal is to move away from independent activities of engineers, law enforcement, educators, judges, and other highway safety specialists and to move toward coordinated efforts. The implementation process outlined in the series of guides promotes forming working groups and alliances that represent all of the elements of the safety system. In so doing, they can use their combined expertise to reach the bottom-line goal of targeted reduction of crashes and fatalities associated with a particular emphasis area.

Goal 6 in the Strategic Highway Safety Plan is keeping drivers alert. For the purposes of this guide, the focus is on inattentive driving due to driver distraction or fatigue. The identified objectives and strategies are aimed at both decreasing the occurrence of distracted or fatigued driving and making the consequences of lapses of attention less severe.

General Description of the Problem

The National Highway Traffic Safety Administration (NHTSA) has identified driver inattention as a causative factor in 25–30 percent of crashes. Inattentive drivers may be temporarily distracted by something inside or outside the vehicle, may be drowsy or fatigued, or may simply have their mind on something other than the task of driving.

The primary source of national data on the role of driver inattention in traffic crashes is the Crashworthiness Data System (CDS), which is based on a national sample of police-reported traffic crashes involving at least one passenger vehicle that has been towed from the crash scene. An analysis of 2000–2003 CDS crash data shows that

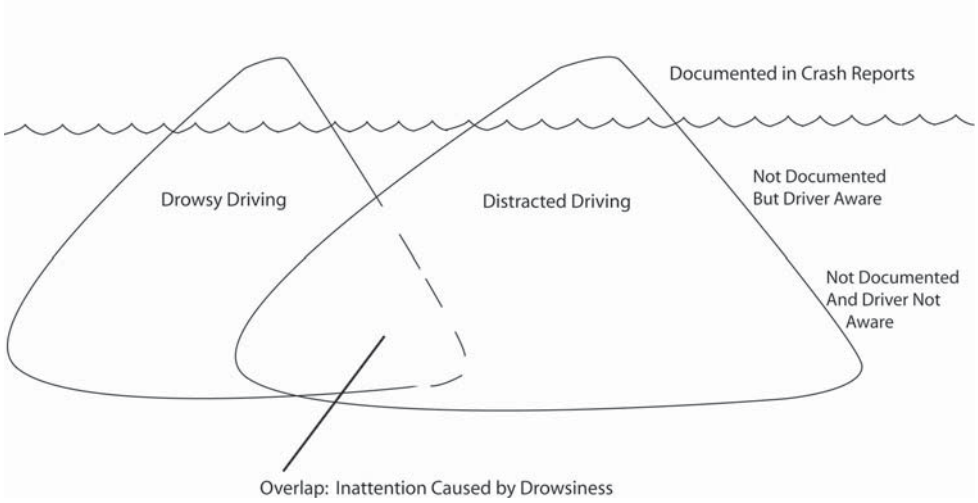
- 11.6 percent of crashes involve one or more distracted drivers,
- 3.9 percent involve one or more drivers who were sleepy or had fallen asleep at the wheel, and
- 10.2 percent involve one or more drivers who "looked but didn't see."

Overall, the percentage of crashes with one or more drivers identified as inattentive (i.e., distracted, fatigued, or "looking but not seeing") was 25.5 percent. The actual percentage is

likely higher, since information on driver attention status was unknown or missing for many of the crash-involved vehicles.

Exhibit I-1 uses an "iceberg" analogy to illustrate the difficulties of documenting the true extent of the drowsy and distracted driver crash problems and to illustrate the relationship between drowsiness and distraction. Crash investigations are retrospective reconstructions of crashes based primarily on crash scenarios, driver and witness statements, and physical evidence at the scene. Police and other investigators are reluctant to allege driver factors such as drowsiness and distraction without explicit statements from drivers or witnesses or a crash scenario that clearly indicates these factors. Just "below the surface" are many undocumented cases where drivers know that they were drowsy or distracted, but don't admit this to police. Furthermore, at a deeper level, drivers themselves may not be aware of the effects of these factors on their driving. In addition, sleep deprivation can itself lead to loss of vigilance, so that much driver inattention may have its roots in drowsiness caused by sleep deprivation and natural time-of-day variations in alertness.

EXHIBIT I-1
"Iceberg" Analogy of Drowsy and Distracted Driver Crash Problems



Fatigue has also been identified as a problem for commercial vehicle operators, especially long-haul truck drivers. This is primarily due to the more frequent nighttime driving, extended driving times, and irregular sleep schedules that characterize long-haul trucking operations. An estimated 1 percent of all large-truck crashes, 3–6 percent of fatal heavy-truck crashes, and 15–33 percent of fatal-to-the-truck-occupant-only crashes have been attributed to driver fatigue (Knipling and Shelton, 1999). Again, these numbers are likely conservative and do not capture the subtle negative effects that "everyday" fatigue has on driver performance and crash risk.

In addition to crash data, survey data and more controlled research studies have also demonstrated the importance of maintaining alertness when driving. The challenge lies in the fact that almost everyone drives while tired or distracted on at least some occasions, and for some of us, it is more often than we may care to admit. Addressing the problem will

necessarily require a broad-based, comprehensive approach involving roadway and environmental improvements, traffic law enforcement, and, perhaps most importantly, changing people's behaviors so that they are less likely to drive when fatigued or while engaged in potentially distracting activities.

Objectives of the Emphasis Area

The objectives for reducing crashes and crash-related injuries and deaths due to inattentive driving are to

- Make roadways safer for drowsy and distracted drivers,
- Provide safe stopping and resting areas,
- Increase driver awareness of the risks of drowsy and distracted driving and promote driver focus, and
- Implement programs that target populations at increased risk of drowsy or distracted driving crashes.

Exhibit I-2 lists these objectives and the strategies designed to meet them. In keeping with the goals of the AASHTO Strategic Highway Safety Plan, the strategies emphasize low-cost, short-term safety improvements for reducing collisions due to distracted and drowsy drivers.

The first objective draws heavily from two earlier guides: Volume 6, addressing run-off-road collisions, and Volume 4, addressing head-on collisions. The second objective also targets the road environment but from a different perspective—seeking to prevent a crash from occurring in the first place. The third objective is directed at the general driving population, whereas the fourth targets subpopulations known to be at increased risk of involvement in distracted or drowsy driving crashes. These high-risk populations include young drivers, drivers who work nighttimes or have irregular work schedules, commercial vehicle operators, persons with undiagnosed sleep disorders, and others.

For each objective, two or more specific strategies are identified. The strategies are intended for implementation by state DOTs, highway safety offices, law enforcement agencies, motor vehicle departments, and others.

Explanation of Objectives

The identified objectives and their respective strategies reflect the need to address the varying dimensions of the problem. Four fundamental objectives are evident from a review of research and basic understanding of the distracted and drowsy driving crash problem. The four objectives address (1) tailoring roadway infrastructure to respond to distracted or drowsy drivers; (2) enhancing the driving environment by increasing opportunities for rest or for attending to activities that otherwise might disrupt driving; (3) increasing general awareness of the safety problems caused by drowsy and distracted driving; and (4) targeting specific high-risk populations prone to drowsy or distracted driving.

EXHIBIT I-2
Objectives and Strategies for Reducing Collisions Due to Driver Inattention

Objectives	Strategies
Objective 6.1 A—Make roadways safer for drowsy or distracted drivers	Strategy 6.1 A1—Install shoulder and/or centerline rumble strips
	Strategy 6.1 A2—Implement other roadway improvements to reduce the likelihood and severity of run-off-road and/or head-on collisions
	Strategy 6.1 A3—Implement roadway improvements to reduce the likelihood and severity of other types of distracted and drowsy driving crashes
Objective 6.1 B—Provide safe stopping and resting areas	Strategy 6.1 B1—Improve access to safe stopping and resting areas
	Strategy 6.1 B2—Improve rest area security and services
Objective 6.1 C—Increase driver awareness of the risks of drowsy and distracted driving and promote driver focus	Strategy 6.1 C1—Conduct education and awareness campaigns targeting the general driving public
	Strategy 6.1 C2—Visibly enforce existing statutes to deter distracted and drowsy driving
Objective 6.1 D—Implement programs that target populations at increased risk of drowsy and distracted driving crashes	Strategy 6.1 D1—Strengthen graduated driver licensing requirements for young novice drivers
	Strategy 6.1 D2—Incorporate information on distracted and fatigued driving into education programs and materials for young drivers
	Strategy 6.1 D3—Encourage employers to offer fatigue management programs to employees working nighttime or rotating shifts
	Strategy 6.1 D4—Enhance enforcement of commercial motor vehicle hours-of-service regulations
	Strategy 6.1 D5—Encourage trucking companies and other fleet operators to implement fatigue management programs
	Strategy 6.1 D6—Implement targeted interventions for other high-risk populations

Targets of the Objectives

The first objective addresses changes to the roadway that either reduce the likelihood that an inattentive driver will crash or reduce the likely severity of inattention crashes once they do occur. This objective is most pertinent for state and local DOT engineers. The second objective addresses changes in the broader driving environment and specifically aims to reduce the occurrence of crashes due to driver inattention by providing safe places for drivers to stop and take a break from driving. While DOT planners are the primary target group for implementing this strategy, engineers, law enforcement, and highway safety officials can also contribute to its success.

The third objective focuses on the general driving population. Since distracted and fatigued driving are primarily behavioral issues, educating drivers, and working to create a change in public opinions about drowsy and distracted drivers, is key to reducing these types of crashes. Finally, the fourth objective addresses specific populations known to be at increased risk of drowsy and distracted driving crashes. Each objective has specific characteristics and needs that require more intensive individualized efforts to bring about the desired changes in behavior that will lower crash risk. Implementing educational interventions requires broad input and support from the highway safety community and draws upon both public and private resources.

SECTION II

Introduction

The six major areas of the AASHTO Strategic Highway Safety Plan—drivers, vehicles, special users, highway, emergency medical services, and management—are subdivided into 22 goals, or key emphasis areas, that impact highway safety. One of these areas addresses reducing crashes and fatalities caused by inattentive drivers.

NHTSA has identified driver inattention as a causative factor in 25–30 percent of crashes (Wang, Knipling, and Goodman, 1996). An inattentive driver may be temporarily distracted by something inside or outside the vehicle, may be drowsy or fatigued, or may simply have his or her mind on something other than driving. Crashes involving drivers who have fallen asleep at the wheel are especially likely to result in serious or fatal injuries.

The focus of this guide is on reducing collisions due to driver distraction or fatigue. There are several challenges to accomplishing this goal. One is that available crash data do not fully document the problem of distracted and fatigued driving. Although most state crash report forms capture some level of information on whether a driver has fallen asleep at the wheel, only recently have states begun collecting data on distraction as a causative factor in crashes. There is only limited information available on the sources of driver distraction, and the reliability of the data has not been demonstrated. Unlike the case with alcohol, there is no objective way of identifying whether someone is too drowsy or too distracted to drive. In general, crash data are thought to significantly underestimate the contribution of distracted and drowsy driving to crashes.

Another challenge is that the reduction of crashes and fatalities due to distracted and drowsy driving necessitates change in driver behavior. Some success can be achieved by improving roadways and vehicles to make them more forgiving and by incorporating new technologies to alert an inattentive driver. Ultimately, however, we must change drivers themselves so that they are less likely to operate their vehicles when drowsy or distracted. This task is made all the more challenging by the simple fact that virtually everyone, at some point, drives while fatigued or while engaging in potentially distracting behaviors.

This emphasis area encompasses a broad mix of behaviors that exhibit themselves in all population groups, on all types of roadways, in all types of vehicles, and under all driving conditions. Addressing the problem will necessarily require a broad-based, comprehensive approach. Roadway design and traffic operations engineers, planners, law enforcement, driver licensing officials, and road safety advocates in both the public and private sectors all have important roles to play in reducing the number of crashes due to inattentive driving.

SECTION III

Type of Problem Being Addressed

General Description of the Problem

Driver distraction is typically defined in terms of an object or event drawing one's attention from the driving task. It is this presence of a triggering event that distinguishes a distracted driver from other inattentive drivers. The research literature identifies four ways in which persons can be distracted while driving. They can be distracted *visually*—for example, when they look away from the roadway to locate a CD or tend to a crying baby. They can also be distracted *audibly*—for example, by a honking car or by children fighting in the back seat of the car. When drivers manipulate radio controls, reach to open the glove compartment, or dial a cell phone number, they are being *physically* distracted from the driving task. And finally, when they engage in a conversation, whether with a passenger or with the person on the other end of a cell phone connection, they are in danger of being distracted *cognitively*. Cell phone use, an activity that has garnered considerable attention from the highway safety community, the media, and state and local lawmakers, has the potential for distracting drivers in all four of these areas. Cell phones also represent just one of many wireless technologies increasingly available to drivers in their vehicles.

Unlike driver distraction, driver drowsiness or fatigue involves no triggering event, but instead is characterized by a progressive withdrawal of attention from the road and traffic demands. Drowsiness is the inevitable result of inadequate sleep. Physical fatigue, on the other hand, can occur in drivers who may be tired from hard work or stress, or who may have been driving for a prolonged period of time. For both drowsy and fatigued drivers, however, the effects are the same: decreased driving performance and an increased risk of crash involvement. Therefore, for the purposes of this report, and generally in traffic safety, the terms "drowsiness" and "fatigue" are used interchangeably to mean tiredness. The ultimate level of drowsiness and fatigue is falling asleep at the wheel, although driving performance and safety may be significantly affected by lesser levels of fatigue or drowsiness.

Both distracted and fatigued driving crashes are thought to be underreported on police crash files, since there may be no evidence of driver distraction or fatigue at the scene of a crash. Moreover, drivers may be reluctant to admit distraction or fatigue if they believe it will increase their likelihood of being charged in a crash. Although most state crash report forms contain a code for identifying drowsy and/or fatigued drivers, only about a third contain codes for identifying drivers who were distracted at the time of their crash.

Human alertness level ranges from high to very low (i.e., unconscious) depending on such factors as amount of prior sleep and time of day (Wylie et al., 1996). A poor night's sleep may reduce a driver's performance in subtle ways that he or she may not understand or perceive. Driver attention to the driving task also varies from high to low. Many distracting actions and thoughts are fleeting and can occur almost continuously during driving. At a highway speed of 65 mph, a vehicle is traveling almost 100 feet per second. A glance at roadside scenery or reaching toward a console cup holder can be the difference between timely perception and response to a crash threat and a serious crash.

In addition, a major effect of sleep deprivation is a reduction in vigilance and attention to visual and other stimuli (Dinges et al., 1998; Balkin et al., 2000). Severe sleep deprivation is associated with long and frequent lapses of attention, but even mild sleep deprivation results in some loss of vigilance. Much driver inattention has its roots in drowsiness caused by sleep deprivation and natural time-of-day variations in alertness associated with circadian rhythms. This interaction between drowsiness and inattention is shown as an overlap between the two "icebergs" in Exhibit I-1.

In June 2003, NHTSA released an updated edition of the *Model Minimum Uniform Crash Criteria Guideline* (NHTSA, 2003). The publication recommended the addition of a new data element to state crash report forms to collect information on driver distraction at the time of the crash. Recommended codes included *not distracted*, *electronic communication devices (cell phone, pager, etc.)*, *other electronic devices (navigation device, palm pilot, etc.)*, *other inside the vehicle*, *other outside the vehicle*, and *unknown*. The addition of this data element was deemed important for documenting emerging highway safety issues. However, there is still a need for increased training of law enforcement in identifying distraction and drowsiness as contributing factors to crashes.

In the absence of definitive crash data, there is ample evidence of the prevalence of driver distraction and fatigue and their importance for driving safety from survey data as well as from controlled research studies. According to the National Sleep Foundation's annual Sleep in America survey, 37 percent of drivers fell sleep or nodded off while driving in the past year (NSF, 2005). And according to a recent NHTSA survey, 14 percent of drivers involved in a crash in the past five years attribute their crash to being distracted and 3 percent attribute it to drowsy driving (Royal, 2003).

Research results also confirm the increased risks associated with distracted or drowsy driving. A frequently cited study published in the *New England Journal of Medicine* concluded that the risk of a crash is over four times greater when a driver uses a cell phone (Redelmeier and Tibshirani, 1997). And in a study published by the AAA Foundation for Traffic Safety, more than half of the drivers involved in sleep-related crashes had slept less than 6 hours the night before their crash, compared to less than 10 percent of drivers in a control sample of crashes (Stutts et al., 1999).

Specific Attributes of the Problem

Overall Magnitude and Scope

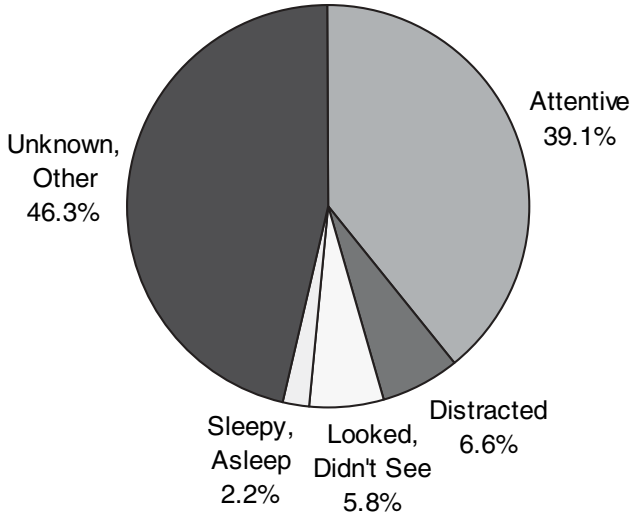
The CDS, a part of NHTSA's National Accident Sampling System,[1] collects detailed data on an annual probability sample of approximately 5,000 police-reported traffic crashes involving at least one passenger vehicle that has been towed from the crash scene. Trained professional crash investigation teams collect information from the scene of the crash, from

[1] Although NHTSA's Fatality Analysis Reporting System, or FARS, data also record information on driver-related factors in fatal crashes, driver inattention is believed to be seriously underreported because it is not contained in most states' crash report forms. In 2002, 2.9 percent of drivers involved in fatal crashes were identified as asleep or fatigued, and 6.5 percent were identified as inattentive (NHTSA, 2004).

an examination of the crash-involved vehicles, from interviews with the crash victims and other witnesses, and from available medical records. Even so, the CDS is far from an ideal source of information on precrash driver factors, since its focus is on vehicle crashworthiness, and crashes are typically investigated well after their occurrence.

Beginning in 1995, a variable describing the attention status of the driver—Driver's Distraction/Inattention to Driving—was added to the CDS data collection protocol. An analysis of 2000–2003 CDS data, weighted to reflect all passenger car crashes in the United States, reveals that 6.6 percent of drivers were distracted at the time of their crash, 2.2 percent were sleepy or asleep, and an additional 5.8 percent "looked but didn't see" (See Exhibit III-1. Supporting tables for this and other figures in this section based on the CDS data are contained in Appendix 1). These three categories together total 14.6 percent of crash-involved drivers. This number does not take into account the fact that for nearly half (46.4 percent) the cases, the driver's attention status at the time of the crash was coded as unknown. Thus, the CDS data almost certainly underestimate the true magnitude of the problem.

EXHIBIT III-1
Distribution of Driver Attention Status Based on Weighted 2000–2003 CDS Data



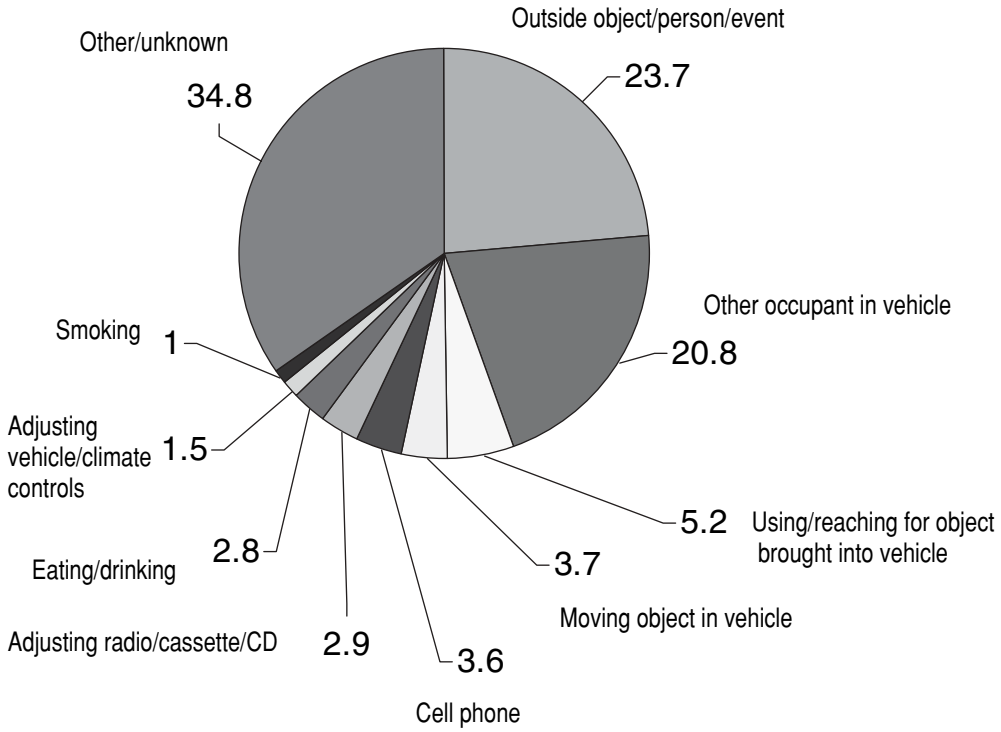
The above numbers are based on all crash-involved *drivers*. The percentage of *crashes* involving an inattentive driver is still higher, since in multi-vehicle crashes it is frequently the case that only the at-fault driver is distracted or fatigued. According to the same 2000–2003 CDS data,

- 11.6 percent of crashes involve one or more distracted drivers (the same for both single-vehicle and multi-vehicle crashes),
- 3.9 percent involve one or more drivers who were sleepy or had fallen asleep (9.1 percent of single-vehicle crashes and 1.3 percent of multi-vehicle crashes), and
- 10.2 percent involve one or more drivers who "look but don't see" (0.7 percent of single-vehicle and 14.8 percent of multi-vehicle crashes).

Overall, the percentage of crashes with one or more drivers who were identified as inattentive (i.e., either distracted or fatigued or "looking but not seeing") was 25.5 percent. Again, the actual number is likely greater, since information on driver attention status was unknown or missing for many of the crash-involved vehicles.

The CDS data also provide information on the specific sources of driver distraction. Exhibit III-2 shows the sources of distraction for those 6.6 percent of drivers identified as distracted at the time of their crash. The most frequently cited distraction was an object, person or event outside the vehicle. Examples here include other cars and drivers on the roadway, pedestrians, work zones, accident scenes, and general "rubbernecking" (i.e., looking at scenery or landmarks). "Other occupant in vehicle" was cited nearly as often, with frequent reference to infants and young children. Further down the list of distractions were objects brought into the vehicle (which might include portable electronic devices, but also purses and packages), moving objects in the vehicle (e.g., packages or items that fall from the seat, pets, and flying insects), and cell phones. Adjusting the radio or other audio and eating/drinking are each cited in less than 3 percent of the cases, and adjusting vehicle or climate controls and smoking are each in about 1 percent of cases. In the remaining 34.8 percent of cases, the specific source of distraction was either unidentified or simply coded as "other."

EXHIBIT III-2
Specific Sources by Percentage of Driver Distraction Identified in the Weighted 2000–2003 CDS Data



These numbers differ slightly from those contained in an earlier report that examined 1995–1999 CDS data. In that report, outside object/person/event was still the number one identified distraction category at 29 percent, but other occupants in vehicle and adjusting

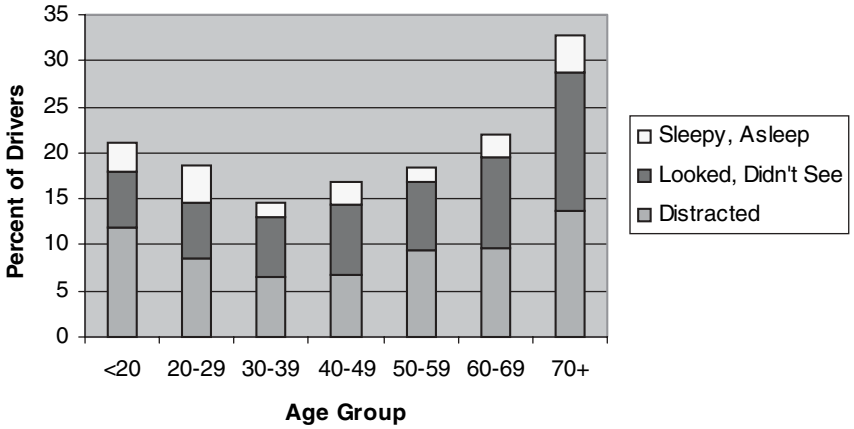
radio/cassette/CD were tied for the numbers two and three positions at 11 percent each. Cell phones appeared further down the list at 1.5 percent (Stutts et al., 2001).

Here, an additional cautionary note is in order regarding the difficulties in collecting reliable data on specific sources of driver distraction. In particular, in the absence of any direct evidence at the scene of a crash, drivers may be much more likely to admit some distractions (e.g., being distracted by a young child or by a passing vehicle) than others (e.g., talking on a cell phone, reading a newspaper) to an investigating officer.

Driver Age and Injury Severity

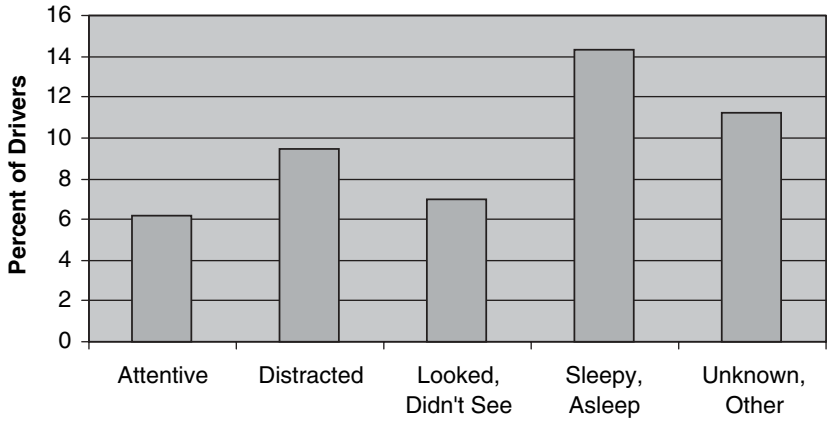
While younger drivers under the age of 20 are especially likely to be distracted at the time of their crash, all age groups are affected (Exhibit III-3) (Appendix 1 shows more detailed tables on the CDS data). Drivers in the 20–29 age group have the highest percentage of "sleepy/asleep" crashes, while the oldest age groups (60–69 and 70+) are overrepresented in "looked but didn't see" crashes. Clearly, no age group is immune to the problem of inattentive driving.

EXHIBIT III-3
Distribution of Driver Attention Status within Categories of Driver Age, Based on Weighted 2000–2003 CDS Data



Information with respect to injury status of the crash-involved drivers is shown in Exhibit III-4. Compared to attentive drivers, distracted drivers are 50 percent more likely to be seriously injured or killed in their crash, while drivers who have fallen asleep are 2.3 times more likely to be seriously injured or killed. NHTSA has conservatively estimated that drowsy driving is responsible for 1,500 deaths per year (Knipling and Wang, 1994, 1995). (The higher percentage of fatal injuries for drivers with unknown attention status reflects the difficulty of determining attention status for drivers killed in crashes.)

EXHIBIT III-4
Percentage of Crashes Involving Serious or Fatal Injury to the Driver, Based on Weighted 2000–2003 CDS Data



Crash Characteristics

Exhibit III-5 provides information on how the crashes of inattentive drivers differ from those of attentive drivers (with supporting tables again contained in Appendix 1). Distracted drivers are somewhat more likely than attentive drivers to be involved in non-collision (i.e., single-vehicle) and rear-end crashes. These two manners of collision together account for nearly 70 percent of distracted and attentive drivers' crashes, with most of the remainder being angle collisions. For crashes where the driver "looked but didn't see," the manner of collision was overwhelmingly an angle collision, reflecting the fact that these crashes primarily occur at roadway or driveway intersections. In contrast, 78 percent of sleepy or asleep drivers are involved in non-collision crashes, with most of the remainder (15 percent) rear-end crashes.

EXHIBIT III-5
Manner of Collision by Driver Attention Status, Based on Weighted 2000–2003 CDS Data

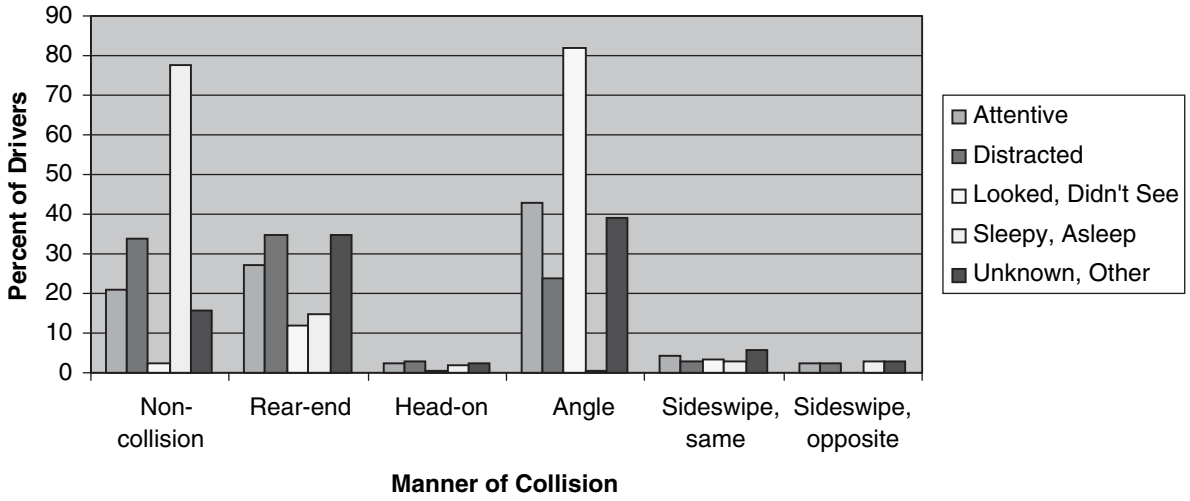
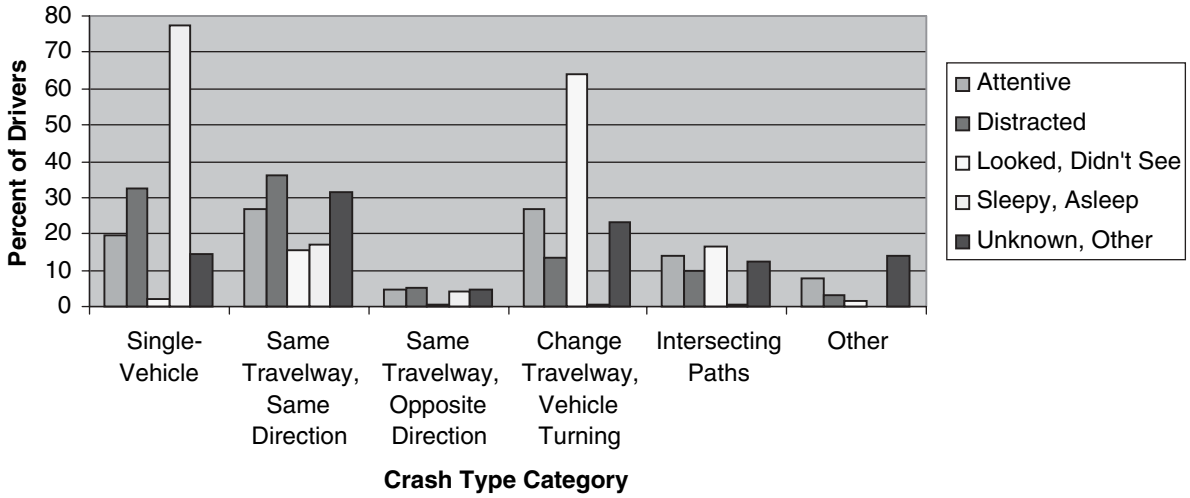


EXHIBIT III-6
Crash Type Category by Driver Attention Status, Based on Weighted 2000–2003 CDS Data

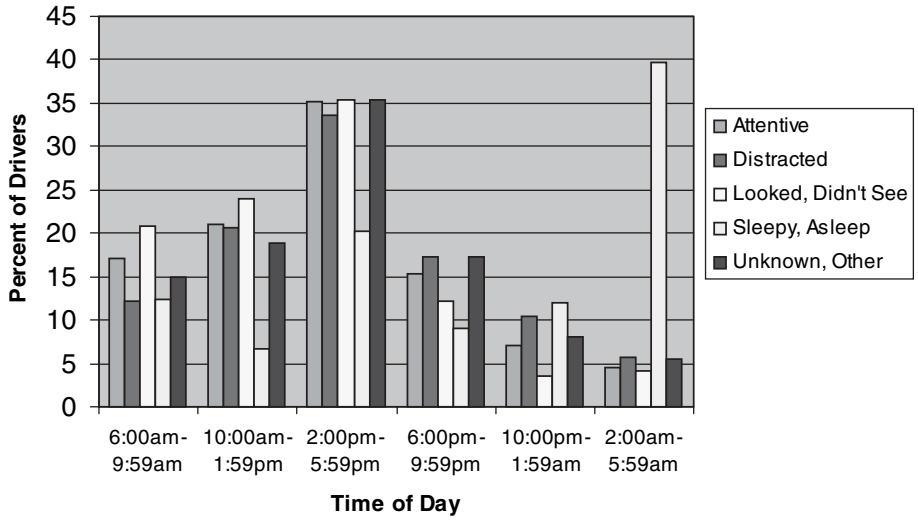


This information is confirmed in Exhibit III-6, which shows that distracted driver crashes are primarily categorized as single-vehicle or "STSD" (same travelway, same direction) crashes, looked but didn't see crashes are primarily categorized as turning crashes, and sleepy/asleep crashes are primarily categorized as single-vehicle events.

Information on the time of day during which attentive and inattentive drivers are involved in crashes is presented in Exhibit III-7. The overinvolvement of sleepy/asleep drivers in nighttime crashes is especially notable: over half (52 percent) of all drowsy driving crashes occur at nighttime, between the hours of 10 p.m. and 6 a.m., with nearly 40 percent occurring between 2 a.m. and 6 a.m. Compared to attentive drivers, the crashes of distracted drivers are also somewhat more likely to occur in the evenings and at nighttime. In contrast, crashes where the driver "looked but didn't see" are more likely to occur during the morning hours, a finding that likely reflects the greater proportion of older drivers in these types of crashes.

Interestingly, these results for drowsy driving crashes by time of day contrast with what survey data reveal about the problem. In the NHTSA/Gallup survey referenced earlier, almost three-fourths of the reported instances of nodding off while driving occurred between 6 a.m. and midnight (Royal, 2003). Thus, while crash report data indicate that drowsy driving is primarily a nighttime problem, survey data suggest that it is also a daytime problem. The discrepancy is likely tied to daytime-nighttime differences in exposure, the difficulty that law enforcement officers have in identifying sleepiness as a factor in crashes, and a reliance on a restricted set of "indicators," such as a single-vehicle, running off the roadway, at nighttime, and not involving alcohol. The discrepancy also suggests a significant underreporting of drowsy driving crashes in police and most other crash investigation data, including the CDS.

EXHIBIT III-7
Time of Day of Crash by Driver Attention Status, Based on Weighted 2000–2003 CDS Data



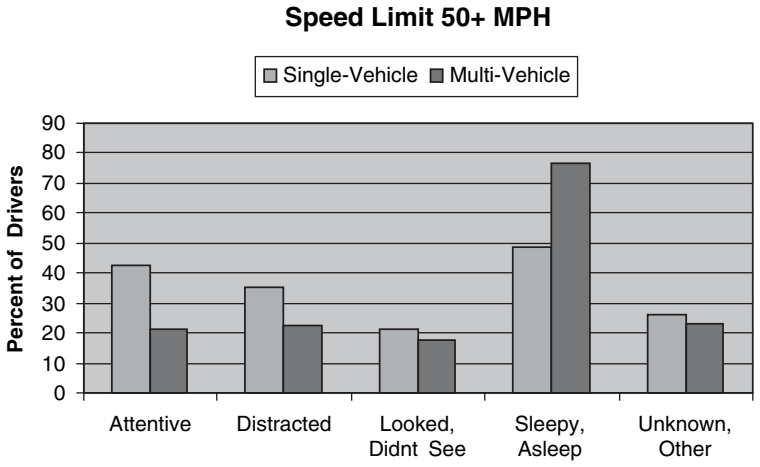
Roadway Characteristics

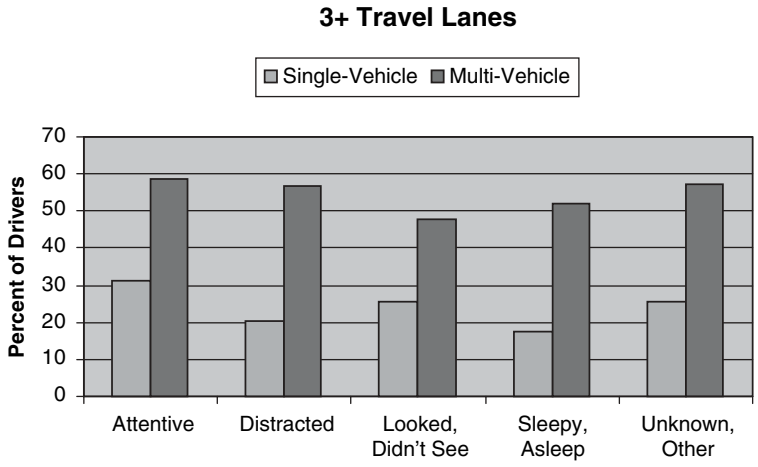
Information on how the attention status of crash-involved drivers varies for different roadway characteristics is summarized in Exhibit III-8. Results are presented separately for single- and multi-vehicle crashes.

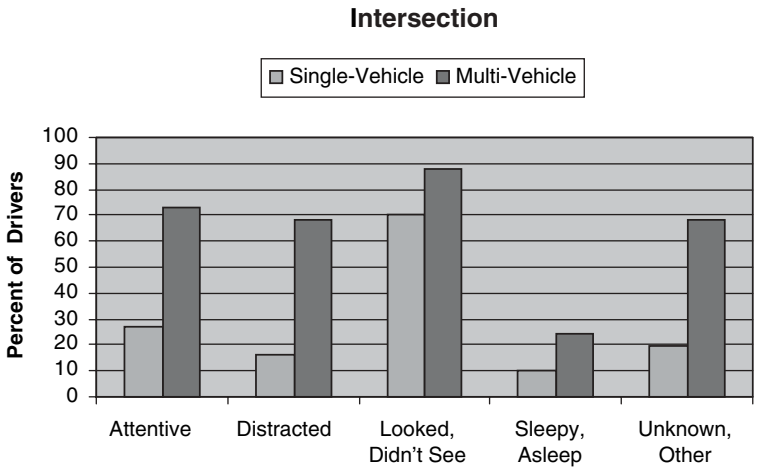
Compared to attentive drivers, the crashes of distracted drivers are somewhat less likely to occur on higher-speed roadways, on multi-lane (three or more lane) roadways, at a curve in the road, and at a roadway intersection. This is especially true with respect to single-vehicle distracted driver crashes. “Looked but didn’t see” crashes, not surprisingly, are much more likely than attentive driver crashes to occur at intersections and are less likely to occur on higher-speed and multi-lane roadways and at a curve in the road.

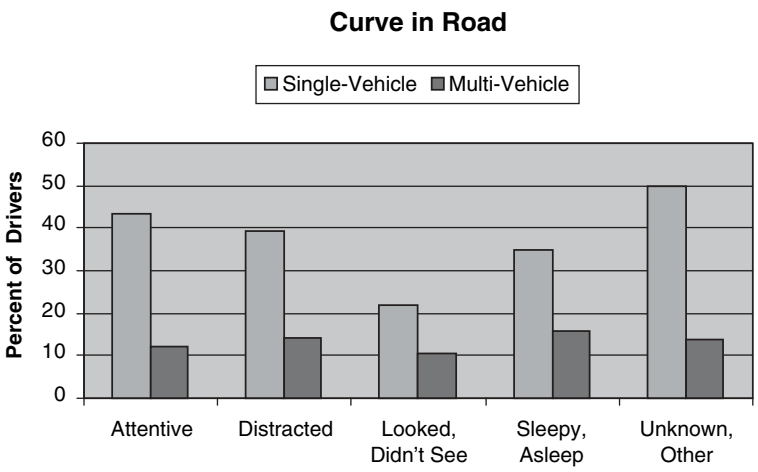
Even though drowsy drivers are overrepresented in crashes on high-speed roadways (55 percent of their total), they are underrepresented in crashes occurring on multi-lane roadways, especially with regard to single-vehicle crashes. This supports the earlier description of the “typical” drowsy driving crash as involving a single vehicle departing a high-speed, two-lane roadway.

EXHIBIT III-8
Driver Attention Status by Roadway Characteristics, Based on Weighted 2000–2003 CDS Data









Commercial Vehicle Crashes

In addition to these results from the CDS that are based on passenger vehicles, drowsy driving has also been identified as a problem for commercial vehicle operators, especially long-haul truck drivers. This is primarily due to the more frequent nighttime driving, extended driving times, and irregular sleep schedules that characterize long-haul trucking operations. An estimated 1 percent of all large-truck crashes, 3–6 percent of fatal heavy-truck crashes, and 15–33 percent of fatal-to-the-truck-occupant-only crashes have been attributed to driver fatigue as a primary factor (Knipling and Shelton, 1999). These percentages are based on crash investigations and thus are probably conservative because they do not capture the subtle negative effects that everyday fatigue has on driver performance and crash risk.

The Federal Motor Carrier Safety Administration (FMCSA) and NHTSA have performed a Large Truck Crash Causation Study (LTCCS) (Craft and Blower, 2004) to identify critical factors contributing to crashes involving large trucks. Of 287 two-vehicle crashes involving a large truck and another vehicle (typically a light vehicle) in a preliminary and unweighted LTCCS dataset, 87 had a "critical reason" assigned to the truck, and 200 had a critical reason assigned to the other vehicle. Of the 87 cases where the critical reason was assigned to the truck, 3 percent involved truck driver "non-performance" (a category that includes drowsiness, fatigue, and illness), and 46 percent involved truck driver recognition errors, including driver inattention, distraction, and poor surveillance. Of the 200 cases with the critical reason assigned to the other vehicle, 11 percent involved driver non-performance and 34 percent involved driver recognition errors as critical reasons. In addition to these critical reason designations, there were many other cases where fatigue and/or non-recognition driver errors (poor surveillance, internal distraction, external distraction, or other inattention) were cited. Although driver fatigue is often associated with drivers of large trucks, in the LTCCS fatigue was actually coded more often to the other vehicle driver (both as the critical reason and as a related factor) in crashes involving both trucks and other vehicles. A final report on the LTCCS should be available later in 2005.

State Data

States vary in the extent to which they collect data on the attention status of drivers involved in crashes. Whereas all but six states responding to a recent survey indicated that their crash report form includes a category for identifying sleep- or fatigue-related crashes, not all forms include places for identifying both fall asleep and other fatigue-related crashes. In some states only one of the categories is identified, and in others they are combined (NSF, 1998). Only 17 states collect information on the role of distraction in traffic crashes, and many of these identify only a few major sources of distraction, such as cell phone use (Sundeen, 2003).

While recent interest in cell phones and other technologies has spurred a number of states to modify their crash report forms to include more information on driver distractions, and in particular cell phone use, the reliability of the resulting data has not been demonstrated. In its recent update on state legislative activities related to cell phone use, the National Conference of State Legislatures summarized published data from seven states (California, Florida, Michigan, Minnesota, Oklahoma, Pennsylvania, and Tennessee) regarding crashes attributed to driver inattention and driver cell phone use. The reported percentage of crashes involving inattention ranged from a low of 0.6 percent to a high of 29.9 percent (Sundeen,

2003), another clear indication of the difficulties in collecting reliable data on driver attention status at the time of a crash.

Neither the National Automotive Sampling System (NASS) General Estimates System (GES), based on a nationally representative probability sample of all police-reported crashes, nor FARS, based on a census of all reported fatal crashes, typically reports state-level data on the prevalence of crashes due to driver inattention or fatigue.

Given the known limitations of routinely reported police crash data, and in particular the underreporting of distracted and drowsy driving as contributing factors to crashes, states are encouraged to undertake special data collection activities to better estimate the magnitude of the problem and to identify the most relevant target populations, target locations, and countermeasures for addressing these problems.

A good example of this type of effort is a pilot study of distracted and drowsy driving carried out in Virginia (Glaze and Ellis, 2003). The study was a collaborative effort that involved completion of a special survey form for crashes involving one or more inattentive drivers. Data were collected over a 6-month period in 2002 by troopers and police officers in a sampling of Virginia counties and cities. Results showed that 17 percent of the identified cases involved drowsiness or fatigue; 13 percent involved a driver being distracted by something outside the vehicle; 10 percent involved looking at scenery or landmarks ("rubbernecking"); and 9 percent involved other passengers or children in the vehicle. These results are quite similar to those reported earlier for the 2000–2003 CDS data, except for a higher level of drowsy driving incidents. This difference, however, may be at least partially explained by a higher percentage of single-vehicle crashes (half of the total reported) in the Virginia data.

Improving Data

Prospective data collection activities such as that undertaken in Virginia (described above) can not only yield useful information and serve as a basis for programmatic activities, but also contribute to increased awareness of the problem of distracted and drowsy driving by law enforcement officials and improved reporting by officers responsible for investigating crashes. Other techniques may also be needed to improve available data for addressing the problem of inattentive driving.

As noted earlier, the 2003 revision of the Model Minimum Uniform Crash Criteria (MMUCC) recommends the addition of a new data element on state crash report forms to collect information on driver distraction at the time of a crash (in addition to the data element for driver physical condition, which includes codes for fatigue and loss of unconsciousness or fell asleep). Although many states have added this data element to their crash report forms, there is as yet no documented evidence that such information can be reliably collected and reported by officers who investigate crashes. And indeed, the high level of "missing" and "unknown" data for the driver attention status variable in the CDS data suggests that reliable data collection may be a problem. One or more special studies examining the reliability of reported data in states that have adopted the MMUCC, and perhaps more importantly, approaches for improving data quality, may be needed.

Other approaches to improving the quality of available data on the role of driver inattention in traffic crashes may also prove useful. For example, the Utah Department of Transportation

follows a four-step approach for identifying and treating high-crash locations. The approach involves (1) querying the Central Accident Records System, a computerized database of all reportable crashes in the state; (2) using geographic information systems (GIS) to spatially map different types of crashes; (3) visually inspecting crash locations via an Internet-based photo logging system; and (4) conducting onsite reviews to further pinpoint potential safety projects. Following this approach, the department estimates that the percentage of fatal crashes in the state due to drowsy driving alone exceeds 11 percent (see Appendix 2).

In the end, it must be recognized that available data on distracted and drowsy driving will likely never be as accurate or complete as the data on other important aspects of driver behavior. Unlike the use of seat belts, driver attention status cannot be so easily categorized as “yes” or “no,” and it certainly cannot be measured and quantified, as with the case of blood alcohol level. Underreporting of the role of driver inattention in crashes will likely remain a problem. However, sufficient evidence exists, from both crash data and other sources, to warrant increased attention to the problem.

SECTION IV

Index of Strategies by Implementation Timeframe and Relative Cost

Exhibit IV-1 provides a classification of the identified strategies according to the expected timeframe and relative cost for this emphasis area. In keeping with the overall goal of these guides, the strategies that have been identified are generally short-term and low-cost undertakings. The primary exceptions are strategies involving roadway or environmental modifications (e.g., for adding paved shoulders or expanding rest areas). The range of costs will vary for the strategies, depending upon the specific intervention undertaken and factors such as the size of the target audience and the availability of suitable existing materials and programs. Implementation timeframe will also vary for these same reasons and may depend upon policies and laws already in place. Placement in the table below is meant to reflect the most common application of the strategy.

EXHIBIT IV-1
Classification of Strategies According to Expected Timeframe and Relative Cost

		Relative Cost to Implement and Operate			
Timeframe for Implementation	**Strategy**	**Low**	**Moderate**	**Moderate to High**	**High**
Short (<1 year)	6.1 A1—Install shoulder and/or centerline rumble strips		✓		
	6.1 C2—Visibly enforce existing statutes to deter distracted and drowsy driving	✓			
	6.1 D2—Incorporate information on distracted/fatigued driving into education programs and materials for young drivers	✓			
	6.1 D3—Encourage employers to offer fatigue management programs to employees working nighttime or rotating shifts		✓		
	6.1 D5—Encourage trucking companies and other fleet operators to implement fatigue management programs		✓		
Medium (1–2 years)	6.1 A2—Implement other roadway improvements to reduce the likelihood and severity of run-off-road and/or head-on collisions			✓*	
	6.1 A3—Implement roadway improvements to reduce the likelihood and severity of other types of distracted and drowsy driving crashes			✓*	
	6.1 B2—Improve rest area security and services		✓		
	6.1 C1—Conduct education and awareness campaigns targeting the general driving public		✓		

EXHIBIT IV-1 (Continued)
Classification of Strategies According to Expected Timeframe and Relative Cost

		Relative Cost to Implement and Operate			
Timeframe for Implementation	**Strategy**	**Low**	**Moderate**	**Moderate to High**	**High**
	6.1 D1—Strengthen graduated driver licensing requirements for young novice drivers	✓			
	6.1 D4—Enhance enforcement of commercial motor vehicle hours of service regulations		✓		
	6.1 D6—Implement targeted interventions for other high-risk populations		✓		
Long (>2 years)	6.1 B1—Improve access to safe stopping and resting areas			✓	

* Cost depends on selected improvement. See related guides.

SECTION V

Descriptions of Strategies

Objectives

The objectives for reducing crashes and crash-related injuries and deaths due to inattentive driving are to

- Make roadways safer for drowsy and distracted drivers,
- Provide safe stopping and resting areas,
- Increase driver awareness of the risks of drowsy and distracted driving and promote driver focus, and
- Target subpopulations at increased risk of drowsy or distracted driving crashes.

The first objective draws heavily from two earlier guides: Volume 6, addressing run-off-road collisions, and Volume 4, addressing head-on collisions. The second objective also targets the driving environment but from a different perspective—seeking to prevent distracted or drowsy driving in the first place. The third objective is directed at the general driving population, whereas the fourth targets subpopulations known to be at increased risk of involvement in distracted or drowsy driving crashes. These high-risk populations include young drivers (especially young males), drivers who work nighttimes or have irregular work schedules, commercial vehicle operators, persons with untreated sleep disorders, law enforcement officers, and young members of the military.

For each objective, two or more specific strategies are identified. The strategies are intended for implementation by state DOTs, highway safety offices, law enforcement agencies, motor vehicle departments, and others. Several of the strategies also require collaboration with and support from other public- and private-sector agencies and organizations. These collaborations are more fully explained in the individual strategy descriptions as well as in the descriptions of agencies and organizations currently implementing the strategy.

Exhibit V-1 summarizes the identified objectives and strategies.

Explanation of Strategy Types

The strategies in this guide were identified from a number of sources, including the literature, contacts with professionals in the field and with state and local agencies throughout the United States, and federal programs. Some of the strategies are widely used, while others are primarily an experimental idea of a single individual or agency. Some have been subjected to well-designed evaluations to prove their effectiveness. However, it was found that many strategies, including some that are widely used, have not been adequately evaluated.

EXHIBIT V-1
Emphasis Area Objectives and Strategies

Objectives	Strategies
Objective 6.1A—Make roadways safer for drowsy and distracted drivers	Strategy 6.1 A1—Install shoulder and/or centerline rumble strips (P/T)
	Strategy 6.1 A2—Implement other roadway improvements to reduce the likelihood and severity of run-off-road and/or head-on collisions (P/T)
	Strategy 6.1 A3—Implement roadway improvements to reduce the likelihood and severity of other types of distracted and drowsy driving crashes (T/E)
Objective 6.1 B—Provide safe stopping and resting areas	Strategy 6.1 B1—Improve access to safe stopping and resting areas (T)
	Strategy 6.1 B2—Improve rest area security and services (T)
Objective 6.1 C—Increase driver awareness of the risks of drowsy and distracted driving and promote driver focus	Strategy 6.1 C1—Conduct education and awareness campaigns targeting the general driving public (T)
	Strategy 6.1 C2—Visibly enforce existing statutes to deter distracted and drowsy driving (E)
Objective 6.1 D—Implement programs that target populations at increased risk of drowsy or distracted driving crashes	Strategy 6.1 D1—Strengthen graduated driver licensing requirements for young novice drivers (P/T)
	Strategy 6.1 D2—Incorporate information on distracted/fatigued driving into education programs and materials for young drivers (T)
	Strategy 6.1 D3—Encourage employers to offer fatigue management programs to employees working nighttime or rotating shifts (P)
	Strategy 6.1 D4—Enhance enforcement of commercial motor vehicle hours of service regulations (P)
	Strategy 6.1 D5—Encourage trucking companies and other fleet operators to implement fatigue management programs (T)
	Strategy 6.1 D6—Implement targeted interventions for other high-risk populations (T/E)

Note: The following pages explain (T), (E), and (P) demarcations.

The implication of the widely varying experience with these strategies, as well as of the range of knowledge about their effectiveness, is that the reader should be prepared to exercise caution in many cases before adopting a particular strategy for implementation. To help the reader, the strategies have been classified into three types, each identified by a letter:

- Proven (P)—Those strategies that have been used in one or more locations and for which properly designed evaluations have been conducted that show them to be effective. These strategies may be employed with a good degree of confidence, but any application can lead to results that vary significantly from those found in previous evaluations. The attributes of the strategies that are provided will help the user judge which strategy is the most appropriate for the particular situation.

- Tried (T)—Those strategies that have been implemented in a number of locations and that may even be accepted as standards or standard approaches, but for which there have not been found valid evaluations. These strategies—while in frequent, or even general, use—should be applied with caution, carefully considering the attributes cited in the guide, and relating them to the specific conditions for which they are being considered. Implementation can proceed with some degree of assurance that there is not likely to be a negative impact on safety and very likely to be a positive one. It is intended that as the experiences of implementation of these strategies continue under the AASHTO Strategic Highway Safety Plan initiative, appropriate evaluations will be conducted so that effectiveness information can be accumulated to provide better estimating power for the user and the strategy can be upgraded to a "proven" (P) one.
- Experimental (E)—Those strategies that have been suggested and that at least one agency has considered sufficiently promising to try on a small scale in at least one location. These strategies should be considered only after the others have proven not to be appropriate or feasible. Even where they are considered, their implementation should initially occur using a very controlled and limited pilot study that includes a properly designed evaluation component. Only after careful testing and evaluations show the strategy to be effective should broader implementation be considered. It is intended that as the experiences of such pilot tests are accumulated from various state and local agencies, the aggregate experience can be used to further detail the attributes of this type of strategy so that it can be upgraded to a "proven" (P) one.

Related Strategies for Creating a Truly Comprehensive Approach

The strategies listed above and described in detail below are those considered unique to this emphasis area. However, to create a truly comprehensive approach to the highway safety problems associated with this emphasis area, five types of related strategies should be included as candidates in any program planning process:

- Public Information and Education (PI&E) Programs—Many highway safety programs can be effectively enhanced with a properly designed PI&E campaign. The traditional emphasis with PI&E campaigns in highway safety is to reach an audience across an entire jurisdiction or a significant part of it. However, there may be a reason to focus a PI&E campaign on a location-specific problem. While this is a relatively untried approach, as compared with areawide campaigns, use of roadside signs and other experimental methods may be tried on a pilot basis. Within this guide, where the application of PI&E campaigns is deemed appropriate, it is usually in support of some other strategy. In such a case, the description for that strategy will suggest this possibility (see the attribute area for each strategy entitled "Associated Needs"). In some cases, specialized PI&E campaigns are deemed unique for the emphasis area and are detailed in the guide. In the future, additional guides may exclusively address the details regarding PI&E strategy design and implementation.
- Enforcement of Traffic Laws—Well-designed and -operated law enforcement programs can have a significant effect on highway safety. It is well established, for instance, that an

effective way to reduce crashes (and their severity) is to have jurisdictionwide programs that enforce an effective law against driving under the influence (DUI) or driving without seat belts. When that law is vigorously enforced with well-trained officers, the frequency and severity of highway crashes can be significantly reduced. This should be an important element in any comprehensive highway safety program. Enforcement programs, by nature, are conducted at specific locations. The effect (e.g., lower speeds, greater use of seat belts, and reduced impaired driving) may occur at or near the specific location where the enforcement is applied. This effect can often be enhanced by coordinating the effort with an appropriate PI&E program. However, in many cases (e.g., speeding and seat belt usage), the impact is areawide or jurisdictionwide. The effect can be either positive (i.e., the desired reductions occur over a greater part of the system) or negative (i.e., the problem moves to another location as road users move to new routes where enforcement is not applied). Where it is not clear how the enforcement effort may impact behavior, or where an innovative and untried method could be used, a pilot program is recommended. Within this guide, where the application of enforcement programs is deemed appropriate, it is often in support of some other strategy. Many of those strategies may be targeted at either a whole system or a specific location. In such cases, the description for that strategy will suggest this possibility (see the attribute area for each strategy entitled "Associated Needs"). In some cases, where an enforcement program is deemed unique for the emphasis area, the strategy will be detailed. As additional guides are completed, they may detail the design and implementation of enforcement strategies.

- Strategies to Improve Emergency Medical and Trauma System Services—Locating and treating injured parties at highway crashes can significantly impact the level of severity and length of time during which an individual spends in treatment. This is especially true when it comes to timely and appropriate treatment of severely injured persons. Thus, a basic part of a highway safety infrastructure is a well-based and comprehensive emergency care program. While the types of strategies included here are often thought of as simply support services, they can be critical to the success of a comprehensive highway safety program. Therefore, an effort should be made to determine if there are improvements that can be made to this aspect of the system, especially for programs focused upon location-specific (e.g., corridors) or area-specific (e.g., rural areas) issues. Additional guides may detail the design and implementation of emergency medical system strategies.

- Strategies Directed at Improving the Safety Management System—The management of the highway safety system is foundational to success. There should be a sound organizational structure, as well as infrastructure of laws, policies, and so forth to monitor, control, direct, and administer a comprehensive approach to highway safety. A comprehensive program should not be limited to one jurisdiction, such as a state department of transportation (DOT). Local agencies often must deal with most of the road system and its related safety problems and are more familiar with their problems. Additional guides may detail the design and implementation of strategies for improving safety management systems.

- Strategies That Are Detailed in Other Emphasis Area Guides—Any program targeted at the safety problem covered in this emphasis area should be created having given due

consideration to the inclusion of other applicable strategies covered in the following guides:

- Volume 4: A Guide for Addressing Head-On Collisions (http://safety.transportation.org/guides.aspx?cid=25)
- Volume 6: A Guide for Addressing Run-Off-Road Collisions (http://safety.transportation.org/guides.aspx?cid=27)
- Volume 7: A Guide for Reducing Collisions on Horizontal Curves (http://safety.transportation.org/guides.aspx?cid=32)
- Volume 13: A Guide for Reducing Collisions Involving Heavy Trucks (http://safety.transportation.org/guides.aspx?cid=34)

Objective 6.1 A—Make Roadways Safer for Drowsy or Distracted Drivers

Strategy 6.1 A1—Install Shoulder and/or Centerline Rumble Strips (P/T)

General Description

Rumble strips are raised or grooved patterns added to the paved surface of a roadway that produce both noise and vibration when a vehicle's tires travel across them. When placed along roadside shoulders, they alert drivers when they are about to run off the roadway, and when placed along centerlines, they alert drivers when they have inadvertently crossed into an opposing travel lane. Both placements have been described in earlier guides: shoulder rumble strips in the guide for addressing run-off-road collisions (Volume 6, http://safety.transportation.org/guides.aspx?cid=27), and centerline rumble strips in the guide for addressing head-on collisions (Volume 4, http://safety.transportation.org/guides.aspx?cid=25).

While not all roadway departure collisions are attributable to drowsy driving, research shows that a large percentage of them are. Morena (2003) distinguishes between run-off-road and a subset of drift-off-road collisions. Whereas run-off-road crashes can occur for many reasons (loss of control, swerving to avoid another vehicle or object, icy roadway conditions, etc.), drift-off-road crashes are solely attributed to drowsy or inattentive drivers. The Federal Highway Administration (FHWA) Rumble Strip website (http://safety.fhwa.dot.gov/roadway_dept/rumble/index.htm) estimates that 40–60 percent of single-vehicle crashes on rural freeways are actually drift-off-road crashes. In examining Michigan roadway data, Morena arrived at a much lower percentage of 16 percent, in part because nearly half (48 percent) of the run-off-road collisions in that state occurred on snowy or icy roadways and an additional 9 percent occurred on wet roadways (Morena, 2003).

In investigating the effectiveness of shoulder rumble strips in preventing only these drift-off-road collisions, Morena (2003) concluded that the rolled-in rumbles and the concrete intermittent rumbles reduced crash frequency by 20 percent, whereas the milled design reduced crash frequency by 39 percent. Earlier studies conducted in Pennsylvania and New

York State had reported 60- to 65-percent reductions in drift-off-road crashes associated with use of the milled rumble strips (Hickey, 1997; Perrillo, 1998). Together, these studies confirm the effectiveness of milled rumble strips in alerting distracted or drowsy drivers traveling on Interstate and other multi-lane roadways in time to avoid a crash.

A variation on the typical installation of rumble strips is being practiced in Utah. Here, test sections of shoulder rumble strips are being painted with glass beads on the inside surface facing approaching traffic, making the edge of the road more visible to motorists at nighttime and under adverse weather conditions. The intent is to help drivers maintain alertness and avoid a run-off-road situation.

Today, most but not all states have adopted policies that require or encourage use of shoulder rumble strips on rural Interstates and Interstate-like roadways. In addition, rumble strips are increasingly being used on rural two-lane roadways. This is important, since analysis of 2000–2003 CDS crash data shows that three-fourths of drowsy driving crashes occur on two-lane roadways. In these situations, where wide paved shoulders are often lacking, states have been experimenting with "edgeline" and other modified shoulder rumble strips (see Strategy 6.1 A2). The modified rumble strips are narrower and retain a greater portion of the roadway shoulder for use by bicyclists.

Shoulder rumble strips are proven effective on freeways. Their incorporation on two-lane rural highways is relatively recent, and hence their effectiveness in the two-lane rural environment has yet to be proven. Two-lane highways have generally lower traffic volumes than freeways, but the quality of the roadside is generally not as good, and run-off-road crashes are the predominant type on such roads. As of the date of publication of this guide, there were a number of studies underway to measure the effectiveness of shoulder rumble strips in reducing run-off-road (and drowsy driving) crashes in the two-lane rural environment.

Another application of rumble strips is along the centerline of two-lane roads. As described in the guide for reducing head-on collisions (see Strategy 18.1 A1) and also in the guide for reducing collisions on horizontal curves (see Strategy 6.2 A5), centerline rumble strips vary in design, but generally straddle the centerline and extend 5 inches to 1.5 feet into the travel lane. Although they were designated as "tried but unproven" in the earlier guides, a recent study carried out by the Insurance Institute for Highway Safety showed that the centerline rumble strips decreased head-on and opposing-direction sideswipe crashes on rural two-lane roads by 21 percent and injury crashes by 25 percent (Persaud et al., 2003). The study compared crash rates on 210 miles of roadway in seven states (California, Colorado, Delaware, Maryland, Minnesota, Oklahoma, and Washington) where centerline rumble strips had been installed, with comparable untreated roadway sections.

Finally, some states are experimenting with the use of *midlane* rumble strips in locations where there is not adequate shoulder width to accommodate a shoulder rumble strip. The midlane rumble strips, which are placed in the center of the travel lane, alert drowsy or distracted drivers in the same way as shoulder or centerline rumble strips. However, there are a number of unresolved issues surrounding their use, including their effects on motorcyclists and whether they might themselves serve as a distraction to drivers. Midlane rumble strips are discussed in the run-off-road guide as an experimental strategy (see Strategy 6.1 A3).

As referenced above, the FHWA maintains a website providing information on a variety of issues surrounding shoulder and centerline rumble strips. The website contains the most recent FHWA Technical Advisory regarding roadway shoulder rumble strips and a link to a recent synthesis study summarizing the current state of the practice. Both documents provide guidance with respect to installing rumble strips. They also discuss the effects of rumble strips on other roadway users, especially bicyclists, and how to mitigate potential adverse effects. The FHWA website can be accessed at http://safety.fhwa.dot.gov/roadway_dept/rumble/index.htm. States are encouraged to refer to the website regularly for updated information about the use and effectiveness of rumble strip applications in keeping vehicles safe on the roadway.

For more detail on attributes, cost, effectiveness, and applications of rumble strips, the reader is encouraged to consult the accompanying *Guide for Addressing Run-Off-Road Collisions* (http://safety.transportation.org/guides.aspx?cid=27) and *Guide for Addressing Head-On Collisions* (http://safety.transportation.org/guides.aspx?cid=25).

Strategy 6.1 A2—Implement Other Roadway Improvements to Reduce the Likelihood and Severity of Run-Off-Road and/or Head-On Collisions (P/T)

General Description

Drowsy driving crashes typically involve a single vehicle traveling on a higher speed roadway departing the roadway or traveled way (NHTSA/NCSDR, 1998b). Thus, roadway improvements such as wider paved shoulders and median barriers that reduce the likelihood and severity of run-off-road and other lane departure collisions will also likely reduce many crashes resulting from drowsy driving.

Less is known about crashes due to driver distraction, in part because there is less available data for studying these crashes, but also because there are many different sources of driver distraction contributing to a wider variety of crash types. Overall, however, the data show that crashes involving distracted drivers are also more likely to involve a single vehicle departing the roadway or travel lane. Data from the 2000–2003 National Sampling System Crashworthiness Data System examined in Section III of this guide showed that while only 20 percent of drivers who were judged to be attentive at the time of their crash were involved in single-vehicle crashes, 32 percent of distracted drivers and 77 percent of sleepy or asleep drivers were in single-vehicle collisions.

Given these characteristics, a number of other strategies identified in the run-off-road and head-on guides may also be effective in reducing crashes and injuries due to drowsy and/or distracted driving. They include

- Applying shoulder treatments that keep vehicles from encroaching on the roadside, such as eliminating shoulder drop-offs and widening and paving shoulders (see Strategy 6.1 A8 in the guide for addressing run-off-road collisions);
- Providing enhanced pavement markings (see Strategy 6.1 A6 in the guide for addressing run-off-road collisions);
- Providing wider cross sections on two-lane roads (a relatively costly option) (see Strategy 18.1 A3 in the guide for addressing head-on collisions) and reallocating total

two-lane roadway width to include a narrow "buffer median" (see Strategy 18.1 A5 in the guide for addressing head-on collisions) to reduce encroachments into opposing travel lanes.

- Providing enhanced shoulder or in-lane delineation and marking for sharp curves (see Strategy 6.1 A4 in the guide for addressing run-off-road collisions) and enhanced pavement markings at high-risk locations (see Strategy 6.1 A6 in the guide for addressing run-off-road collisions).
- Installing median barriers for narrow-width medians on multi-lane roads (see Strategy 18.1 B2 in the guide for addressing head-on collisions);
- Minimizing overturning in the event a vehicle does run off the road, including designing safer slopes and ditches (see Strategy 6.1 B1 in this guide) and removing or relocating objects in hazardous locations (see Strategy 6.1 B2 in this guide); and
- Reducing the severity of run-off-road crashes, including improved design of roadside hardware (see Strategy 6.1 C1 in this guide) and improved design and application of barrier and attenuation systems (see Strategy 6.1 C2 in this guide).

The effectiveness of these strategies have not been evaluated specifically with respect to drowsy and distracted driving crashes. However, all have been tried and either proven effective or shown promise in preventing lane departures or in lessening the severity of such departures. Since many distracted and drowsy driving crashes are known to involve lane departures, it is reasonable to assume that such countermeasures would also reduce these types of crashes. Note that many of these strategies are also referenced in the *Guide for Reducing Collisions on Horizontal Curves* (http://safety.transportation.org/guides.aspx?cid=32) and are similarly characterized by roadway departure collisions.

An example of a specific roadway treatment that may benefit both drowsy and distracted drivers is the "safety edge," designed to prevent crashes caused by unsafe pavement edge drop-offs. The safety edge is a paved fillet of 45º or less added to the pavement edge during new construction or resurfacing that provides a transition section and allows a departing vehicle to return safely to the roadway (see Exhibit V-2). FHWA is working with the Georgia DOT to demonstrate the treatment and to gain more experience in constructing the edge with various types of equipment and under various conditions (see http://safety.fhwa.dot.gov/media/pdf/safetyedge.pdf). Also, the AAA Foundation for Traffic Safety is sponsoring a study by the Center for Transportation Research and Education at Iowa State University and Midwest Research Institute examining the safety impacts of pavement edge drop-offs. A final report on the project is due in the summer of 2005. For information, contact Scott Osberg at sosberg@aaafoundation.org.

As another example, many states are replacing standard guardrails with median cable barriers, which are more forgiving upon impact. The Utah DOT is installing cable median barriers along divided highway corridors with high rates of head-on collisions, resulting in significant reductions in serious and fatal injuries (see Exhibit V-3).

For more detail on attributes, cost, effectiveness, and applications of these various roadway treatments, the reader is encouraged to consult the accompanying guide for addressing run-off-road collisions and guide for addressing head-on collisions.

EXHIBIT V-2
Roadway Safety Edge

EXHIBIT V-3
Utah's Cable Median Barrier

Strategy 6.1 A3—Implement Roadway Improvements to Reduce the Likelihood and Severity of Other Types of Distracted and Drowsy Driving Crashes (T/E)

General Description

The unsignalized intersection guide contains a number of strategies under the general objective of improving driver awareness of intersections as viewed from the intersection approach. One of the strategies is to "call attention to the intersection by installing [transverse] rumble strips on intersection approaches" (see Strategy 17.1 E6), and another is to "install flashing beacons at stop-controlled intersections" (see Strategy 17.1 E11). Both could help to alert drowsy or distracted drivers approaching an unanticipated intersection.

Improved roadway delineation can also help drivers who are not fully alert respond to the demands of a changing roadway and traffic environment. Examples here include wider edge lines, raised pavement markings, and post-mounted delineators or chevrons. Strategies to improve roadway delineation have been described in several guides, including the unsignalized intersection guide noted above (Strategy 17.1 E1), the horizontal curve guide (Strategy 6.2 A2), and the run-off-road guide (Strategy 6.1 A6).

Interestingly, many of the roadway improvements identified in FHWA's *Highway Design Handbook for Older Drivers and Pedestrians* (Staplin et al., 2001; available at http://www.tfhrc.gov/humanfac/01103/coverfront.htm), intended to improve safety for older road users, should also benefit drowsy or distracted drivers. This is because roadway improvements designed to accommodate aging drivers' generally poorer vision, slower reaction times, poorer divided attention skills, and other functional declines will also accommodate drivers who may be similarly impaired due to drowsiness or lack of focus on the driving task. In other words, what is good for older drivers may benefit all drivers. Examples of the types of roadway treatments in the *Highway Design Handbook* that might also benefit drowsy or distracted drivers include advance stop signs; advance signing for lane closures; larger and more reflective signage; and improved delineation of curbs, medians, and obstacles. However, none of the recommended changes has been specifically evaluated with respect to reducing crashes due to distracted or drowsy driving.

Information on Agencies or Organizations Currently Implementing this Strategy

The Kansas Department of Transportation recently constructed the state's first high-speed rural roundabout at a site with a history of serious personal injury crashes. Although it is difficult to definitively link crashes at such locations to distracted and/or drowsy driving, driver inattention was believed to be a strong contributor to these crashes. See Appendix 3 for additional information on this experimental strategy.

Objective 6.1 B—Provide Safe Stopping and Resting Areas on Interstates

Strategy 6.1 B1—Improve Access to Safe Stopping and Resting Areas (T)

General Description

The importance of rest areas for reducing fatigue-related crashes for truck drivers was stressed in the guide for addressing crashes involving heavy trucks: Strategy 12.1 A1 describes the need to increase efficiency of use of existing parking spaces, and Strategy 12.1 A2 describes the need to create additional parking spaces for heavy trucks.

Rest areas are also important for safe motor vehicle operation. The California DOT website notes that "Rest areas provide opportunities for motorists to safely stop, stretch, take a nap, use the restroom, get water, check maps, place telephone calls, switch drivers, check vehicles and loads, and exercise pets. Rest areas reduce drowsy and distracted driving and provide a safe and convenient alternative to unsafe parking along the roadside" (Caltrans, 2004).

Studies have generally not revealed a shortage of rest area parking for non-commercial motor vehicle operators. However, some states continue to fall short in providing rest area facilities within the FHWA-recommended 50 miles or 1-hour driving time on major roadways. A 1989 NCHRP study estimated that while the average spacing between rest areas on Interstate highways nationwide was within this guideline, the average spacing *within individual states* ranged widely from 25 to 105 miles (King, 1989). States are encouraged to inventory their facilities with special attention to the needs of motorists and to explore options for expanding existing facilities or constructing new facilities where a need is indicated.

Constructing full-service rest areas is an expensive and time-consuming undertaking and is not in keeping with the focus of this guide on relatively inexpensive, short-term strategies for reducing distracted and drowsy driving crashes. In addition, such facilities are generally located on Interstate and other major roadways, whereas most crashes attributed to driver fatigue occur on two-lane rural roadways (NHTSA/NCSDR, 1998b).

To address the need for safe stopping and resting areas on these smaller roadways, it is recommended that states provide a continuum of options for safe stopping, ranging from smaller rest areas with most of the usual amenities to simple roadside parks with minimal or no amenities. Although some states already do this, the process may not be formalized, and there may not be any consistent signing and marking to announce these areas to motorists.

Appendix 4 provides information on Iowa's "roadside park" program, while Appendix 5 provides information on efforts in Texas to provide motorists expanded opportunities for safe stopping and resting. The latter has included innovative use of Federal Transportation Enhancement funds to both construct new facilities and renovate old facilities, all with the goal of making Texas roadways safer.

With regard to commercial motor vehicles, a 2002 FHWA report to Congress concluded that although overall truck and bus parking was adequate when both public and private facilities are considered, a shortage of total parking may exist in 12 states (FHWA, 2002). Parking supply generally exceeds demand at commercial truck stops, but the demand for truck parking spaces at public rest areas exceeds supply levels. As part of the study, individual state action plans were drafted to begin addressing these shortages. A combination of approaches was identified by the states, including expansion and improvement of existing public rest areas, expansion and improvement of commercial truck stops and travel plazas, formation of public-private partnerships, education of drivers about available spaces, provision of real-time information to drivers about space availability, and modification of parking enforcement rules (FHWA, 2002). States are encouraged to follow through with these recommendations as appropriate for their own situations.

Although there is no shortage of parking at commercial truck stops in most areas of the country, these stops are typically located off the Interstate and require a driver to exit the road to stop. A common complaint of truck drivers is the lack of real-time information on truck parking availability. It is believed that truck drivers would make better use of truck stop parking if they knew in advance whether spaces were available.

One of the recommendations of the FHWA study was that intelligent transportation systems be developed and deployed to provide commercial drivers with real-time information on the location and availability of parking spaces. Accordingly, the FMCSA Office of R&T is working with the Volpe National Transportation Systems Center to develop and pilot test "Smart Park" systems. A report describing this application and system requirements has been published (Smith et al., 2004), and a broad agency announcement soliciting proposals is imminent at this writing. Phase I of the initiative will include design and feasibility studies, followed by demonstrations and evaluation in Phase II. This program will involve a partnership of federal and state agencies, the truck stop industry, and the trucking industry. Appendix 6 provides the Volpe report, entitled *Intelligent Transportation Systems and Truck Parking*.

An additional strategy that can be implemented relatively quickly and at relatively low cost is to open weigh stations to parking by truck drivers. The majority of states now allow truck drivers to stop at weigh stations when not in use, and some states even provide added amenities such as restroom facilities and vending machines. See Appendix 7 for an example from the Kentucky Transportation Cabinet.

Information on Agencies or Organizations Currently Implementing this Strategy

The Minnesota DOT has developed an extensive program for rest area construction, maintenance, and operation that is in large part driven by the need to address the needs of drowsy drivers. The program was developed to ensure that resources expended on rest areas were achieving their primary function of meeting safety needs. The program includes public-private partnerships. See http://www.dot.state.mn.us/restareas.

EXHIBIT V-4
Strategy Attributes for Improving Access to Safe Stopping and Resting Areas (T)

Technical Attributes	
Target	The target audience for this strategy is both commercial and private vehicle operators seeking a safe place to stop and rest or take a break from driving.
Expected Effectiveness	A 1989 NCHRP report found the safety benefits of roadside rest areas to be difficult to measure and quantify (King, 1989). The author concluded the following: "The preceding analysis of the effects of highway rest areas on highway safety has shown that these effects operate through different mechanisms including: reduction in voluntary shoulder stops; some reduction in involuntary stops and in vehicle-miles of travel by defective vehicles and impaired drivers; reduction of driver or passenger discomfort or other sources of driver distraction; transmission of safety-related information to drivers; and reduction of driving under hazardous weather, roadway and visibility conditions." Thus, even if the presence of rest areas is found to be associated with a decrease in crashes, it may or may not reflect a decrease in crashes due to drowsy or distracted driving.
Keys to Success	Partnerships with the private sector can be a key to constructing new rest area facilities or expanding existing facilities, especially with regard to large trucks and on non-Interstate roadways.
Potential Difficulties	Cost can be a significant barrier to constructing new rest area facilities. Some states have sought alternative funding, such as transportation enhancement program funds, and/or partnered with the private sector.
Appropriate Measures and Data	There are clear challenges in demonstrating a reduction in sleep-related crashes attributable to rest areas. However, process measures of the success of efforts to improve rest area availability and access include number and type of rest spaces provided, number of users during daytime and nighttime hours, average duration of a stop, number and percentage of parking spaces occupied, etc. In addition, subjective data (for example, reasons for stopping) might be gathered directly from surveys of users.
Associated Needs	Efforts to improve rest area availability and access are best carried out as part of a comprehensive statewide plan that has broad public input and support, especially with regard to potential partnerships with the private sector. Since commercial truck stops typically have many more available parking spaces than public rest areas, cooperative efforts with the truck stop industry may have the greatest potential to allay commercial vehicle rest parking problems.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Existing policies might restrict a state's ability to form partnerships with other agencies or with the private sector to expand rest area facilities. A state may need to review and revise policies regarding provision of rest areas, as well as the provision and design of roadside parks or pullouts. The Minnesota DOT has established a series of policies governing the location and operation of their rest areas. See http://www.dot.state.mn.us/restareas.
Issues Affecting Implementation Time	Implementation time depends on the specific improvements being made. For a new facility with parking for both commercial vehicles and cars, along with restrooms, picnic areas and other amenities, more than a year will be required for planning, design, contracting for services, and construction. For pullout facilities with no special amenities, a few months' time may be sufficient. To some extent, implementation time will depend on where a state currently stands with regard to having a comprehensive plan and facilitating policies in place (see above).
Costs Involved	As noted above, costs are the primary constraint in constructing new rest area facilities or expanding existing facilities. These costs will vary widely depending upon the need for land acquisition, availability of suitable building sites, and construction costs. They can be reduced considerably, however, if partnerships are pursued in the private sector or if more limited options, such as roadside parks, are adopted for expanding the availability of safe stopping and resting areas.

(*continued on next page*)

EXHIBIT V-4 (Continued)
Strategy Attributes for Improving Access to Safe Stopping and Resting Areas (T)

Training and Other Personnel Needs	None identified.
Legislative Needs	A number of federal regulations govern activities within rest areas along the Interstate system. States may have or need legislation to enable public-private partnerships, long-term leasing arrangements, or other contractual arrangements designed to enable construction of rest areas. A summary of applicable federal legislation and legislation in Minnesota governing rest areas is included in the section on Governance in Minnesota's Rest Area program website: http://www.dot.state.mn.us/restareas/.
Other Key Attributes	
	None identified.

The FMCSA Office of R&T has initiated an experimental "Smart Park" program to provide real-time truck stop parking availability information to commercial drivers. The FMCSA will be working with industry, state, and local jurisdictions to develop and pilot test this program. The FMCSA R&T point-of-contact for "Smart Park" is Quon Kwan, (202) 385-2389, quon.kwan@fmcsa.dot.gov.

In addition to its 40 full-service rest areas, Iowa has approximately 140 "roadside parks" that provide safe stopping and resting areas on less traveled roadways. The areas are locally sponsored and maintained, with the Iowa DOT issuing permits for their construction and providing appropriate signage (see Appendix 4).

The Texas DOT maintains approximately 750 "pullout" style rest areas, primarily on less traveled two-lane roadways, and has used transportation enhancement funds to expand and improve its full-service rest areas (see Appendix 5).

Kentucky has opened its truck weigh stations to truckers needing safe overnight parking spaces for sleeping (see Appendix 7).

In contrast to the practice in the United States of providing large-scale, full-service rest areas, Canada has long maintained a system of more frequent, smaller opportunities for stopping and resting, including simple pullout areas for both trucks and cars. (See http://transcanadahighway.com for a sample map of available facilities.)

Strategy 6.1 B2—Improve Rest Area Security and Services (T)

General Description

A significant challenge facing states is persuading motorists to stop at rest areas when they are feeling drowsy or when something is distracting them from the task of driving. Surveys have revealed that many motorists are reluctant to use rest areas because of concerns for personal safety (Fact Finders, Inc., 1994; Euritt et al., 1992; King, 1989). Two-thirds of the respondents to a survey of licensed drivers in New York State said that they would be very

likely to stop at a rest area if they felt drowsy while driving; however, less than 30 percent said they would do so if driving alone at night, and for females, this percentage declined to just 17 percent (Fact Finders, Inc., 1994). Similar results were reported in an earlier study of motorists in Texas (Euritt et al., 1992).

To address problems of rest area security, the Rest Area Team for the New York State Task Force on Drowsy Driving recommended the following (New York State Task Force, 1994):

- Establishing state police substations or satellite offices at key rest area locations;
- Installing security lighting;
- Providing direct telephone access to the police;
- Investigating the feasibility of security cameras where appropriate;
- Employing uniformed DOT maintenance personnel at each rest area, with 24-hour staffing at selected rest areas; and
- Implementing design improvements, such as improved lighting and visibility from the roadway, to enhance rest area safety, security, and appearance.

In addition to being safe and secure, rest areas should be appealing to motorists, i.e., they should be clean, attractive, and provide basic amenities. To reduce drowsy driving crashes, rest areas should ideally provide an opportunity for motorists to get a hot cup of coffee, but for rest areas located along Interstates, only vending machines are typically available since federal law prohibits commercial operations on Interstate right-of-ways. One option is to allow private non-profit groups to dispense coffee, if not on a regular basis then during holidays or other peak travel periods. This is an approach that has been followed in California for a number of years (see http://www.dot.ca.gov/hq/LandArch/rest-areas.htm). Another option again involves joining with the private sector to construct and/or operate rest area facilities off of the Interstate right-of-way. The popularity of travel plazas along many toll roads and other private roadways attests to the importance of amenities for encouraging motorists to stop and take a break from driving. The Minnesota DOT has formed partnerships with a number of non-profit organizations to develop rest areas. The DOT is also seeking to change state legislation to enable and encourage private organizations to partner with the DOT in construction and operation of rest areas. See http://www.dot.state.mn.us/restareas and click on "Partnerships."

A growing number of states are moving beyond providing basic amenities to creating rest areas where motorists will *want* to stop and spend time. As part of its "Road Connect" program, Texas is in the process of equipping all of its rest areas and travel information centers with free wireless Internet service, along with pay-telephone-like kiosks for travelers without computers. The kiosks will enable motorists to access information on nearby sites, find accommodations, check weather conditions, etc. In addition, since 1999 TxDOT has used federal enhancement funding to update the state's rest areas and make them more attractive to motorists by designing facilities that incorporate regional history and culture and that blend in with the natural landscape (see Appendix 8).

Similar activities are underway in Iowa. Here, old and outdated rest area facilities are being replaced by new, theme-based buildings designed by a team of landscape architects and

artists. The themes are selected to reveal something about the history and significance of the area and help promote interest in local tourism. Since the program was begun in 1997, 10 of the state's 40 rest areas have been updated. More recently, the state has also moved to equip its rest areas with wireless Internet services that provide visitors with access to electronic monitors and maps with a wide range of options to assist them in their travels (see Appendix 9).

While these efforts in Texas and Iowa must be considered experimental with respect to reducing crashes due to drowsy and distracted driving, they clearly are designed to encourage motorists to stop and take a break from driving. Early evidence suggests that they are quite successful in this regard, with wireless Internet access appealing especially to young males, a high-risk group for drowsy driving crashes.

EXHIBIT V-5
Strategy Attributes for Improving Rest Area Security and Services (T)

Technical Attributes	
Target	The target audience for this strategy is both commercial and private vehicle operators seeking a safe place to stop and rest or take a break from driving.
Expected Effectiveness	Although improvements to rest area security and services have not been formally evaluated with respect to crash reduction, states that have undertaken such improvement have shown increased use of the facilities, greater self-reported security, and increased satisfaction with and use of services (Blomquist and Carson, 1998; New York State Task Force, 1994). In Texas, daily traffic counts at new rest area facilities have increased from 52 to 116 percent over those for the facilities they replaced (see Appendix 5).
Keys to Success	DOTs should work closely with state law enforcement agencies, in particular state highway patrol offices, to address any problems with respect to rest area security. In addition, attention should be paid to increasing public perception of safety when stopping at rest areas, for example, by providing on-duty security, call boxes, etc. Partnerships with non-profit organizations in the private sector can also help to expand rest area services.
Potential Difficulties	Costs can be a barrier to providing increased security, especially if this involves additional personnel to patrol and maintain rest area facilities. Regular patrol by law enforcement agencies may be difficult to achieve, due to dwindling budgets and demands for their primary services. Use of technology for remote surveillance will help overcome this. Costs to update and improve on existing facilities can also pose barriers, although it should be noted that wireless Internet providers generally bear most or all of the costs of providing this service, since they also reap benefits.
Appropriate Measures and Data	Process measures include the number and type of improvements and the number or percentage of spaces affected by the changes. Costs experienced will also need to be tabulated. There are clear challenges in demonstrating a reduction in sleep-related crashes attributable to rest areas. However, process measures of the success of efforts to improve rest area security and services might include observations of the number of users during daytime and nighttime hours, average duration of a stop, number and percentage of parking spaces occupied, number and types of crimes reported, etc. In addition, subjective data might be gathered directly from surveys of users, for example, regarding reasons for stopping, perceptions of safety, and services utilized.
Associated Needs	Efforts to improve rest area security and services are best carried out as part of a comprehensive statewide plan that has broad public input and support, especially with regard to potential partnerships in the private sector.

EXHIBIT V-5 (Continued)
Strategy Attributes for Improving Rest Area Security and Services (T)

Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Existing federal law prohibits commercial operations within the Interstate right-of-way, including the selling of coffee and other food and drink at rest areas (except from vending machines).
Issues Affecting Implementation Time	Implementation time depends on the specific improvements being made; much can be done in less than a year.
Costs Involved	Costs associated with improvements to existing facilities will vary depending upon the nature of the improvement. At the high end might be improvements to outdoor lighting, installation of security telephones and cameras, and restroom/facility renovation. Less expensive improvements might include landscaping, signage and information, or the addition of vending machines. Providing increased security at rest areas could involve ongoing personnel costs or might be incorporated into regularly scheduled law enforcement or maintenance activities. Some improvements, such as partnering with local service organizations to provide coffee during peak travel periods, should involve no significant costs.
Training and Other Personnel Needs	The only identified personnel needs would be any additional personnel to ensure rest area security, including time spent by highway patrol or other law enforcement personnel.
Legislative Needs	Enabling legislation may be needed within a state to allow private organizations to provide services at rest areas off the Interstate system.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing this Strategy

The North Carolina DOT Division of Motor Vehicle Enforcement Section conducts Operation Rest Assured, a statewide rest area safety and surveillance patrol program. For more information, call the DMV Enforcement Section at (919) 861-3185 or check the website at http://www.doh.dot.state.nc.us/operations/dp_chief_eng/roadside/rest/download/RestAreaFlyer.pdf.

The Illinois DOT is installing security cameras and call boxes in all of its 53 Interstate rest areas. Video images from the cameras will be available to the Illinois DOT, the Illinois State Police, and other law enforcement agencies so that they can monitor the rest areas on a routine basis or go to a specific camera when a call box is activated to help determine the problem (see http://transportation.org/aashto/success.nsf/allpages/33-ILCameras).

Further information on efforts in Texas to improve services at its rest areas is contained in Appendix 8, while information on Iowa's activities is contained in Appendix 9.

Objective 6.1 C—Increase Driver Awareness of the Risks of Drowsy and Distracted Driving and Promote Driver Focus

Strategy 6.1 C1—Conduct Education and Awareness Campaigns Targeting the General Driving Public (T)

General Description

Education by itself will not immediately effect change in population behavior. This is especially true if the educational intervention is an isolated event (e.g., a single TV public service announcement or a pamphlet in the mail) rather than a multi-faceted and sustained intervention over time. The latter can succeed in changing behavior if it alters the public mindset about what is acceptable and unacceptable behavior and creates new societal norms—in this case about driving while drowsy and driving while choosing to engage in other potentially distracting activities, such as talking on a cell phone. In this sense, education is a necessary, but by no means sufficient, condition for reducing crashes resulting from driver inattention. Many legislative countermeasures require an educational component, but even roadway and environmental countermeasures such as rest areas and rumble strips are most effective if they also incorporate an educational component, e.g., to inform motorists of their purpose and persuade them to heed their warnings.

The goals of a comprehensive educational campaign directed at reducing drowsy and/or distracted driving should be to increase public awareness of the problem, motivate a response (i.e., a change in behavior), and provide information on effective responses. As an example, the National Sleep Foundation (NSF) annually releases results of its Sleep in America poll to the media highlighting the prevalence of sleepiness among U.S. adults and the consequences of falling asleep while driving. Its website and related materials also outline the warning signs for drowsy driving and let drivers know exactly what does and does not work to counteract drowsiness behind the wheel (see www.drowsydriving.org). Working with NHTSA, the AAA Foundation for Traffic Safety, and others, NSF conducts an ongoing national public awareness campaign to reduce drowsy driving.

In the case of distracted driving, public education campaigns and materials have sometimes focused on the broad problem of driver inattention and have sometimes more narrowly focused on specific causes of driver inattention, such as cell phones. Examples of the former include the Network of Employers for Traffic Safety's (NETS's) "Who's Driving" campaign and the AAA Foundation for Traffic Safety's "Pay Attention" brochure. Examples of the latter include efforts by the California Highway Patrol to educate drivers in that state about the dangers of cell phone use while driving, as well as PI&E efforts by individual insurance and cell phone companies.

Many of these materials are available to states to adopt and use in their own PI&E campaigns. In particular, states are encouraged to regularly check NHTSA, NSF, AAA Foundation for Traffic Safety, and NETS websites for updated information on programs and materials for reducing drowsy and distracted driving.

One very important message to convey with respect to drowsy driving is the synergistic effects of sleep loss and alcohol. Most people are unaware that even modest sleep loss, when

accompanied by alcohol, can result in significant decreases in performance and alertness (Lumley et al., 1987; Dement and Vaughan, 1999). This is important, given that alcohol is a factor in 15-20 percent of sleep crashes identified on police crash files (Pack et al., 1995; Wang et al., 1996). Other important messages to convey are the effects of medications and drugs on alertness and the dangers associated with undiagnosed sleep disorders, such as sleep apnea.

With respect to distracted driving, it is important to emphasize that *any* activity that draws a driver's attention from the primary task of driving can increase the risk of crashing. Cell phones are often singled out as a source of distraction, but as the data presented in Section III of this report clearly show, many activities distract drivers and lead to crashes—manipulating the radio or CD player, reaching for objects inside the vehicle, eating and drinking, and tending to young children are all important sources of distraction. And even if drivers have their "hands on the wheel and eyes on the road," they can still be at risk of crashing if they are not cognitively focused on the task of driving.

In addition to print materials, public service announcements, billboards, and other typical mediums for a public information and awareness campaign, states should incorporate information on drowsy and distracted driving in their driver license manuals and on their driver license tests. A June 2003 review of state driver license manuals by the AAA Foundation for Traffic Safety revealed that only six (Arkansas, Michigan, Minnesota, New Jersey, Virginia, and Wisconsin) contained sections on distracted driving. And while 20 states did note potential dangers of cell phone use while driving, less than half this number discussed other potential distractions such as eating and drinking, reading, radio controls, and distractions from children and other passengers (AAA Foundation for Traffic Safety, 2003). By incorporating information on drowsy and distracted driving into state driver license manuals and tests and making materials available at licensing offices, state departments of motor vehicles (DMVs) can help raise public awareness of these important safety issues.

EXHIBIT V-6
Strategy Attributes for Conducting Education and Awareness Campaigns Targeting the General Driving Public (T)

Technical Attributes	
Target	The target population for this strategy is the general driving public.
Expected Effectiveness	By their nature, public education and awareness campaigns are difficult to evaluate, and research is still needed to identify the most effective messages and most effective approaches for conveying information. As noted above, interventions of this sort are implemented primarily to support other interventions, as well as to help cultivate long-term changes in public attitudes and behaviors.
Keys to Success	Research has shown that the most effective education and awareness campaigns are those that are multi-faceted and long term. Partnerships with non-government organizations in the private sector (e.g., the NSF, the Network of Employers for Traffic Safety, and AAA) can greatly expand available resources. Involvement of marketing professionals in developing campaign materials and strategies can also increase the likely success of a campaign. To reach the broadest audience, campaigns utilizing television and radio media generally need to include some paid or donated media coverage in addition to free public service announcements.
Potential Difficulties	There may be difficulties in agreeing on the educational message or content of the campaign. Some states have been reluctant to provide information about steps drivers can take to avoid

(*continued on next page*)

EXHIBIT V-6 (Continued)
Strategy Attributes for Conducting Education and Awareness Campaigns Targeting the General Driving Public (T)

Difficulties	a distracted or drowsy driving crash because of fears of liability. For example, even though brief naps accompanied by caffeine intake (equivalent to two cups of coffee) has been demonstrated to improve alertness in drowsy drivers, states may be reluctant to publicize this information since drivers may follow this advice but still crash, and blame the state for their crash. The NSF and NHTSA are good resources to draw upon regarding the appropriateness of information being presented.
Appropriate Measures and Data	Process measures include the typical ones for these types of campaigns. The number and types of message delivery, as well as the types of media, may be documented. Typical measures of effectiveness of a public education and awareness campaign include the percentage of the targeted audience who report being aware of the campaign and are knowledgeable of its messages. As noted above, however, most public education and awareness efforts with regard to traffic safety are carried out for broader purposes and are not expected by themselves to have a measurable impact on driver behavior or involvement in crashes.
Associated Needs	Partnerships with the private sector can be instrumental to the success of a comprehensive public education and awareness campaign. A professional public information service may be needed.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	None identified.
Issues Affecting Implementation Time	These issues would depend on the scope of the public education efforts. Large-scale media campaigns obviously would require much more “up front” planning and coordination than more confined efforts, such as revising a driver license manual or producing a brochure or other print material.
Costs Involved	Similar to the above issue, costs would be highly variable depending upon the nature and scope of the educational effort. Large-scale public education campaigns can be expensive, especially if carried out over an extended timeframe. Shorter “spot campaigns” conducted, for example, during peak travel periods at holidays, will have lower associated costs.
Training and Other Personnel Needs	If public agency personnel, such as law enforcement officers, are to be used to deliver messages during public contacts, some briefing training for them (e.g., roll-call training) may be needed.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing this Strategy

NETS, a public-private partnership dedicated to improving traffic safety in the workplace, has developed “Who’s Driving?” a workplace program that specifically addresses distracted driving, and “Asleep at the Wheel,” a program addressing drowsy driving. Information on both programs can be obtained from the NETS website at http://www.trafficsafety.org/.

The Utah DOT and Utah Highway Patrol have teamed with Med One Medical to conduct a broad-based campaign to educate the public about the dangers of drowsy driving. Information on their “Sleep Smart Drive Smart” campaign is available at

http://www.sleepsmartdrivesmart.com/. Also, see Appendix 10 on partnering with other agencies and organizations to increase public awareness.

AAA California and the AAA Foundation for Traffic Safety have teamed to develop two radio and one television public service announcements (PSAs). During October–December, 2003, the radio PSAs were distributed to 750 radio stations, were broadcast an estimated 22,000 times, and reached a total estimated audience of over 79 million persons. For information about these materials, contact Fairly Washington, Communications Director, at (202) 638-5944. The AAA Foundation has also produced a number of brochures and other materials on distracted and drowsy driving that can be ordered from their website (http://www.aaafoundation.org/products/index.cfm).

AAA South developed the "Stay Focused: Keep Your Mind on the Road" campaign to educate motorists about common distractions and their effects on driving, along with tips for better managing these distractions. See http://www.aaasouth.com/acs_news/focus.asp.

In response to high crash rates along sections of Route 18 and Route 22 in northwest Oregon, ODOT created an innovative public-private partnership to conduct a three-pronged campaign of education, engineering, and enforcement. Since many of the crashes occurring were cross-over crashes, the educational campaign used billboards, tabletop "tent" ads, bumper stickers, and movie screen advertising to focus attention on the hazards of drowsy driving in the corridor. For more information on the campaign, see http://www.tfhrc.gov/pubrds/02mar/03.htm.

The American Medical Association has adopted a broad policy defining sleepiness behind the wheel as a major public health issue and encouraging a national public education campaign by appropriate federal agencies and relevant advocacy groups. See the full policy statement on the website at http://www.ama-assn.org/apps/pf_new/pf_online?f_n=browse&doc=policyfiles/HnE/H-15.958.HTM.

An anti-drowsy driving campaign message used in Utah and some other states makes use of pillows, laid out on the ground as coffins, to symbolize the number of people killed in traffic crashes due to drowsy driving. See Appendix 11 for photos of Utah's "36 Pillow" media event.

Strategy 6.1 C2—Visibly Enforce Existing Statutes to Deter Distracted and Drowsy Driving (E)

General Description

Enactment of legislation prohibiting or restricting drivers from using cell phones or engaging in other potentially distracting activities while driving is a controversial topic. The National Conference of State Legislatures reports that since 1999 every state has considered legislation related to the use of wireless phones (Sundeen, 2003). However, no state currently bans talking on all types of cell phones while driving, and only two states (New York and New Jersey) plus the District of Columbia prohibit use of hand-held phones. As of August 2004, 17 states have enacted legislation placing some level of restriction on cell phone use, most often by school bus drivers and sometimes by novice drivers (Sundeen, 2003; GHSA, 2004). In addition, 10 states considered legislation in 2003 directed at driving distractions beyond cell phone use (Sundeen, 2003).

To date, there is little evidence that such legislation changes driver behavior with regard to cell phone use. An evaluation of the long-term effects of the New York State law, which went into effect November 2001, showed that following an initial decline (from 2.3 percent to 1.1 percent) in the percentage of drivers observed using hand-held cell phones, use rates climbed back to 2.1 percent 16 months post-law (McCartt and Geary, 2004). The authors concluded that, as with other traffic safety laws, enforcement *and publicity of enforcement* are critical to compliance. Even though enforcement of the New York ban on hand-held phone use had been fairly consistent, averaging 7,800 citations per month during the previous year, media attention had declined and there was no ongoing, coordinated enforcement and publicity campaign to reinforce compliance with the law.

Although laws prohibiting use of hand-held cell phones while driving have not been proven effective in terms of reduced cell phone use and crashes, the media attention surrounding passage of a law (and subsequent enforcement) can have the positive effect of raising public awareness of the importance of maintaining focus while driving. At the same time, such laws might also have a *negative* effect if they send a message that use of *hands-free* cell phones is "safe," leading to more frequent and/or longer conversations. A study published in the *New England Journal of Medicine* showed no safety benefits from the use of hands-free versus hand-held cell phones (Redelmeier and Tibshirani, 1997), a finding that has been confirmed in laboratory and simulator studies (Strayer et al., 2002). In general, the cognitive distraction of cell phone conversations is what is most critical to motoring safety.

Rather than trying to legislate driver behavior directly, an alternative approach to discouraging distracted and drowsy driving is to send a clear message to the driving public that those who choose to engage in potentially distracting activities while driving, or who choose to drive when drowsy or fatigued, will be held accountable for their decision should a crash occur. New Jersey recently enacted "Maggie's Law," which allows criminal prosecution of fatigued drivers who cause injury to someone in a crash. The law defines fatigue as being without sleep for a period of 24 hours or more and allows prosecution under the state's existing vehicular homicide statute pertaining to reckless driving. Although problems remain in crafting laws that are neither too broad nor too narrow, and that can be enforced by the judicial system, there appears to be strong public support for laws that can be effectively applied to prosecute the most serious instances of abuse.

Even without such legislation, however, law enforcement officials can send a powerful educational message to the public if they actively enforce statutes already in place to sanction serious instances of distracted or drowsy driving. As a starting point, drivers who cause crashes due to their willful engagement in distracting activities, or due to driving while drowsy, should be cited and prosecuted. In response to a recent survey by the NSF, 48 states indicated that they could prosecute such cases under their state's existing statutes. However, states need to evaluate their situation more closely to determine the extent to which drivers actually *are* being cited and prosecuted, and to identify barriers to successful prosecution. If the evidence suggests that cases of inattentive driving are not being taken seriously either by law enforcement officials or the judiciary, then steps should be taken to educate and inform these key parties. If cases are being prosecuted, either in criminal or civil courts, then word needs to get out to the public that this is being done.

By bringing the issue of distracted and drowsy driving before the public and fostering public debate on the legal responsibilities of drivers and the role of law enforcement and the courts

in upholding these responsibilities, states will be educating the public about the risks of distracted and drowsy driving. The long-term goal of such efforts is to effect a change in public attitudes and behaviors so that people are less likely to choose to engage in potentially distracting activities while driving or to drive impaired from inadequate sleep.

EXHIBIT V-7
Strategy Attributes for Visibly Enforcing Current Statutes to Deter Distracted and Drowsy Driving (E)

Technical Attributes	
Target	The primary target for this strategy is the general driving public; however, law enforcement officials and the judiciary may also be targeted.
Expected Effectiveness	The effectiveness of increased enforcement and prosecution of instances of distracted and drowsy driving has not been evaluated. Many factors could impact the effectiveness of this strategy. These include the overall level of enforcement, the nature of the cases (especially whether or not they are "high-profile" cases), media coverage, and the degree of cooperation from prosecuting lawyers and judges. In general, from similar experience in enforcing sanctions against drunk driving, the effectiveness of this strategy is best viewed on a long-term basis and as part of larger efforts to increase public awareness and understanding of the problem.
Key to Success	A key to the success of this strategy is strong support from law enforcement officials and the judiciary. Communicating the problem and benefits to law enforcement and judicial leaders will help to create a facilitating environment. A "champion" to support this effort from within the law enforcement ranks will be a major factor for success.
Potential Difficulties	In the absence of an objective measure of drowsiness, akin to the blood alcohol concentration for drunk driving, obtaining convictions for driving while drowsy will continue to pose challenges. A recent New Jersey law attempts to overcome this limitation by defining fatigue as reckless driving if a person has been awake for 24 or more hours. Driving distractions exist along an even broader continuum, making it difficult to prosecute all but the most flagrant instances of abuse or most serious crashes. Unfortunately, it is unlikely that these difficulties will be resolved in the near future.
Appropriate Measures and Data	Measures to evaluate the success of this strategy include the number of reported warnings or citations issued by law enforcement for distracted or drowsy driving; the number of crashes where distracted or drowsy driving is identified as a contributing factor; the percentage of drivers identified as distracted or drowsy at the time of the crash who are cited for these impairments; and the ultimate disposition of these citations. Process data should also be collected on training activities by law enforcement offices and on the level of media coverage (newspaper articles, TV, and radio) of crashes attributed to drowsy or distracted driving. Finally, opinion polls might track public perception of the problem and perceived likelihood that those guilty of distracted or drowsy driving will be punished.
Associated Needs	See training and other personnel needs below.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Existing policies with regard to identifying, citing, and prosecuting distracted and fatigued drivers may need to be modified to support the actions being recommended as part of this strategy. Cooperation between the principal agencies (e.g., DOT, law enforcement, and judiciary) will be needed, suggesting that a formal liaison function be established.
Issues Affecting Implementation Time	Unless a state chooses to pursue legislation, this strategy can be implemented within a relatively short time frame.

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EXHIBIT V-7 (Continued)
Strategy Attributes for Visibly Enforcing Current Statutes to Deter Distracted and Drowsy Driving (E)

Costs Involved	Some costs may be involved for training law enforcement officials, informing the judiciary, and monitoring cases involving distracted or fatigued driving; however, these costs should be minimal.
Training and Other Personnel Needs	Law enforcement officials may need training in how to detect drowsiness as a factor in crashes and approaches for collecting more reliable information regarding cell phone use and other potential distractions as factors in crashes. They should also be educated about the important role they can play in informing the public about the dangers of distracted and drowsy driving as part of normal traffic patrol operations and other interactions with the public (see related strategy 6.1 D6). The judiciary may need to be informed about the nature of the problem and the seriousness of the effort in which their cooperation is needed.
Legislative Needs	Although legislation such as New York State's ban on hand-held cell phones or New Jersey's "Maggie's Law" can make it easier for states to prosecute cases where distracted or drowsy driving has resulted in a crash, such legislation is not considered to be a requirement for this strategy.
Other Key Attributes	
	None identified

Information on Agencies or Organizations Currently Implementing this Strategy

The Governor's Highway Safety Association maintains a website that tracks state and local legislation with regard to cell phone use while driving. The website is http://ghsa.org/html/stateinfo/laws/cellphone_laws.html

Information on the New Jersey legislation addressing drowsy driving ("Maggie's Law") is available on the NSF website at http://www.drowsydriving.org/press_room/news_stories/maggiestmnt.cfm. The text of the law is also available at http://www.njleg.state.nj.us/2002/Bills/A1500/1347_R2.HTM. Pending evaluation of the effects of the law, it is considered an experimental strategy.

Objective 6.1 D—Implement Programs That Target Populations at Increased Risk of Drowsy or Distracted Driving Crashes

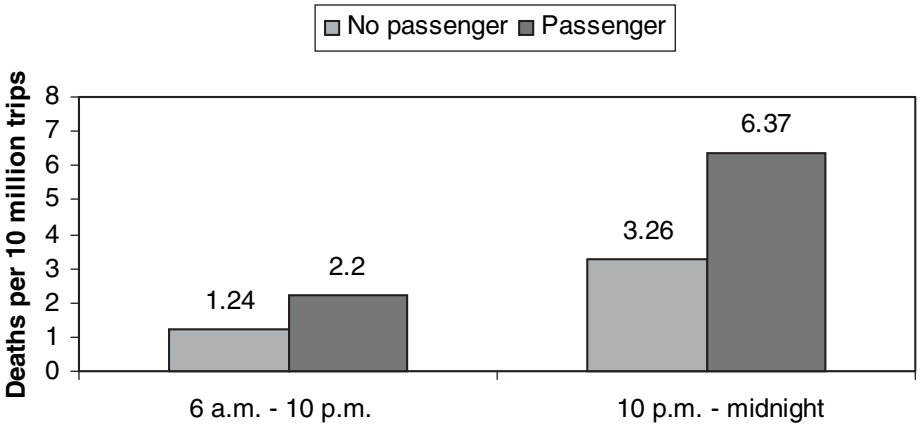
Strategy 6.1 D1—Strengthen Graduated Driver Licensing Requirements for Young Novice Drivers (P/T)

General Description

In recent years all but a few U.S. states have adopted some form of graduated driver licensing (GDL) for young beginning drivers. Central to the GDL concept is a probationary license period between learner and full licensure stages, typically lasting 6–12 months. During this period, additional restrictions are placed on the teen's driving privilege. Most often these involve restrictions on unsupervised driving at nighttime and with other passengers in the vehicle. In addition, many states now require a certain number of hours of supervised driving prior to full licensure.

The rationale behind GDL is that learning to drive is a high-risk venture, and teens need to be able to gain driving experience in as low-risk an environment as possible. Nighttime driving and driving with teen passengers both significantly increase a novice driver's likelihood of crashing. Nationally, 41 percent of teenage motor vehicle deaths in 2002 occurred between 9 p.m. and 6 a.m. (IIHS, 2003). In addition, having two or more passengers in the car under the age of 21 has been shown to more than double a beginning driver's risk of crashing (Chen et al., 2000; McKnight and Peck, 2002; Foss and Goodwin, 2003; see Exhibit V-8). Both situations reflect an added layer of complexity and distraction to the driving task. Despite this evidence, only six states have nighttime driving restrictions starting before 11 p.m., and only about half limit the number of teen passengers to two or fewer (IIHS, 2004).

EXHIBIT V-8
Death Rate of 16- and 17-Year-Old Drivers with and without Passengers
Source: Chen et al., 2000



Sleep experts point to another potential benefit of restricted nighttime driving for teens—namely, if teens are not allowed to drive at night, they are more likely to be at home, and perhaps also more likely to go to bed earlier and get more sleep (Drobnich and Murray, in press). This, in turn, could lead to less daytime drowsiness and a reduced risk of a sleep-related crash.

The National Transportation Safety Board recently recommended an additional restriction on novice drivers: it recommended that drivers with learners or provisional licenses be prohibited from using cell phones or other wireless communication devices while driving (NTSB, 2003). The rationale was the same as for other restrictions on a novice driver's license—learning to drive is a challenging undertaking and needs to occur in as low-risk an environment as possible. Beginning drivers need to be able to direct their full attention to the task of driving and not be distracted by trying to operate a cell phone and carry on a conversation. To date, Maine, New Jersey, and the District of Columbia have enacted such legislation.

In 2002, 5,178 teens died in motor vehicle crashes as either drivers or passengers of motor vehicles (IIHS, 2003). The extent to which fatigue or inattention contributed to these crashes is not known; nevertheless, license restrictions that discourage nighttime driving and that

reduce the likelihood of distractions by limiting the number of passengers in vehicles and prohibiting use of cell phones should help lower this number.

While it is recognized that implementing or amending legislation can be a lengthy process, states that are reviewing their GDL requirements or considering enacting GDL legislation should consider the rationale behind passenger restrictions and earlier nighttime driving restrictions. Both have proven effective in reducing traffic fatalities among novice drivers. In addition, states should consider the as yet unevaluated (and thus categorized in this report as "tried") restriction on cell phone use by novice drivers.

For more detailed information on specific strategy attributes with respect to strengthening GDL requirements to reduce young driver crashes, the reader is encouraged to refer to the guide for reducing collisions involving young drivers.

Information on Agencies or Organizations Currently Implementing this Strategy

As noted above, Maine, New Jersey, and the District of Columbia have all placed restrictions on cell phone use by novice drivers. The Governors Highway Safety Association website maintains information on cell phone restrictions placed on novice drivers. See http://www.ghsa.org/html/stateinfo/laws/cellphone_laws.html.

According to information maintained by the Insurance Institute for Highway Safety, Delaware, Idaho, Mississippi, New York, North Carolina, and South Dakota all have restrictions in place that prohibit unsupervised driving after 10 p.m. by drivers holding provisional licenses. Twenty-five states have some restrictions in place regarding the number of passengers that can be carried, although the number of passengers allowed and the timeframe for the restriction varies greatly. See "Licensing Systems for Young Drivers" at http://www.iihs.org/safety_facts/state_laws/grad_license.htm.

Strategy 6.1 D2—Incorporate Information on Distracted/Fatigued Driving into Education Programs and Materials for Young Drivers (T)

General Description

Young drivers, ages 16–24, are a high-risk group for both distracted and drowsy driving crashes. When learning to drive, even small distractions such as tuning the radio or talking to a passenger can pose problems for teens. This is one reason why passenger restrictions for new drivers have been shown to have such a dramatic effect on crash involvement. An analysis of 1995–1999 national crash data showed the highest percentage of distracted driving crashes for drivers under the age of 20. Leading the list of distractions were radios and cassette tape or CD players, outside-the-vehicle distractions, and other occupants inside the vehicle (Stutts et al., 2001). Young adults are also more likely to own and use cell phones and other wireless technologies, such as voice mail and instant messaging, while driving (Royal, 2003; Stutts et al., 2002).

In addition, young drivers are a high-risk group for drowsy driving crashes. An analysis of national crash data revealed that nearly two-thirds of drivers in drowsy driving crashes

were under the age of 30 (Knipling and Wang, 1995), and in an analysis of North Carolina crash data, age 20 was the peak age for drivers involved in a sleep-related crash (Pack et al., 1995). An expert panel convened by NHTSA and the NCSDR recommended that educational efforts to reduce drowsy driving crashes be directed at young males ages 16–24 and shift workers (NHTSA/NCSDR, 1998b). Subsequently, NCSDR hosted a workshop to develop strategies for best educating youth about sleep and drowsy driving (NCSDR, 1998), and the NSF prepared a report summarizing sleep-related issues affecting adolescents (NSF, 2000).

A starting point for educating youth about the dangers of both drowsy and distracted driving is to incorporate pertinent information into driver education and training programs. It has been estimated that half of all novice drivers participate in a formal driver education program (NCSDR, 1998). The new model driver education curriculum developed jointly by NHTSA and the American Driver and Traffic Safety Education Association (ADTSEA) addresses both areas, although not in great detail. States that provide for driver education for young novice drivers can require or encourage incorporation of appropriate material in all approved driver education programs and can reinforce the message by including relevant questions on their driver license test.

Educational materials should also be made available through other venues such as websites, school health and safety classes, college orientations, and military training programs. In addition, efforts should be directed toward parents, teachers, law enforcement, and others who have opportunities to influence young people's high-risk driving behavior.

Information on programs and materials that have shown promise in educating teens and young adults about the dangers of drowsy and distracted driving are identified below under "Information on Agencies or Organizations Currently Implementing this Strategy." Of particular note is a Texas-based program for college students that was developed in response to the death of a Texas A&M student who fell asleep at the wheel (see http://studentorgs.utexas.edu/sa/resources/spotlights/fall00/drowsy/medina.html); and materials directed at high school age drivers developed by NHTSA in collaboration with Scholastic magazine (see http://www.nhlbi.nih.gov/health/public/sleep/aaw/awake.htm).

Information on Agencies or Organizations Currently Implementing this Strategy

Student government officials at both Texas A&M and Baylor universities have implemented a program to educate students about the dangers of driving while drowsy and provide an option for students who are too sleepy to continue driving. The program, which has not been formally evaluated, includes discounts at cooperating Hotel 8 and Hampton Inn hotels throughout the state. See http://studentorgs.utexas.edu/sa/resources/spotlights/fall00/drowsy/medina.html for further information.

The Utah DOT partnered with Med One Medical, the Department of Public Safety, and the Highway Patrol to develop a campaign for high school students to raise awareness of drowsy driving. The campaign involved a contest to create a 25-second television commercial about the dangers of drowsy driving, with the winning commercial to be aired on a local television station (see Appendix 10).

EXHIBIT V-9
Strategy Attributes for Incorporating Information on Distracted/Fatigued Driving into Education Programs and Materials for Young Drivers (T)

Technical Attributes	
Target	Young drivers ages 16-24 and those who teach or can influence them.
Expected Effectiveness	To our knowledge, none of the identified programs has undergone formal evaluation. In general, education programs by themselves have not been proven to reduce crashes. However, education is believed to be a necessary component to a comprehensive approach to addressing the problem of distracted and drowsy driving. Some education programs include elements that may impact crash occurrence directly. For example, the Lupe Medina program for college students makes discounted hotel rooms available for drowsy drivers. However, this program has also not been formally evaluated.
Keys to Success	As noted in the strategy addressing education and awareness campaigns for the general driving public, successful educational interventions should increase awareness of a problem, motivate a response, and provide information with regard to effective responses. For teens and young adults, it is especially important that materials be carefully targeted to the intended audience.
Potential Difficulties	Although many materials and programs are available, without adequate information on their relative merits, making choices regarding the best programs presents a challenge. Two resources that are currently available to states include the NSF (for information on educational materials with respect to sleep deprivation and its consequences) and the AAA Foundation for Traffic Safety (for educational materials on distracted driving). In addition, the NHTSA website should be checked for links to useful materials and information.
Appropriate Measures and Data	Process measures would include the typical ones used to document a public education program. These include the number and types of programs delivered as well as the types of media used. Assuming a captive audience, drivers exposed and not exposed to the educational intervention could be compared with respect to knowledge, attitudes, and behaviors regarding distracted or drowsy driving. For education campaigns directed at a wider audience, survey data can be used to gather similar information before and after the campaign is conducted.
Associated Needs	None, beyond the specific educational materials (brochures, videos, posters, teacher guides, etc.) which are generally readily available.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	A cooperative effort will be needed between the safety organization shepherding this effort, the public education system that delivers driving training, other driver training organizations, and other potential conveyors of the material. A function may need to be created within the lead agency to create a clearinghouse of available information and materials and maintain it.
Issues Affecting Implementation Time	These will vary depending on the particular educational intervention being implemented. Overall, however, there are no particular known constraints that would delay implementation of an educational intervention.
Costs Involved	Costs are typically modest for the types of programs and materials described under this strategy.
Training and Other Personnel Needs	Training requirements should be minimal, except if new individuals need to be prepared to deliver the training outside the normal scope of ongoing driver education programs.

EXHIBIT V-9 (Continued)
Strategy Attributes for Incorporating Information on Distracted/Fatigued Driving into Education Programs and Materials for Young Drivers (T)

Legislative Needs	None identified, except in the possible case of a legislatively mandated curriculum for driver education.
Other Key Attributes	
	None identified.

In Pennsylvania, Highway Patrol and other law enforcement officers visit area middle and high schools to present a 1-hour program called "Survival 101." The multi-media program includes information on factors contributing to teen crashes, including driver distraction and fatigue (see Appendix 12).

Cingular Wireless has developed a program to educate novice drivers about the importance of managing distractions while driving, including cell phone use. The program includes a video, detailed teacher's guide, poster, and classroom activities. See http://www.be-sensible.com/.

The USAA Educational Foundation has developed the Driver Safety Awareness Program (DSAP), which includes a module on distracted and drowsy driving. See http://www.usaaedfoundation.org/DSAP.htm.

Materials addressing drowsy driving developed by NHTSA in cooperation with Scholastic Magazine and the National Heart, Lung and Blood Institute (NHLBI) are available on the NHLBI website at http://www.nhlbi.nih.gov/health/public/sleep/aaw/awake.htm.

The National Institutes of Health has also developed a science-based sleep curriculum for high school age students that includes information on the risks of drowsy driving. See http://science.education.nih.gov/supplements/nih3/sleep/default.htm.

Although not directly focused on educating young persons about the risks of drowsy driving, efforts underway in communities nationwide to delay school start times, especially for high schools, can promote increased sleep by teens and decrease the likelihood of drowsy driving. Preliminary evidence also suggests that they may decrease teen crash involvement (either because teens are less drowsy or because they are in school later in the day). See http://www.sleepfoundation.org/hottopics/index.php?secid=18&id=206 (or go to www.sleepfoundation.org and click on "Teens and Sleep").

Strategy 6.1 D3—Encourage Employers to Offer Fatigue Management Programs to Employees Working Nighttime or Rotating Shifts (P)

General Description

In 1996 Congress directed NHTSA to collaborate with the NCSDR to develop an educational program to reduce fatigue-related crashes. As part of its work, NHTSA convened an expert panel to review relevant literature, identify risk factors, identify population groups at highest risk, and recommend countermeasures for lowering their risk (NHTSA/NCSDR, 1998b). Identified high-risk populations included people ages 16–29, especially young males; shift workers whose sleep is disrupted by working at night or working long or irregular

hours; and people with untreated sleep disorders. Subsequent focus groups with shift workers and their supervisors provided input to the development of a comprehensive workplace education program that includes a video, posters, brochures for workers and their families, tip cards, six brief PowerPoint training sessions, and a program administrator's guide. (See Exhibit V-10. Information and materials available on the NHTSA website at http://www.nhtsa.gov/people/injury/drowsy_driving1/human/drows_driving/index.html.)

EXHIBIT V-10
NHTSA Drowsy Driving Safety Materials

An estimated 21 million workers, or 20 percent of the workforce, engage in some form of shift work (NHTSA/NCSDR, 1998a). Included are truck drivers, police officers, taxi drivers, transit operators, and others for whom driving is a part of their job. Many more shift workers are employed in industries, hospitals, and in service professions. For those working nighttime shifts, the trip home in the morning can be especially dangerous. An examination of the time of day distribution of drowsy driving crashes not involving alcohol shows a sharp increase in such crashes between 4 a.m. and 8 a.m. (Pack et al., 1995).

Shift workers average only about 5 hours of sleep a night, or about 1.5 hours less than non-shift workers. Also, the sleep they do get is often fragmented and less restorative (Kessler, 1992; NHTSA/NCSDR, 1998a). Persons with nighttime jobs are working against their natural biological clocks that cause them to be sleepiest in the middle of their work period and most alert just when they get home and need to sleep. For those working rotating shifts, there may be little opportunity for their bodies to adjust to the changing wake/sleep schedules. A study involving telephone interviews with drivers involved in recent crashes showed that 18 percent of those in sleep-related crashes worked night shifts, compared to just 4 percent of drivers in non-sleep-related crashes (Stutts et al., 2003).

The workplace program developed by NHTSA and the NCSDR provides shift workers and their employers information on warning signs for dangerous drowsy driving, how to safely manage the commute home, tips for better sleep, and guidance for dealing with family members and friends. For employers, it provides detailed information on planning and

implementing a workplace program. In its evaluation, NHTSA found workers to be highly receptive to the program's messages.

Other agencies and organizations have also developed programs and materials that target shift workers. For example, the Transit Cooperative Research Program sponsored the development of a "Toolbox for Transit Operator Fatigue" designed specifically for that high-risk population (Gertler et al., 2002). Finally, a wide range of resources exist in the private sector to assist employees in creating safer working environments for employees working irregular or long hours. A number of these resources are identified below (see Information on Agencies and Organizations Currently Implementing this Strategy).

EXHIBIT V-11
Strategy Attributes for Encouraging Employers to Offer Fatigue Management Programs to Employees Working Nighttime or Rotating Shifts (P)

Technical Attributes	
Target	The primary target audience for this strategy is employers whose employees engage in some form of shift-work; however, materials might also be made available to shift workers (and their families) directly.
Expected Effectiveness	The "Wake Up and Get Some Sleep" program developed by NHTSA and the NCSDR was tested by more than 20 U.S. companies to reflect the special interests, concerns, and needs of shift workers. Although not specifically evaluated with respect to decreasing crashes, the program was well received by both shift workers and management (NHTSA/NCSDR, 1998). Proprietary programs and services offered by private companies are generally backed by data demonstrating their effectiveness with respect to such measures as increased productivity, decreased absenteeism, decreased operating costs, etc. One example case study reported by Circadian Technologies involved an assessment of driver fatigue among employees of a large trucking company, followed by an intervention that included avoiding rapid rotations in the starting time of work, reducing the number of consecutive shifts worked, and providing rest breaks that allowed two consecutive nights of sleep. As a result, the total number of truck accidents dropped 23.5 percent, with severe accidents dropping 55 percent. In addition, the total cost of loss-of-attention accidents (defined as collisions involving hitting the rear of another vehicle or loss of control) decreased 81 percent (O'Neill and Heltmann, 2004; Available at http://www.circadian.com/publications/driver.pdf). Although this strategy is identified as "proven," it should be noted that the breadth and quality of fatigue management programs will vary and may or may not produce the desired reduction in fatigue-related crashes and injuries.
Keys to Success	Keys to success include commitment by workplace management to offering and following through on a program and the comprehensiveness of the program (i.e., the extent to which it addresses all of the many facets of sleep affecting shift workers).
Potential Difficulty	The primary difficulty would be in obtaining "buy-in" from employers.
Appropriate Measures and Data	Process measures include the number and type of programs adopted, by type of employer. The number of employees to which the program applies is also an important piece of data. At the employer level, measures of success might include physical changes to the workplace environment (e.g., increased lighting at nighttime, availability of napping rooms, availability of nutritious snacks), policy changes (e.g., a change in work scheduling, allowing for short naps), and documented decreases in worker absenteeism or injury (either on or off the job). At the employee level, data can be collected with regard to knowledge of good sleep practices and self-reported sleep patterns (e.g., from a sleep diary) and level of alertness. Over the longer term, one would expect to see a reduction in crashes among workers exposed to the program.
Associated Needs	None identified.

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EXHIBIT V-11 (Continued)
Strategy Attributes for Encouraging Employers to Offer Fatigue Management Programs to Employees Working Nighttime or Rotating Shifts (P)

Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Since this strategy is directed at employers, the sponsoring public agency will want to establish contacts and liaison with employer associations, as well as major employers in their jurisdiction.
Issues Affecting Implementation Time	The timeframe for implementation will be variable, depending on relationships already in place, the size of the workplace, the level of enthusiasm for the program by management, and other factors.
Costs Involved	Costs for such programs are generally modest and are borne by the employer. Ideally, the program should "pay for itself" in benefits back to the employer, including reduced absenteeism, increased worker retention, increased morale among workers, and decreased injury. In some cases, however, additional facilities will be needed, which may add significantly to program cost.
Training and Other Personnel Needs	No special training or other personnel needs are typically required. Available workplace fatigue management programs typically include an instructor's guide and all necessary materials.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing this Strategy

NHTSA's Wake Up and Get Some Sleep Program is described at http://www.nhtsa.dot.gov/people/injury/drowsy_driving1/human/drows_driving/.

The NSF has produced "Sleep Strategies for Shiftworkers" and other related materials, which are available at http://www.sleepfoundation.org/.

The National Institute for Occupational Safety and Health (NIOSH) has produced "Plain Language about Shiftwork" (Publication No. 97-145), available at no charge by calling 1-800-35-NIOSH. The publication can also be downloaded from the NIOSH website at http://www.cdc.gov/niosh/pdfs/97-145.pdf.

"Toolbox for Transit Operator Fatigue" was developed as a Transit Cooperative Research Program project specifically to address fatigue driving issues affecting transit operators. A copy of the final report is available at http://trb.org/news/blurb_detail.asp?id=2531.

Appendix 13 (http://www.circadian.com/publications/training.pdf) describes the benefits to employers of offering lifestyle training to employees engaged in shiftwork, while Appendix 14 (http://www.circadian.com/publications/apnea.pdf) describes a program to screen employees for obstructive sleep apnea.

Strategy 6.1 D4—Enhance Enforcement of Commercial Motor Vehicle Hours of Service Regulations (P)

General Description

As debate continues over what changes will be incorporated into revised federal hours of service (HOS) regulations for Interstate motor carriers, there is a general consensus in the industry, at least, that the revised regulations have had a positive overall impact on safety (Woodruff, 2005). At the same time, there is also evidence that HOS regulations are commonly violated (Braver et al., 1992; McCartt et al., 1997). Nearly half of the truckers surveyed at truck stops and inspection stations in New York State reported that they sometimes, often, or always drove more than the 10 hours permitted by the rules, that they took off less time than the required 8 hours, or that they drove longer than recorded in their logbooks (McCartt et al., 1997). Another recent survey revealed that 25 percent of commercial vehicle operators reported working 75 or more hours in the preceding 7 days, and 10 percent reported working more than 90 hours (Freund, 1999).

Given the reality of widespread violations, states are encouraged to undertake more systematic and focused enforcement activities in support of their motor carrier safety regulations, including driver licensing, vehicle maintenance, and HOS (Patten, 2001b). Identifying and targeting high-risk drivers, high-risk companies, and high-risk roadways contribute to more efficient use of the limited resources available for enforcement activities.

Improved enforcement, carried out as part of FMCSA-mandated Compliance Reviews and Roadside Inspection programs, can help to increase operator and carrier compliance with HOS regulations. The emphasis of this strategy is on *systematic, well-publicized, and focused enforcement efforts.* Such focused enforcement efforts can be used to identify companies at increased risk for violation of HOS regulations, and thus increase efficiency of other ongoing enforcement activities.

Of course, HOS enforcement is not conducted independently but rather as a part of an overall commercial vehicle safety inspection program that includes both driver and vehicle inspection. Many of the critical elements of a comprehensive enforcement program are not specific to HOS enforcement but rather relate to enforcement of all regulations. Patten (2001a and 2001b; see Appendices 17 and 18) conducted a survey of best enforcement practices and developed a report describing a "toolbox" of practices to enhance the effectiveness of motor carrier safety enforcement, including HOS. The "toolbox" included the following practices:

- Use of mobile safety inspection teams to supplement fixed sites.
- Use of ASPEN software (developed by and available from the FMCSA) to collect and access inspection data. This permits access to the following subsystems:
  - Commercial Driver License Information System (CDLIS) for driver license status.
  - Past Inspection Query (PIQ) for recent inspection reports, including driver HOS checks.
  - Inspection Selection System (ISS) to screen motor carrier vehicles and identify priority (high-risk) carriers for inspection.

- Exchange of data via the Safety and Fitness Electronic Records (SAFER) mailbox (a data exchange system developed by the FMCSA).
- Use of the FMCSA Safety Status Measurement System (SafeStat) to identify high-risk carriers for on-site compliance reviews.
- Use of the Performance and Registration Information Systems Management (PRISM) to link the commercial vehicle registration process to motor carrier safety.
- Use of electronic clearance equipment at inspection stations to rapidly screen vehicles and select high-risk carriers for inspection.
- Regular on-site motor carrier safety compliance reviews and/or audits (conducted in coordination with the FMCSA).
- Use of state commercial vehicle crash investigation teams for selected crashes.
- Regular provision of safety performance information (e.g., out-of-service rates) to carriers to encourage safety improvements.
- Development and use of a state-maintained Internet site with motor carrier safety information (e.g., federal and state HOS regulations and fatigue education materials).

Commercial drivers know the locations of fixed inspection sites and may avoid them if they are driving in violation of the HOS rules or have other likely out-of-service violations. The use of mobile inspection units is an important intervention to catch these violators. In Connecticut, a wireless data access system was developed to equip mobile inspection vehicles with data access and exchange capabilities (involving systems like the ISS and PIQ) for improved HOS and other enforcement. Connecticut equipped 68 mobile units, a significant complement to the state's five fixed sites. Appendix 15 describes the Connecticut initiative and system.

Current systems for prioritizing vehicles and drivers for inspection are based upon the motor carrier's safety record, not on the safety records of individual drivers. Research has shown, however, that commercial drivers within fleets may vary widely in their violation histories and other safety measures (Knipling et al., 2004). Efforts are underway to develop metrics, systems, and protocols for making inspection selection more specific to individual drivers (Lantz et al., 2004). This is an expected enhancement to be made to existing systems in the coming years.

States can expand their support of HOS regulations in other important ways as well. Many provide safety information, education, and consultation to the motor carrier industry, including instruction on HOS and other compliance. Patten (2001a) surveyed state motor carrier safety agencies in 1999 concerning their enforcement and educational activities and the perceived effectiveness of these activities. Potential educational activities include distribution of safety-related publications (brochures, manuals, bulletins, etc.), seminars and workshops for fleet safety managers, "circuit rider" visits to motor carriers to provide free or low-cost safety consultation, volunteer mentoring for new or problem carriers by established safe carriers, non-punitive compliance reviews, and advisory warning letters sent to problem carriers before any punitive actions are taken. Thirty-three responding states (79 percent of the sample) regularly conducted state-sponsored education activities for motor carriers, and

97 percent of responding officials from these states rated the programs as effective or very effective. Strategy 12.1 G1 of the guide for reducing collisions involving heavy trucks describes various state motor carrier safety educational and consultative activities in more detail.

States can also promote use of new technologies such as electronic on-board recorders (EOBRs) for improved compliance with HOS regulations and newer technologies that assist truck drivers in monitoring their own levels of alertness. Information can be made available to trucking companies about available new technologies for monitoring and helping to maintain driver alertness. The effectiveness of in-vehicle technologies for reducing heavy-truck crashes was addressed in Strategy 12.1 G2 of the heavy-truck guide.

EXHIBIT V-12
Strategy Attributes for Enhancing Enforcement of Commercial Motor Vehicle Hours of Service Regulations (P)

Technical Attributes	
Target	Large truck operators and fleet managers covered by FMCSA safety regulations.
Expected Effectiveness	Apart from the sheer number of inspections, the biggest factor affecting the effectiveness of enhanced HOS enforcement efforts is likely to be the degree to which high-risk carriers and drivers can be identified and targeted by roadside inspection and other enforcement methods. Studies of motor carrier risk conducted by the U.S. DOT Volpe Center (available at http://ai.volpe.dot.gov/CarrierResearchResults/outreach/safestatov.ppt) show that at-risk carriers identified through SafeStat have future crash rates that are more than twice the industry average. Moreover, an effectiveness study of roadside inspections conducted by the Volpe Center (2004) has shown that more than 12,000 crashes, 9,000 injuries, and 500 fatalities are prevented annually by commercial vehicle roadside inspections. There have been steady annual increases in these prevention estimates associated with increased numbers of roadside inspections and improved targeting of high-risk operators.
Keys to Success	In addition to the number of inspections and the degree to which high-risk carriers and drivers can be identified, other factors affecting compliance include severity of penalties and the degree to which progressive fleets recognize the fatigue problem and voluntarily take aggressive management action to prevent HOS violations. A key to the success of this strategy, therefore, is the cooperation and support of federal, state, and local motor carrier safety enforcement programs. It is important that the trucking industry and its employees perceive that violators are not only detected but punished. The combination of high-level, enforcement “bursts” plus high visibility (much like is done with DWI checkpoints) can help to accomplish this goal.
Potential Difficulties	It will be a challenge to achieve a high level of coordination and oversight to ensure that the enforcement activities are coordinated and well publicized. Some enforcement officers and local judges may be hesitant to impose heavy fines on commercial drivers for HOS violations. There may be insufficient staff in some areas to carry out the level of enforcement desired.
Appropriate Measures and Data	Process measures will include documentation of the number and type of programs implemented, as well as measurement of enforcement types, locations, and levels (e.g., person-hours of enforcement.) Shorter-term, surrogate measures of program effectiveness include number of stops made, number of HOS violations detected, and the nature and severity of these violations. If roadside inspections are targeted toward identified high-risk carriers, then a high driver out-of-service rate due to HOS violations is to be expected and, indeed, is indicative of successful targeting.

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EXHIBIT V-12 (Continued)
Strategy Attributes for Enhancing Enforcement of Commercial Motor Vehicle Hours of Service Regulations (P)

	The primary long-term measure of program effectiveness is the number and percentage of heavy-truck crashes where HOS violations are identified as a contributing factor.
Associated Needs	The effectiveness of an enforcement program can generally be increased if it has an associated public information component.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	Coordination among federal, state, and local enforcement programs is essential, especially since many of the systems currently available to improve enforcement are multi-governmental. Therefore, it is preferable to establish a working arrangement among participants from the start of the process. Enforcement agencies may need to develop new internal policies, procedures, and capabilities for targeted enforcement of commercial motor vehicles.
Issues Affecting Implementation Time	Issues affecting implementation time include availability of funding for the activity and the level of support and cooperation already in place to implement such a strategy.
Costs Involved	The federal Motor Carrier Safety Assistance Program (MCSAP) distributes millions of dollars to states ($165M in FY2003) to fund motor carrier safety enforcement and education efforts. These funds supplement state funding. Federally run enforcement services like the ISS can be accessed at no charge to the states. States are likely to incur costs associated with intensive, high-publicity enforcement efforts, primarily to cover overtime pay for trained inspectors and costs associated with the media publicity. Educational initiatives may also require supplemental funding.
Training and Other Personnel Needs	As noted above, additional staff hours may be needed to carry out the enforcement activities, although no special training is required. The individual or individuals in charge of developing the strategy may benefit from working with someone who has conducted similar activities with regard to DWI enforcement.
Legislative Needs	Efforts to change intrastate HOS regulations or fines for HOS violations typically require action by the state legislature.
Other Key Attributes	
	As noted, HOS enforcement effectiveness in a state is largely a reflection of the overall commercial motor vehicle enforcement program.

Information on Agencies or Organizations Currently Implementing this Strategy

Appendix 15 provides a state agency profile of an initiative by the Connecticut Department of Motor Vehicles to increase the speed and efficiency of roadside inspections, and support more mobile inspections, through wireless data access at the roadside. This program deployed the safety information exchange components of the Intelligent Transportation Systems (ITS) Commercial Vehicle Information Systems and Networks (CVISN) technology program.

Strategy 6.1 D5—Encourage Trucking Companies and Other Fleet Operators to Implement Fatigue Management Programs (T)

General Description

In 2003 large trucks were involved in 457,000 crashes, resulting in nearly 5,000 deaths and an estimated additional 122,000 injuries (NHTSA, 2004). An estimated 1 percent of all large-

truck crashes, 3-6 percent of fatal heavy-truck crashes, and 15–33 percent of crashes fatal to the truck occupant only can be attributed primarily to driver fatigue. Fatigue also plays a large (but not yet quantified) contributing role in crashes (Knipling and Shelton, 1999). As emphasized previously, driver vigilance is essential for safe driving, and a major effect of fatigue—even low-to-moderate levels—is reduced vigilance. For commercial drivers, fatigue and alertness are ever-present concerns. A combination of long hours on the road, nighttime driving, and irregular work and sleep schedules combine to make fatigue an especially challenging problem.

Instrumented vehicle studies involving volunteer commercial drivers and in-cab video recording have demonstrated the role that drowsiness plays in increasing the risk of driver errors and resulting crashes. An instrumented vehicle study by Hanowski et al. (2000) found that the average truck driver drowsiness level (as measured by degree of eyelid "droop") for truck-driver-at-fault traffic incidents was more than 10 times greater than the average drowsiness level for normal, non-incident driving periods. This further demonstrates that drowsiness is manifested not only in asleep-at-the-wheel, run-off-road crashes, but also in driver errors associated with a variety of crash types and scenarios.

Since the early 1990s, commercial vehicle operator fatigue has been a top safety priority for government researchers and regulators, as well as for the trucking industry. In 1990 the National Transportation Safety Board released the results of its study of fatal-to-the-driver, large-truck crashes, reporting that fatigue was the probable cause in 31 percent of the investigated crashes (NTSB, 1990). The Congressionally mandated *Driver Fatigue and Alertness Study*, completed by FHWA in 1996, provided first-time knowledge of drivers' alertness and performance levels and the factors that influence them (Wylie et al., 1996). Participants at the 1995 National Truck and Bus Safety Summit identified driver fatigue as the highest priority safety issue facing the industry. Commercial driver fatigue and related issues such as HOS rules and driver distraction continue to be primary concerns among industry observers and safety stakeholders (FMCSA, 2003).

Created in 1999, the FMCSA has continued FHWA's initiatives in carrying out a wide range of driver alertness and fatigue-related research and technology projects (see http://www.fmcsa.dot.gov/safetyprogs/fatigue/fatigue.htm for a summary). Many of these fatigue-related research projects have been directed toward supporting improved HOS rules for commercial drivers. Others have looked at the potential for fleet fatigue management practices going beyond compliance with HOS rules to address driver fatigue more proactively and comprehensively. Currently, the FMCSA is collaborating with Transport Canada to develop and promote a model North American Fatigue Management Program for motor carriers. The joint U.S.-Canadian effort builds on program design and development work performed earlier in the Canadian provinces of Alberta and Quebec. Working with industry and government, researchers identified fatigue management requirements; developed a training program for drivers, dispatchers, and carrier safety managers; and evaluated the program in six fleets. The next phase of the collaborative program will develop more formalized fatigue management protocols and operationally test the effectiveness of comprehensive fatigue management programs (FMPs) on a larger scale in both the United States and Canada.

In the meantime, trucking companies and other fleet operators should be encouraged to develop and implement FMPs on their own. A recent synthesis entitled *Effective Commercial*

Truck and Bus Safety Management Techniques (Knipling et al., 2003), sponsored by the FMCSA and based on the North American FMP model and other carrier fatigue management approaches, identified the following components of an effective FMP:

- "Alertness-friendly" scheduling that take sleep needs and circadian rhythms into consideration during dispatching and empowers drivers to adjust schedules, without recrimination, when needs dictate;
- Medical screening, counseling, and treatment for sleep disorders, in particular sleep apnea; and
- Fatigue education, for both drivers and carrier managers, emphasizing the importance of driver alertness, the nature of sleep, the effects of sleep deprivation, and "sleep hygiene" practices for improved driver sleep and alertness.

One currently available fatigue management training program is Understanding Fatigue and Alert Driving, which was developed by the American Transportation Research Institute (ATRI, formerly the American Trucking Associations Foundation) in partnership with the FMCSA. This is primarily a "train-the-trainer" program designed for carrier safety managers, who in turn would use program materials to educate their drivers. The program package includes an instructor guide, student materials, a film, and slides. ATRI periodically presents the "train-the-trainer" fatigue instruction and a similar driver health and wellness program at various locations across the country. ATRI contact information is provided below.

Studies have also looked at fleet management practices and compared these with driver fatigue outcomes. An FMCSA-sponsored research study involving a random sample of drivers from both trucking and motor coach companies showed that trucking company practices mitigating driver fatigue included carrier assistance with loading and unloading, carrier efforts to minimize nighttime driving, and driver voluntary attendance at corporate safety and training meetings. Motor coach company practices most likely to mitigate operator fatigue included attempts to minimize nighttime driving and drivers' perceptions of the company's safe driving culture and policies (Crum et al., 2002)

Companies should also consider incorporating available new technologies into their FMPs. Examples of technologies that have been tested in NHTSA and the FMCSA research programs include the actigraph (a "sleep watch" that estimates sleep based on body motion and predicts likely alertness level), in-vehicle alertness monitoring and warning systems (based on eyelid closure or other measures of alertness), and EOBRs for tracking on-duty status. Lane departure warning systems are also seeing increased use within the trucking industry and are generally well accepted by drivers (Brewster et al., 2005; Malloy, 2005). These systems typically consist of forward-looking video cameras that use image processing to detect unplanned lane departures (i.e., lane departures not accompanied by turn signal use). They provide a warning, such as a simulated rumble strip sound, when the vehicle crosses the lane line. They are also capable of providing a general assessment of the quality of driving performance based on the degree of lateral movement within the lane lines. Deterioration of lane tracking is one of the most reliable signs of incipient driver drowsiness and eventually leads to lane departures if drivers do not stop for rest.

EXHIBIT V-13
Strategy Attributes for Encouraging Trucking Companies and Other Fleet Operators to Implement Fatigue Management Programs (T)

Technical Attributes	
Target	Commercial motor vehicle operators.
Expected Effectiveness	Most of the work on fatigue management technologies to date has focused on basic research and development of technologies providing proof-of-concept. Nevertheless, new results from a pilot test of several technologies (Brewster et al., 2005) have demonstrated the potential practical effectiveness of these devices, in particular lane-tracking-based lane departure warning systems. A recent synthesis report completed for TRB's Commercial Truck and Bus Safety Synthesis Program identified effective safety management methods currently being employed by commercial truck and bus carriers to address a variety of safety problems, including driver alertness (Knipling et al., 2003). Some of the specific methods reviewed include on-board monitoring, improved driver scheduling and dispatching, fatigue management, carrier-based medical programs, and advanced safety technologies. The effectiveness of each identified approach was ranked by a sample of commercial motor vehicle safety managers and a sample of other experts in the field. Most of these methods were not rated highly in relation to more familiar and fundamental safety management methods such as scheduled vehicle maintenance and rigorous driving hiring criteria, perhaps in part because fatigue-management-related protocols are not completely developed and have not been widely disseminated.
Key to Success	A key to the success of this strategy will be to conduct successful pilot programs that can then be used to market the strategy to other companies and locations. Of course, good pilot programs include a professionally designed, valid evaluation study. State transportation departments can assist in this strategy by educating trucking companies about the importance of the problem and publicizing available solutions.
Potential Difficulties	The primary challenge lies in convincing trucking companies of the need for, and benefit of, an FMP and then working with them to ensure that the various components of the program are implemented as intended. A limitation of many commercial vehicle safety initiatives relates to the large number of independent operators and small companies that work on the margin. While these operators are not the primary target of the strategy, they exist in large enough numbers to limit intervention success. It is difficult to convince these operators that any loss of margin that could result from fatigue management efforts will be worthwhile.
Appropriate Measures and Data	Process measures include the number and percentage of trucking companies implementing the programs, the types of programs implemented, and the number of drivers and vehicle miles impacted. Depending on the nature of the program or approach being implemented, appropriate measures of program effectiveness might include the number of identified cases of sleep apnea or other sleep problems; the percentage of employees experiencing excessive daytime sleepiness, as measured by the Epworth Sleepiness Scale or another measure; self-reports of number of hours of sleep; reported satisfaction with work scheduling, etc. Ultimately, one would look for a decrease in the number of crashes or injuries, both on and off the job.
Associated Needs	An information and education effort may be needed as part of this effort to make industry aware of the problem being addressed, as well as the benefits that can result from the program. State trucking associations may play an important role in this information dissemination.

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EXHIBIT V-13 (Continued)
Strategy Attributes for Encouraging Trucking Companies and Other Fleet Operators to Implement Fatigue Management Programs (T)

Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	This strategy should involve a joint undertaking by the state motor vehicle department, state trucking association, and individual trucking companies. A structure is needed to involve these stakeholders from the beginning of the effort, and to encourage joint monitoring and decision making.
Issues Affecting Implementation Time	The timeframe for implementing this strategy may be shortened if state motor vehicle departments already have a history of working successfully with trucking organizations and individual trucking companies on safety-related issues. Elements of implementation time will include recruiting participants, establishing and operating a joint venture, designing the programs, educating drivers, acquiring and installing any new equipment involved (e.g., on-board monitoring devices and other fatigue management technologies), and initiating and monitoring the program.
Costs Involved	Costs would be variable, depending on the nature and scope of the program. At the low end would be training sessions and materials for employees. Purchase and installation of some of the new alerting technologies or vehicle-monitoring devices would likely fall at the high end of the cost continuum. Approaches such as medical screening, changes in shift scheduling, and workplace modifications are likely to fall between these extremes. In general, costs for this strategy should be relatively modest and should be absorbed by the trucking company or fleet operator (with expectations that the benefits of the program will outweigh its costs).
Training and Other Personnel Needs	Key truck safety contacts in the state motor vehicle department may require training to become fully knowledgeable of the various options available for trucking companies wanting to implement FMPs. Education and training on fatigue for both drivers and carrier management personnel is a key element of FMPs.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

Information on Agencies or Organizations Currently Implementing this Strategy

As noted, the FMCSA and Transport Canada are collaborating on a program to develop FMP protocols and to empirically demonstrate the value of FMPs. Information on this program is available from the FMCSA Program Manager for FMPs, Mr. Robert Carroll, 202-385-2388, Robert.carroll@fmcsa.dot.gov.

The FMCSA and the NSF are teaming to develop a sleep apnea education and outreach program targeting truck drivers, motor carriers, and other related stakeholders. A toolkit of materials for the "Get on the Road to Better Health" campaign will be available on the FMCSA and NSF websites. See Appendix 16 for more information on this program.

Summaries of FMCSA and NHTSA research studies carried out to evaluate the effectiveness of various technologies to increase driver alertness are available on the following websites: http://www.fmcsa.dot.gov/safetyprogs/saftresearch.htm, http://www-nrd.nhtsa.dot.gov/vrtc/ca/its.htm#completed, and http://www.fmcsa.dot.gov/safetyprogs/fatigue/fatigue.htm.

ATRI is an independent research and development organization affiliated with the American Trucking Associations (ATA). ATRI is conducting research on commercial driver HOS, fatigue management, fatigue-related technologies, and driver medical conditions relevant to alertness and driving performance. More information is available at http://www.atri-online.org.

Strategy 6.1 D6—Implement Targeted Interventions for Other High-Risk Populations (T/E)

General Description

There are a number of other populations at increased risk for involvement in inattention or fatigue-related crashes. While some of these populations also fall into the category of shift workers, they each have unique characteristics that set them aside and that provide an opportunity for targeted intervention. This strategy addresses three especially high-risk populations: (1) persons with untreated sleep disorders, (2) law enforcement officers, and (3) young military personnel.

Along with young people and shift workers, persons with untreated sleep disorders were a third high-risk group identified by the joint NCSDR/NHTSA Expert Panel on Driver Fatigue and Sleepiness (NCSDR, 1998). Specifically, the panel was concerned about the documented high crash risks associated with sleep apnea and narcolepsy. Sleep apnea is a condition in which a person's airway collapses during sleep, causing temporary blockage of air into the lungs, which then triggers an awakening response. The pattern can be repeated throughout the night, usually without the individual being aware of the awakenings. However, the resulting fragmented sleep can lead to extreme daytime sleepiness and a two- to seven-fold increase in the risk of motor vehicle crash involvement. An estimated 4–5 percent of men and 2 percent of women have undiagnosed sleep apnea (see NCSDR, 1998; also see the NSF website).

Narcolepsy is a much less common, but potentially more serious condition in that a person with narcolepsy can fall asleep with little or no warning, sometimes "napping" for as long as 10–20 minutes. Although some states have adopted regulations and guidelines for drivers with narcolepsy as well as sleep apnea, a major drawback continues to be that the vast majority of these cases are not diagnosed.

Three strategies that states can adopt to address the needs of this population are (1) incorporate information on sleep disorders and their potential impact on driving safety in driver licensing handbooks, (2) work with the driver licensing medical advisory board to help educate physicians in recognizing and diagnosing suspected sleep disorders, and (3) partner with the medical community to provide free sleep screenings and education during Sleep Awareness Week and/or at other times (see Appendix 16 for description of a successful program statewide in Michigan).

A number of factors contribute to fatigue among law enforcement officers. These include irregular work hours, night work, overtime duties, "moonlighting," and the high stress that comes with the job. Although data on police involvement in fatigue-related crashes remains mostly anecdotal, a recent study raises some alarming concerns (Vila, 2000). As part of the study, the author collected detailed information on officers' work hours and related accident and on-the-job injury data, as well as objective and perceived measures of sleepiness. The resulting book, *Tired Cops: The Prevalence and Potential Consequences of Police Fatigue* (Vila,

2000), documents study findings and provides guidance for developing fatigue and alertness policies and programs for law enforcement agencies. Many of the recommendations parallel those described in the earlier strategy on FMPs for commercial vehicle operators.

State DOT and law enforcement agencies can help address this problem by reviewing law enforcement in-service training and education programs to ensure that they adequately address key sleep topics (e.g., the importance of good sleep habits, the hazards of shift work, and mechanisms for coping) and providing resources where needed. States can also encourage law enforcement agencies to review their policies and procedures for establishing work schedules.

Training law enforcement officers to better recognize and manage fatigue in their own lives may have the added benefit of encouraging them to (1) be more conscientious in identifying and reporting fatigue-related motor vehicle crashes and (2) include fatigue and the risks of drowsy and inattentive driving when speaking to driver education classes and other audiences.

The third high-risk population identified in this strategy is military personnel. While injury rates among military personnel have declined since the early 1980s, unintentional injury remains the most significant health problem for all three branches of the military services, and motor vehicle injuries are the largest single cause of death (Jones et al., 2000; Powell et al., 2000). Increases in seat belt use and decreases in alcohol use have contributed to the decline in motor-vehicle-related deaths, but there is room for improvement. Defense Secretary Donald Rumsfeld challenged all branches of the military to cut the rate of preventable accidents and fatalities by at least 50 percent by 2005 (see http://detnews.com/2004/autosinsider/0406/08/c03-176756.htm).

Drowsiness is a frequent component of many military crashes, often the result of young soldiers driving for too long and without enough rest when returning to their base after a 3-day pass. Although state DOTs and other agencies have little direct influence over policies and programs in place on military bases, information and materials could be made available to, and partnerships formed with, private civilian organizations to help promote safety. In addition, law enforcement in military communities can exert a greater presence at times when soldiers are leaving and, most importantly, returning to their bases. If done with the knowledge and consent of base officials and publicized ahead of time to the soldiers, such targeted enforcement can serve as a valuable tool for reinforcing messages about the importance of maintaining alertness when behind the wheel.

Information on Agencies or Organizations Currently Implementing this Strategy

The NSF maintains a state-by-state listing of Community Sleep Awareness Partners on its website at http://www.sleepfoundation.org/sleepcenters/index.php. These are healthcare providers who have "committed to promoting public understanding of sleep and sleep disorders and supporting sleep-related education, research and advocacy to improve public health and safety in their communities."

EXHIBIT V-14
Strategy Attributes for Implementing Targeted Interventions for Other High-Risk Populations (T/E)

Technical Attributes	
Target	There are three high-risk populations for sleep-related crashes: persons with untreated sleep disorders, law enforcement officers, and members of the military.
Expected Effectiveness	As with other strategies that have their basis in education, the strategies identified in this section are not expected to have direct and measurable effects on crash experience, at least not in the short term. However, with regard to the identification and treatment of persons with sleep apnea, the research clearly shows that (1) the vast majority of these persons have not been diagnosed and (2) once diagnosed, treatment can lower crash risk. It has been estimated that as many as 29 percent of adult males and 9 percent of adult females have some degree of sleep apnea (Young et al., 1993). Persons with sleep apnea are 3-15 times more likely to be involved in crashes (Young et al., 1997; Teran-Santos et al., 1999; Horstmann et al., 2000). Once diagnosed and treated, excessive daytime sleepiness and the risk of crashing diminishes (Ytterstad and Norton, 1998; Krieger et al., 1997). Although both the law enforcement and military communities have recently become alerted to the high risks associated with extended hours of wakefulness and lack of adequate sleep, and some programs have been implemented to address these concerns, there is no known evaluation of their impact on the occurrence of motor vehicle crashes.
Key to Success	A key to success for educating the public about sleep disorders and identifying persons affected is to team with the health community, and in particular Community Sleep Awareness Partners working with the NSF. The NSF can also assist with the most appropriate information and language to include in driver license manuals and other materials. Both the NSF and the AAA Foundation for Traffic Safety can also assist in working with law enforcement agencies in identifying and addressing their particular needs. The International Association of Chiefs of Police and other law enforcement associations and unions can also be encouraged to sponsor efforts to help officers.
Potential Difficulties	Most sleep disorders are undiagnosed. Messages to the public on sleep disorders probably need to include information to help people recognize the potential relevance to them. Getting the attention of law enforcement officers will also be difficult. There may be a reluctance to accept the idea that their performance is degraded, as well as a resistance to give up overtime and second-job income. As with other educational efforts, a long-term commitment is needed to ensure success of these strategies.
Appropriate Measures and Data	Beyond basic process measures such as the amount and type of educational materials and information made available, the primary measures of success of efforts to reduce crash risk for persons with undiagnosed sleep disorders are the number of individuals screened, the number of potential cases identified, and the number of cases eventually seeking treatment. With regard to activities targeting law enforcement officers, appropriate measures would include number of agencies contacted about the program, the number participating, the number and type of changes implemented, and police officers' self reports of the value of the intervention. In addition, data should be collected on the officers' crash involvement and whether drowsiness was a factor in the crash.
Associated Needs	As noted above, the sleep disorder strategy would benefit from the support of the medical community, especially in identifying drivers with potential sleep disorders.
Organizational and Institutional Attributes	
Organizational, Institutional and Policy Issues	There may be either state or local policies in place affecting scheduling and work and pay practices for law enforcement officers. These policies would need to be identified and taken into consideration in planning an intervention program. It may be necessary for agencies to negotiate with unions.

(*continued on next page*)

EXHIBIT V-14 (Continued)
Strategy Attributes for Implementing Targeted Interventions for Other High-Risk Populations (T/E)

	It is desirable to involve all stakeholders in planning for this effort in a cooperative structure, early in the process.
Issues Affecting Implementation Time	None identified. Both of these strategies could be implemented within a fairly short time period unless, in the case of law enforcement, changes in policies and union agreements are required.
Costs Involved	Costs associated with identifying drivers with sleep disorders should be minimal, assuming that the screening is conducted on a volunteer basis by trained health professionals.
	Costs associated with programs for law enforcement officers will be highly variable, depending upon the size of the department and the particular fatigue management approaches implemented. Associated material costs should be minimal, since many materials are readily available and in the public domain.
Training and Other Personnel Needs	Law enforcement training officers will themselves need to be trained so that they can effectively assess the extent and nature of any problem in their department and work with management as well as affected staff to address the problem.
Legislative Needs	None identified.
Other Key Attributes	
	None identified.

The Ingham Center for Sleep & Alertness at the Ingham Regional Medical Center in Lansing, Michigan, an NSF Community Partner, provides a good example of how the medical and highway safety and law enforcement communities can support one another's efforts to address the problem of drowsy driving. In addition to making presentations at annual highway safety conferences and to a variety of state and local agencies, the Center for Sleep & Alertness worked with the Michigan State Police Motor Carrier Division to provide one-on-one education and sleep disorder screening to commercial vehicle operators in violation of HOS regulations. The center has also led "train the trainer" sessions for law enforcement officers, providing basic training on impairment from sleep deprivation and its role in accident investigation. For more information about these activities, contact Pamela Minkley with the Ingham Center for Sleep & Alertness (517-377-8520) or Dan Vartanian, NETS Coordinator with the Office of Highway Safety Planning (517-333-5322).

Although distracted and fatigued driving are recognized as significant personal motor vehicle risk factors in all branches of the military, no specific programs were identified addressing these factors. A Defense Safety Oversight Council (DSOC) Private Motor Vehicle Task Force is currently investigating these issues. Developing permanent partnerships (e.g., partnering with local law enforcement at Department of Defense installations) is one of the task force's identified approaches for achieving behavior change. See http://afsafety.af.mil/AFSC/JSSC_Mtg_0704.htm, DSOC Private Motor Vehicle Task Force Initiatives.

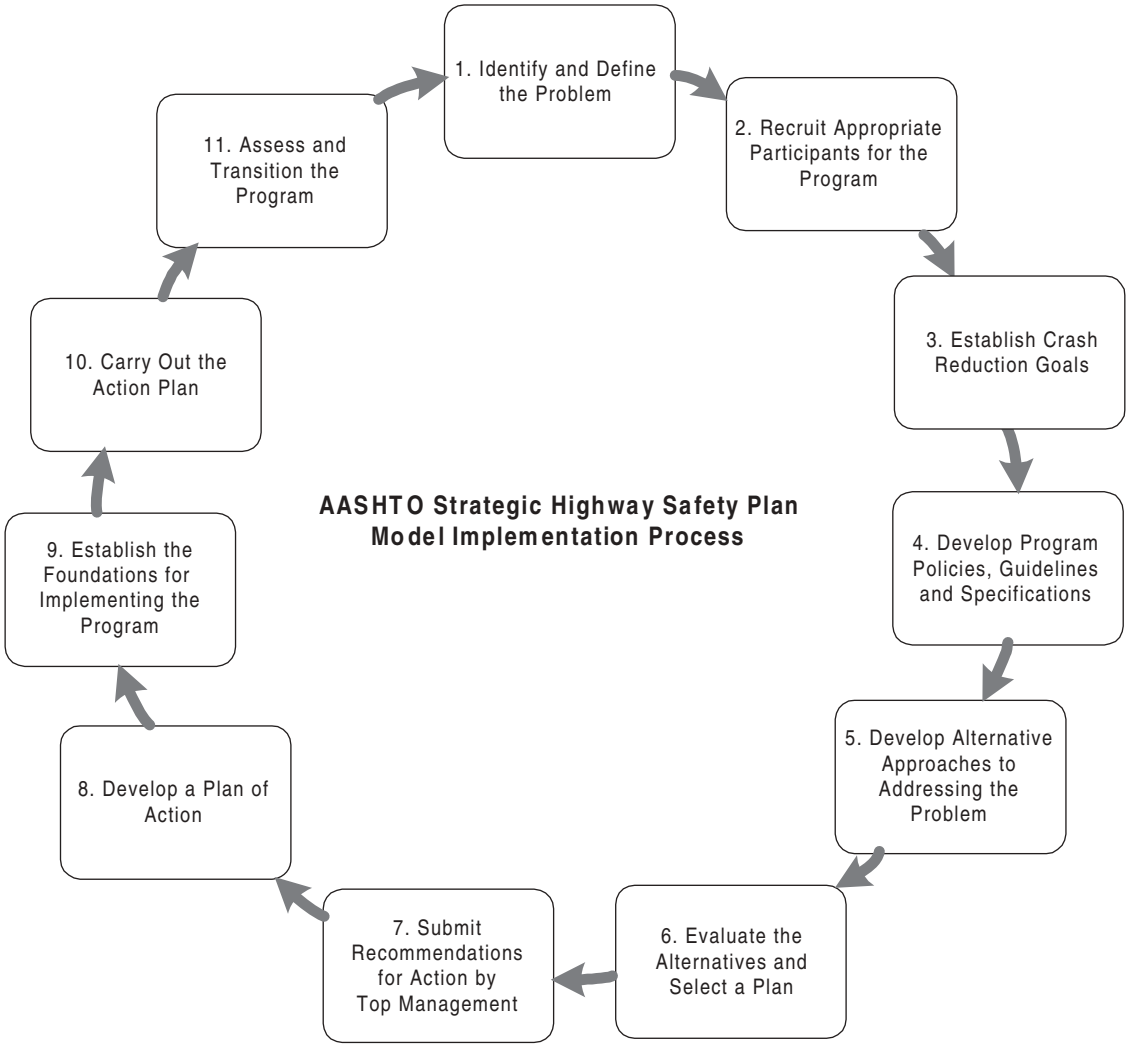
SECTION VI

Guidance for Implementation of the AASHTO Strategic Highway Safety Plan

Outline for a Model Implementation Process

Exhibit VI-1 gives an overview of an 11-step model process for implementing a program of strategies for any given emphasis area of the AASHTO Strategic Highway Safety Plan. After a short introduction, each of the steps is outlined in further detail.

EXHIBIT VI-1



Purpose of the Model Process

The process described in this section is provided as a model rather than a standard. Many users of this guide will already be working within a process established by their agency or working group. It is not suggested that their process be modified to conform to this one. However, the model process may provide a useful checklist. For those not having a standard process to follow, it is recommended that the model process be used to help establish an appropriate one for their initiative. Not all steps in the model process need to be performed at the level of detail indicated in the outlines below. The degree of detail and the amount of work required to complete some of these steps will vary widely, depending upon the situation.

It is important to understand that the process being presented here is assumed to be conducted only as a part of a broader, strategic-level safety management process. The details of that process, and its relation to this one, may be found in a companion guide. (The companion guide is a work in progress at this writing. When it is available, it will be posted online at http://transportation1.org/safetyplan.)

Overview of the Model Process

The process (see Exhibit VI-1, above) must be started at top levels in the lead agency's organization. This would, for example, include the CEO, DOT secretary, or chief engineer, as appropriate. Here, decisions will have been made to focus the agency's attention and resources on specific safety problems based upon the particular conditions and characteristics of the organization's roadway system. This is usually, but not always, documented as a result of the strategic-level process mentioned above. It often is publicized in the form of a "highway safety plan." Examples of what states produce include Wisconsin DOT's Strategic Highway Safety Plan (see Appendix A) and Iowa's Safety Plan (available at http://www.iowasms.org/toolbox.htm).

Once a "high-level" decision has been made to proceed with a particular emphasis area, the first step is to describe, in as much detail as possible, the problem that has been identified in the high-level analysis. The additional detail helps confirm to management that the problem identified in the strategic-level analysis is real and significant and that it is possible to do something about it. The added detail that this step provides to the understanding of the problem will also play an important part in identifying alternative approaches for dealing with it.

Step 1 should produce endorsement and commitments from management to proceed, at least through a planning process. With such an endorsement, it is then necessary to identify the stakeholders and define their role in the effort (Step 2). It is important at this step to identify a range of participants in the process who will be able to help formulate a comprehensive approach to the problem. The group will want to consider how it can draw upon potential actions directed at

- Driver behavior (legislation, enforcement, education, and licensing),
- Engineering,

- Emergency medical systems, and
- System management.

With the establishment of a working group, it is then possible to finalize an understanding of the nature and limitations of what needs to be done in the form of a set of program policies, guidelines, and specifications (Steps 3 and 4). An important aspect of this is establishing targets for crash reduction in the particular emphasis area (Step 3). Identifying stakeholders, defining their roles, and forming guidelines and policies are all elements of what is often referred to as "chartering the team." In many cases, and in particular where only one or two agencies are to be involved and the issues are not complex, it may be possible to complete Steps 1 through 4 concurrently.

Having received management endorsement and chartered a project team—the foundation for the work—it is now possible to proceed with project planning. The first step in this phase (Step 5 in the overall process) is to identify alternative strategies for addressing the safety problems that have been identified while remaining faithful to the conditions established in Steps 2 through 4.

With the alternative strategies sufficiently defined, they must be evaluated against one another (Step 6) and as groups of compatible strategies (i.e., a total program). The results of the evaluation will form the recommended plan. The plan is normally submitted to the appropriate levels of management for review and input, resulting ultimately in a decision on whether and how to proceed (Step 7). Once the working group has been given approval to proceed, along with any further guidelines that may have come from management, the group can develop a detailed plan of action (Step 8). This is sometimes referred to as an "implementation" or "business" plan.

Plan implementation is covered in Steps 9 and 10. There often are underlying activities that must take place prior to implementing the action plan to form a foundation for what needs to be done (Step 9). This usually involves creating the organizational, operational, and physical infrastructure needed to succeed. The major step (Step 10) in this process involves doing what was planned. This step will in most cases require the greatest resource commitment of the agency. An important aspect of implementation involves maintaining appropriate records of costs and effectiveness to allow the plan to be evaluated after-the-fact.

Evaluating the program, after it is underway, is an important activity that is often overlooked. Management has the right to require information about costs, resources, and effectiveness. It is also likely that management will request that the development team provide recommendations about whether the program should be continued and, if so, what revisions should be made. Note that management will be deciding on the future for any single emphasis area in the context of the entire range of possible uses of the agency's resources. Step 11 involves activities that will give the desired information to management for each emphasis area.

To summarize, the implementation of a program of strategies for an emphasis area can be characterized as an 11-step process. The steps in the process correspond closely to a 4-phase approach commonly followed by many transportation agencies:

- Endorsement and chartering of the team and project (Steps 1 through 4),
- Project planning (Steps 5 through 8),
- Plan implementation (Steps 9 and 10), and
- Plan evaluation (Step 11).

Details about each step follow. The Web-based version of this description is accompanied by a set of supplementary material to enhance and illustrate the points.

The model process is intended to provide a framework for those who need it. It is not intended to be a how-to manual. There are other documents that provide extensive detail regarding how to conduct this type of process. Some general ones are covered in Appendix B and Appendix C. Others, which relate to specific aspects of the process, are referenced within the specific sections to which they apply.

Implementation Step 1: Identify and Define the Problem

General Description

Program development begins with gathering data and creating and analyzing information. The implementation process being described in this guide is one that will be done in the context of a larger strategic process. It is expected that this guide will be used when the strategic process, or a project-level analysis, has identified a potentially significant problem in this emphasis area.

Data analyses done at the strategic level normally are done with a limited amount of detail. They are usually the top layer in a "drill-down" process. Therefore, while those previous analyses should be reviewed and used as appropriate, it will often be the case that further studies are needed to completely define the issues.

It is also often the case that a core technical working group will have been formed by the lead agency to direct and carry out the process. This group can conduct the analyses required in this step, but should seek, as soon as possible, to involve any other stakeholders who may desire to provide input to this process. Step 2 deals further with the organization of the working group.

The objectives of this first step are as follows:

1. Confirm that a problem exists in this emphasis area.
2. Detail the characteristics of the problem to allow identification of likely approaches for eliminating or reducing it.
3. Confirm with management, given the new information, that the planning and implementation process should proceed.

The objectives will entail locating the best available data and analyzing them to highlight either geographic concentrations of the problem or over-representation of the problem within the population being studied.

Identification of existing problems is *a responsive approach*. This can be complemented by a *proactive approach* that seeks to identify potentially hazardous conditions or populations.

For the responsive type of analyses, one generally begins with basic crash records that are maintained by agencies within the jurisdiction. This is usually combined, where feasible, with other safety data maintained by one or more agencies. The other data could include

- Roadway inventory,
- Driver records (enforcement, licensing, courts), or
- Emergency medical service and trauma center data.

To have the desired level of impact on highway safety, it is important to consider the highway system as a whole. Where multiple jurisdictions are responsible for various parts of the system, they should all be included in the analysis, wherever possible. The best example of this is a state plan for highway safety that includes consideration of the extensive

mileage administered by local agencies. To accomplish problem identification in this manner will require a cooperative, coordinated process. For further discussion on the problem identification process, see Appendix D and the further references contained therein.

In some cases, very limited data are available for a portion of the roads in the jurisdiction. This can occur for a local road maintained by a state or with a local agency that has very limited resources for maintaining major databases. Lack of data is a serious limitation to this process, but must be dealt with. It may be that for a specific study, special data collection efforts can be included as part of the project funding. While crash records may be maintained for most of the roads in the system, the level of detail, such as good location information, may be quite limited. It is useful to draw upon local knowledge to supplement data, including

- Local law enforcement,
- State district and maintenance engineers,
- Local engineering staff, and
- Local residents and road users.

These sources of information may provide useful insights for identifying hazardous locations. In addition, local transportation agencies may be able to provide supplementary data from their archives. Finally, some of the proactive approaches mentioned below may be used where good records are not available.

Maximum effectiveness often calls for going beyond data in the files to include special supplemental data collected on crashes, behavioral data, site inventories, and citizen input. Analyses should reflect the use of statistical methods that are currently recognized as valid within the profession.

Proactive elements could include

- Changes to policies, design guides, design criteria, and specifications based upon research and experience;
- Retrofitting existing sites or highway elements to conform to updated criteria (perhaps with an appropriate priority scheme);
- Taking advantage of lessons learned from previous projects;
- Road safety audits, including on-site visits;
- Safety management based on roadway inventories;
- Input from police officers and road users; and
- Input from experts through such programs as the NHTSA traffic records assessment team.

The result of this step is normally a report that includes tables and graphs that clearly demonstrate the types of problems and detail some of their key characteristics. Such reports

should be presented in a manner to allow top management to quickly grasp the key findings and help them decide which of the emphasis areas should be pursued further, and at what level of funding. However, the report must also document the detailed work that has been done, so that those who do the later stages of work will have the necessary background.

Specific Elements

1. Define the scope of the analysis
    - 1.1. All crashes in the entire jurisdiction
    - 1.2. A subset of crash types (whose characteristics suggest they are treatable, using strategies from the emphasis area)
    - 1.3. A portion of the jurisdiction
    - 1.4. A portion of the population (whose attributes suggest they are treatable using strategies from the emphasis area)
2. Define safety measures to be used for responsive analyses
    - 2.1. Crash measures
        - 2.1.1. Frequency (all crashes or by crash type)
        - 2.1.2. Measures of exposure
        - 2.1.3. Decide on role of frequency versus rates
    - 2.2. Behavioral measures
        - 2.2.1. Conflicts
        - 2.2.2. Erratic maneuvers
        - 2.2.3. Illegal maneuvers
        - 2.2.4. Aggressive actions
        - 2.2.5. Speed
    - 2.3. Other measures
        - 2.3.1. Citizen complaints
        - 2.3.2. Marks or damage on roadway and appurtenances, as well as crash debris
3. Define measures for proactive analyses
    - 3.1. Comparison with updated and changed policies, design guides, design criteria, and specifications
    - 3.2. Conditions related to lessons learned from previous projects
    - 3.3. Hazard indices or risk analyses calculated using data from roadway inventories to input to risk-based models
    - 3.4. Input from police officers and road users
4. Collect data
    - 4.1. Data on record (e.g., crash records, roadway inventory, medical data, driver-licensing data, citations, other)
    - 4.2. Field data (e.g., supplementary crash and inventory data, behavioral observations, operational data)
    - 4.3. Use of road safety audits, or adaptations
5. Analyze data
    - 5.1. Data plots (charts, tables, and maps) to identify possible patterns, and concentrations (See Appendixes Y, Z and AA for examples of what some states are doing)

5.2. Statistical analysis (high-hazard locations, over-representation of contributing circumstances, crash types, conditions, and populations)
5.3. Use expertise, through road safety audits or program assessment teams
5.4. Focus upon key attributes for which action is feasible:
5.4.1. Factors potentially contributing to the problems
5.4.2. Specific populations contributing to, and affected by, the problems
5.4.3. Those parts of the system contributing to a large portion of the problem

6. Report results and receive approval to pursue solutions to identified problems (a*pprovals being sought here are primarily a confirmation of the need to proceed and likely levels of resources required*)
6.1. Sort problems by type
6.1.1. Portion of the total problem
6.1.2. Vehicle, highway/environment, enforcement, education, other driver actions, emergency medical system, legislation, and system management
6.1.3. According to applicable funding programs
6.1.4. According to political jurisdictions
6.2. Preliminary listing of the types of strategies that might be applicable
6.3. Order-of-magnitude estimates of time and cost to prepare implementation plan
6.4. Listing of agencies that should be involved, and their potential roles (including an outline of the organizational framework intended for the working group). Go to Step 2 for more on this.

Implementation Step 2: Recruit Appropriate Participants for the Program

General Description

A critical early step in the implementation process is to engage all the stakeholders that may be encompassed within the scope of the planned program. The stakeholders may be from outside agencies (e.g., state patrol, county governments, or citizen groups). One criterion for participation is if the agency or individual will help ensure a comprehensive view of the problem and potential strategies for its resolution. If there is an existing structure (e.g., a State Safety Management System Committee) of stakeholders for conducting strategic planning, it is important to relate to this, and build on it, for addressing the detailed considerations of the particular emphasis area.

There may be some situations within the emphasis area for which no other stakeholders may be involved other than the lead agency and the road users. However, in most cases, careful consideration of the issues will reveal a number of potential stakeholders to possibly be involved. Furthermore, it is usually the case that a potential program will proceed better in the organizational and institutional setting if a high-level "champion" is found in the lead agency to support the effort and act as a key liaison with other stakeholders.

Stakeholders should already have been identified in the previous step, at least at a level to allow decision makers to know whose cooperation is needed, and what their potential level of involvement might be. During this step, the lead agency should contact the key individuals in each of the external agencies to elicit their participation and cooperation. This will require identifying the right office or organizational unit, and the appropriate people in each case. It will include providing them with a brief overview document and outlining for them the type of involvement envisioned. This may typically involve developing interagency agreements. The participation and cooperation of each agency should be secured to ensure program success.

Lists of appropriate candidates for the stakeholder groups are recorded in Appendix K. In addition, reference may be made to the NHTSA document at http://www.nhtsa.dot.gov/safecommunities/SAFE%20COMM%20Html/index.html, which provides guidance on building coalitions.

Specific Elements

1. Identify internal "champions" for the program
2. Identify the suitable contact in each of the agencies or private organizations who is appropriate to participate in the program
3. Develop a brief document that helps sell the program and the contact's role in it by
    - 3.1. Defining the problem
    - 3.2. Outlining possible solutions
    - 3.3. Aligning the agency or group mission by resolving the problem
    - 3.4. Emphasizing the importance the agency has to the success of the effort

   3.5. Outlining the organizational framework for the working group and other stakeholders cooperating on this effort
   3.6. Outlining the rest of the process in which agency staff or group members are being asked to participate
   3.7. Outlining the nature of commitments desired from the agency or group for the program
   3.8. Establishing program management responsibilities, including communication protocols, agency roles, and responsibilities
   3.9. Listing the purpose for an initial meeting
4. Meet with the appropriate representative
   4.1. Identify the key individual(s) in the agency or group whose approval is needed to get the desired cooperation
   4.2. Clarify any questions or concepts
   4.3. Outline the next steps to get the agency or group onboard and participating
5. Establish an organizational framework for the group
   5.1. Roles
   5.2. Responsibilities

Implementation Step 3: Establish Crash Reduction Goals

General Description

The AASHTO Strategic Highway Safety Plan established a national goal of saving 5,000 to 7,000 lives annually by the year 2003 to 2005. Some states have established statewide goals for the reduction of fatalities or crashes of a certain degree of severity. Establishing an explicit goal for crash reduction can place an agency "on the spot," but it usually provides an impetus to action and builds a support for funding programs for its achievement. Therefore, it is desirable to establish, within each emphasis area, one or more crash reduction targets.

These may be dictated by strategic-level planning for the agency, or it may be left to the stakeholders to determine. (The summary of the Wisconsin DOT Highway Safety Plan in Appendix A has more information.) For example, Pennsylvania adopted a goal of 10 percent reduction in fatalities by 2002,[1] while California established a goal of 40 percent reduction in fatalities and 15 percent reduction in injury crashes, as well as a 10 percent reduction in work zone crashes, in 1 year.[2] At the municipal level, Toledo, Ohio, is cited by the U.S. Conference of Mayors as having an exemplary program. This included establishing specific crash reduction goals (http://www.usmayors.org/uscm/uscm_projects_services/health/traffic/best_traffic_initiative_toledo.htm). When working within an emphasis area, it may be desirable to specify certain types of crashes, as well as the severity level, being targeted.

There are a few key considerations for establishing a quantitative goal. The stakeholders should achieve consensus on this issue. The goal should be challenging, but achievable. Its feasibility depends in part on available funding, the timeframe in which the goal is to be achieved, the degree of complexity of the program, and the degree of controversy the program may experience. To a certain extent, the quantification of the goal will be an iterative process. If the effort is directed at a particular location, then this becomes a relatively straightforward action.

Specific Elements

1. Identify the type of crashes to be targeted
    - 1.1. Subset of all crash types
    - 1.2. Level of severity
2. Identify existing statewide or other potentially related crash reduction goals
3. Conduct a process with stakeholders to arrive at a consensus on a crash reduction goal
    - 3.1. Identify key considerations
    - 3.2. Identify past goals used in the jurisdiction
    - 3.3. Identify what other jurisdictions are using as crash reduction goals
    - 3.4. Use consensus-seeking methods, as needed

[1] Draft State Highway Safety Plan, State of Pennsylvania, July 22, 1999
[2] Operations Program Business Plan, FY 1999/2000, State of California, Caltrans, July 1999

Implementation Step 4: Develop Program Policies, Guidelines, and Specifications

General Description

A foundation and framework are needed for solving the identified safety problems. The implementation process will need to be guided and evaluated according to a set of goals, objectives, and related performance measures. These will formalize what the intended result is and how success will be measured. The overlying crash reduction goal, established in Step 3, will provide the context for the more specific goals established in this step. The goals, objectives, and performance measures will be used much later to evaluate what is implemented. Therefore, they should be jointly outlined at this point and agreed to by all program stakeholders. It is important to recognize that evaluating any actions is an important part of the process. Even though evaluation is not finished until some time after the strategies have been implemented, it begins at this step.

The elements of this step may be simpler for a specific project or location than for a comprehensive program. However, even in the simpler case, policies, guidelines, and specifications are usually needed. Furthermore, some programs or projects may require that some guidelines or specifications be in the form of limits on directions taken and types of strategies considered acceptable.

Specific Elements

1. Identify high-level policy actions required and implement them (legislative and administrative)
2. Develop goals, objectives, and performance measures to guide the program and use for assessing its effect
    - 2.1. Hold joint meetings of stakeholders
    - 2.2. Use consensus-seeking methods
    - 2.3. Carefully define terms and measures
    - 2.4. Develop report documenting results and validate them
3. Identify specifications or constraints to be used throughout the project
    - 3.1. Budget constraints
    - 3.2. Time constraints
    - 3.3. Personnel training
    - 3.4. Capacity to install or construct
    - 3.5. Types of strategies not to be considered or that must be included
    - 3.6. Other

Implementation Step 5: Develop Alternative Approaches to Addressing the Problem

General Description

Having defined the problem and established a foundation, the next step is to find ways to address the identified problems. If the problem identification stage has been done effectively (see Appendix D for further details on identifying road safety problems), the characteristics of the problems should suggest one or more alternative ways for dealing with the problem. It is important that a full range of options be considered, drawing from areas dealing with enforcement, engineering, education, emergency medical services, and system management actions.

Alternative strategies should be sought for both location-specific and systemic problems that have been identified. Location-specific strategies should pertain equally well to addressing high-hazard locations and to solving safety problems identified within projects that are being studied for reasons other than safety.

Where site-specific strategies are being considered, visits to selected sites may be in order if detailed data and pictures are not available. In some cases, the emphasis area guides will provide tables that help connect the attributes of the problem with one or more appropriate strategies to use as countermeasures.

Strategies should also be considered for application on a systemic basis. Examples include

1. Low-cost improvements targeted at problems that have been identified as significant in the overall highway safety picture, but not concentrated in a given location.
2. Action focused upon a specific driver population, but carried out throughout the jurisdiction.
3. Response to a change in policy, including modified design standards.
4. Response to a change in law, such as adoption of a new definition for DUI.

In some cases, a strategy may be considered that is relatively untried or is an innovative variation from past approaches to treatment of a similar problem. Special care is needed to ensure that such strategies are found to be sound enough to implement on a wide-scale basis. Rather than ignoring this type of candidate strategy in favor of the more "tried-and-proven" approaches, consideration should be given to including a pilot-test component to the strategy.

The primary purpose of this guide is to provide a set of strategies to consider for eliminating or lessening the particular road safety problem upon which the user is focusing. As pointed out in the first step of this process, the identification of the problem, and the selection of strategies, is a complex step that will be different for each case. Therefore, it is not feasible to provide a "formula" to follow. However, guidelines are available. There are a number of texts to which the reader can refer. Some of these are listed in Appendix B and Appendix D.

In addition, the tables referenced in Appendix G provide examples for linking identified problems with candidate strategies.

The second part of this step is to assemble sets of strategies into alternative "program packages." Some strategies are complementary to others, while some are more effective when combined with others. In addition, some strategies are mutually exclusive. Finally, strategies may be needed to address roads across multiple jurisdictions. For instance, a package of strategies may need to address both the state and local highway system to have the desired level of impact. The result of this part of the activity will be a set of alternative "program packages" for the emphasis area.

It may be desirable to prepare a technical memorandum at the end of this step. It would document the results, both for input into the next step and for internal reviews. The latter is likely to occur, since this is the point at which specific actions are being seriously considered.

Specific Elements

1. Review problem characteristics and compare them with individual strategies, considering both their objectives and their attributes
    - 1.1. Road-user behavior (law enforcement, licensing, adjudication)
    - 1.2. Engineering
    - 1.3. Emergency medical services
    - 1.4. System management elements
2. Select individual strategies that do the following:
    - 2.1. Address the problem
    - 2.2. Are within the policies and constraints established
    - 2.3. Are likely to help achieve the goals and objectives established for the program
3. Assemble individual strategies into alternative program packages expected to optimize achievement of goals and objectives
    - 3.1. Cumulative effect to achieve crash reduction goal
    - 3.2. Eliminate strategies that can be identified as inappropriate, or likely to be ineffective, even at this early stage of planning
4. Summarize the plan in a technical memorandum, describing attributes of individual strategies, how they will be combined, and why they are likely to meet the established goals and objectives

Implementation Step 6: Evaluate Alternatives and Select a Plan

General Description

This step is needed to arrive at a logical basis for prioritizing and selecting among the alternative strategies or program packages that have been developed. There are several activities that need to be performed. One proposed list is shown in Appendix P.

The process involves making estimates for each of the established performance measures for the program and comparing them, both individually and in total. To do this in a quantitative manner requires some basis for estimating the effectiveness of each strategy. Where solid evidence has been found on effectiveness, it has been presented for each strategy in the guide. In some cases, agencies have a set of crash reduction factors that are used to arrive at effectiveness estimates. Where a high degree of uncertainty exists, it is wise to use sensitivity analyses to test the validity of any conclusions that may be made regarding which is the best strategy or set of strategies to use. Further discussion of this may be found in Appendix O.

Cost-benefit and cost-effectiveness analyses are usually used to help identify inefficient or inappropriate strategies, as well as to establish priorities. For further definition of the two terms, see Appendix Q. For a comparison of the two techniques, see Appendix S. Aspects of feasibility, other than economic, must also be considered at this point. An excellent set of references is provided within online benefit-cost guides:

- One is under development at the following site, maintained by the American Society of Civil Engineers: http://ceenve.calpoly.edu/sullivan/cutep/cutep_bc_outline_main.htm
- The other is *Guide to Benefit-Cost Analysis in Transport Canada*, September 1994, http://www.tc.gc.ca/finance/bca/en/TOC_e.htm. An overall summary of this document is given in Appendix V.

In some cases, a strategy or program may look promising, but no evidence may be available as to its likely effectiveness. This would be especially true for innovative methods or use of emerging technologies. In such cases, it may be advisable to plan a pilot study to arrive at a minimum level of confidence in its effectiveness, before large-scale investment is made or a large segment of the public is involved in something untested.

It is at this stage of detailed analysis that the crash reduction goals, set in Step 3, may be revisited, with the possibility of modification.

It is important that this step be conducted with the full participation of the stakeholders. If the previous steps were followed, the working group will have the appropriate representation. Technical assistance from more than one discipline may be necessary to go through more complex issues. Group consensus will be important on areas such as estimates of effectiveness, as well as the rating and ranking of alternatives. Techniques are available to assist in arriving at consensus. For example, see the following Web site for an overview: http://web.mit.edu/publicdisputes/practices/cbh_ch1.html.

Specific Elements

1. Assess feasibility
    - 1.1. Human resources
    - 1.2. Special constraints
    - 1.3. Legislative requirements
    - 1.4. Other
    - 1.5. This is often done in a qualitative way, to narrow the list of choices to be studied in more detail (see, for example, Appendix BB)
2. Estimate values for each of the performance measures for each strategy and plan
    - 2.1. Estimate costs and impacts
        - 2.1.1. Consider guidelines provided in the detailed description of strategies in this material
        - 2.1.2. Adjust as necessary to reflect local knowledge or practice
        - 2.1.3. Where a plan or program is being considered that includes more than one strategy, combine individual estimates
    - 2.2. Prepare results for cost-benefit and/or cost-effectiveness analyses
    - 2.3. Summarize the estimates in both disaggregate (by individual strategy) and aggregate (total for the program) form
3. Conduct a cost-benefit and/or cost-effectiveness analysis to identify inefficient, as well as dominant, strategies and programs and to establish a priority for the alternatives
    - 3.1. Test for dominance (both lower cost and higher effectiveness than others)
    - 3.2. Estimate relative cost-benefit and/or cost-effectiveness
    - 3.3. Test productivity
4. Develop a report that documents the effort, summarizing the alternatives considered and presenting a preferred program, as devised by the working group (for suggestions on a report of a benefit-cost analysis, see Appendix U).
    - 4.1. Designed for high-level decision makers, as well as technical personnel who would be involved in the implementation
    - 4.2. Extensive use of graphics and layout techniques to facilitate understanding and capture interest
    - 4.3. Recommendations regarding meeting or altering the crash reduction goals established in Step 3.

Implementation Step 7: Submit Recommendations for Action by Top Management

General Description

The working group has completed the important planning tasks and must now submit the results and conclusions to those who will make the decision on whether to proceed further. Top management, at this step, will primarily be determining if an investment will be made in this area. As a result, the plan will not only be considered on the basis of its merits for solving the particular problems identified in this emphasis area (say, vis-à-vis other approaches that could be taken to deal with the specific problems identified), but also its relative value in relation to investments in other aspects of the road safety program.

This aspect of the process involves using the best available communication skills to adequately inform top management. The degree of effort and extent of use of media should be proportionate to the size and complexity of the problem being addressed, as well as the degree to which there is competition for funds.

The material that is submitted should receive careful review by those with knowledge in report design and layout. In addition, today's technology allows for the development of automated presentations, using animation and multimedia in a cost-effective manner. Therefore, programs involving significant investments that are competing strongly for implementation resources should be backed by such supplementary means for communicating efficiently and effectively with top management.

Specific Elements

1. Submit recommendations for action by management
    - 1.1. "Go/no-go" decision
    - 1.2. Reconsideration of policies, guidelines, and specifications (see Step 3)
    - 1.3. Modification of the plan to accommodate any revisions to the program framework made by the decision makers
2. Working group to make presentations to decision makers and other groups, as needed and requested
3. Working group to provide technical assistance with the review of the plan, as requested
    - 3.1. Availability to answer questions and provide further detail
    - 3.2. Assistance in conducting formal assessments

Implementation Step 8: Develop a Plan of Action

General Description

At this stage, the working group will usually detail the program that has been selected for implementation. This step translates the program into an action plan, with all the details needed by both decision makers, who will have to commit to the investment of resources, and those charged with carrying it out. The effort involves defining resource requirements, organizational and institutional arrangements needed, schedules, etc. This is usually done in the form of a business plan, or plan of action. An example of a plan developed by a local community is shown in Appendix X.

An evaluation plan should be designed at this point. It is an important part of the plan. This is something that should be in place before Step 9 is finished. It is not acceptable to wait until after the program is completed to begin designing an evaluation of it. This is because data are needed about conditions before the program starts, to allow comparison with conditions during its operation and after its completion. It also should be designed at this point, to achieve consensus among the stakeholders on what constitutes "success." The evaluation is used to determine just how well things were carried out and what effect the program had. Knowing this helps maintain the validity of what is being done, encourages future support from management, and provides good intelligence on how to proceed after the program is completed. For further details on performing evaluations, see Appendix L, Appendix M, and Appendix W.

The plan of action should be developed jointly with the involvement of all desired participants in the program. It should be completed to the detail necessary to receive formal approval of each agency during the next step. The degree of detail and complexity required for this step will be a function of the size and scope of the program, as well as the number of independent agencies involved.

Specific Elements

1. Translation of the selected program into key resource requirements
    - 1.1. Agencies from which cooperation and coordination is required
    - 1.2. Funding
    - 1.3. Personnel
    - 1.4. Data and information
    - 1.5. Time
    - 1.6. Equipment
    - 1.7. Materials
    - 1.8. Training
    - 1.9. Legislation
2. Define organizational and institutional framework for implementing the program
    - 2.1. Include high-level oversight group
    - 2.2. Provide for involvement in planning at working levels
    - 2.3. Provide mechanisms for resolution of issues that may arise and disagreements that may occur
    - 2.4. Secure human and financial resources required

3. Detail a program evaluation plan
    - 3.1. Goals and objectives
    - 3.2. Process measures
    - 3.3. Performance measures
        - 3.3.1. Short-term, including surrogates, to allow early reporting of results
        - 3.3.2. Long-term
    - 3.4. Type of evaluation
    - 3.5. Data needed
    - 3.6. Personnel needed
    - 3.7. Budget and time estimates
4. Definition of tasks to conduct the work
    - 4.1. Develop diagram of tasks (e.g., PERT chart)
    - 4.2. Develop schedule (e.g., Gantt chart)
    - 4.3. For each task, define
        - 4.3.1. Inputs
        - 4.3.2. Outputs
        - 4.3.3. Resource requirements
        - 4.3.4. Agency roles
        - 4.3.5. Sequence and dependency of tasks
5. Develop detailed budget
    - 5.1. By task
    - 5.2. Separate by source and agency/office (i.e., cost center)
6. Produce program action plan, or business plan document

Implementation Step 9: Establish Foundations for Implementing the Program

General Description

Once approved, some "groundwork" is often necessary to establish a foundation for carrying out the selected program. This is somewhat similar to what was done in Step 4. It must now be done in greater detail and scope for the specific program being implemented. As in Step 4, specific policies and guidelines must be developed, organizational and institutional arrangements must be initiated, and an infrastructure must be created for the program. The business plan or action plan provides the basis (Step 7) for this. Once again, the degree of complexity required will vary with the scope and size of the program, as well as the number of agencies involved.

Specific Elements

1. Refine policies and guidelines (from Step 4)
2. Effect required legislation or regulations
3. Allocate budget
4. Reorganize implementation working group
5. Develop program infrastructure
    - 5.1. Facilities and equipment for program staff
    - 5.2. Information systems
    - 5.3. Communications
    - 5.4. Assignment of personnel
    - 5.5. Administrative systems (monitoring and reporting)
6. Set up program assessment system
    - 6.1. Define/refine/revise performance and process measures
    - 6.2. Establish data collection and reporting protocols
    - 6.3. Develop data collection and reporting instruments
    - 6.4. Measure baseline conditions

Implementation Step 10: Carry Out the Action Plan

General Description

Conditions have been established to allow the program to be started. The activities of implementation may be divided into activities associated with field preparation for whatever actions are planned and the actual field implementation of the plan. The activities can involve design and development of program actions, actual construction or installation of program elements, training, and the actual operation of the program. This step also includes monitoring for the purpose of maintaining control and carrying out mid- and post-program evaluation of the effort.

Specific Elements

1. Conduct detailed design of program elements
    - 1.1. Physical design elements
    - 1.2. PI&E materials
    - 1.3. Enforcement protocols
    - 1.4. Etc.
2. Conduct program training
3. Develop and acquire program materials
4. Develop and acquire program equipment
5. Conduct pilot tests of untested strategies, as needed
6. Program operation
    - 6.1. Conduct program "kickoff"
    - 6.2. Carry out monitoring and management of ongoing operation
        - 6.2.1 Periodic measurement (process and performance measures)
        - 6.2.2 Adjustments as required
    - 6.3 Perform interim and final reporting

Implementation Step 11: Assess and Transition the Program

General Description

The AASHTO Strategic Highway Safety Plan includes improvement in highway safety management. A key element of that is the conduct of properly designed program evaluations. The program evaluation will have been first designed in Step 8, which occurs prior to any field implementation. For details on designing an evaluation, please refer to Step 8. For an example of how the New Zealand Transport Authority takes this step as an important part of the process, see Appendix N.

The program will usually have a specified operational period. An evaluation of both the process and performance will have begun prior to the start of implementation. It may also continue during the course of the implementation, and it will be completed after the operational period of the program.

The overall effectiveness of the effort should be measured to determine if the investment was worthwhile and to guide top management on how to proceed into the post-program period. This often means that there is a need to quickly measure program effectiveness in order to provide a preliminary idea of the success or need for immediate modification. This will be particularly important early in development of the AASHTO Strategic Highway Safety Plan, as agencies learn what works best. Therefore, surrogates for safety impact may have to be used to arrive at early/interim conclusions. These usually include behavioral measures. This particular need for interim surrogate measures should be dealt with when the evaluation is designed, back in Step 8. However, a certain period, usually a minimum of a couple of years, will be required to properly measure the effectiveness and draw valid conclusions about programs designed to reduce highway fatalities when using direct safety performance measures.

The results of the work are usually reported back to those who authorized it and the stakeholders, as well as any others in management who will be involved in determining the future of the program. Decisions must be made on how to continue or expand the effort, if at all. If a program is to be continued or expanded (as in the case of a pilot study), the results of its assessment may suggest modifications. In some cases, a decision may be needed to remove what has been placed in the highway environment as part of the program because of a negative impact being measured. Even a "permanent" installation (e.g., rumble strips) requires a decision regarding investment for future maintenance if it is to continue to be effective.

Finally, the results of the evaluation using performance measures should be fed back into a knowledge base to improve future estimates of effectiveness.

Specific Elements

1. Analysis
    - 1.1 Summarize assessment data reported during the course of the program
    - 1.2 Analyze both process and performance measures (both quantitative and qualitative)

   1.3 Evaluate the degree to which goals and objectives were achieved (using performance measures)
   1.4 Estimate costs (especially vis-à-vis pre-implementation estimates)
   1.5 Document anecdotal material that may provide insight for improving future programs and implementation efforts
   1.6 Conduct and document debriefing sessions with persons involved in the program (including anecdotal evidence of effectiveness and recommended revisions)
2. Report results
3. Decide how to transition the program
   3.1 Stop
   3.2 Continue as is
   3.3 Continue with revisions
   3.4 Expand as is
   3.5 Expand with revisions
   3.6 Reverse some actions
4. Document data for creating or updating database of effectiveness estimates

SECTION VII

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Appendixes

The following appendixes are not published in this report. However, they are available online at http://safety.transportation.org.

1 2000-2003 NASS Crashworthiness Data System Tables
2 Identifying High Crash Locations—Utah DOT
3 Profile of State Agency Implementation Efforts—Kansas Rural High-Speed Roundabout
4 Profile of State Agency Implementation Efforts—Iowa's Roadside Parks
5 Profile of State Agency Implementation Efforts—Building More and Better Safety Rest Areas
6 Intelligent Transportation Systems and Truck Parking
7 Profile of State Agency Implementation Efforts—Use of Weigh Stations for Heavy Truck Parking in Kentucky
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12 Profile of State Agency Implementation Efforts—"Survival 101"—Law Enforcement Reaching Out to Teens
13 Shiftwork Lifestyle Training: Employee and Employer Benefits—Circadian Technologies
14 Reducing the Costs, Risks and Liabilities of Obstructive Sleep Apnea—Circadian Technologies
15 Profile of State Agency Implementation Efforts—Using Technology to Enhance CMV Enforcement—Connecticut DOT
16 Get on the Road to Better Health Campaign—Campaign & Materials Outline—National Sleep Foundation
17 I-95 Corridor Coalition Field Operational Test #10: Coordinated Safety Management Volume II. Survey of State Motor Carrier Safety Activities—Patten, 2001 (Vol. 2)
18 P I-95 Corridor Coalition Field Operational Test #10: Coordinated Safety Management Volume III. A Toolbox for Enhancing Motor Carrier Safety Enforcement—Patten, 2001 (Vol. 3)

A Wisconsin Department of Transportation 2001 Strategic Highway Safety Plan
B Resources for the Planning and Implementation of Highway Safety Programs
C South African Road Safety Manual
D Comments on Problem Definition
E Issues Associated with Use of Safety Information in Highway Design: Role of Safety in Decision Making
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AA Sample Intersection Collision Diagram
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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation