Reducing Speeding-Related Crashes Involving Passenger Vehicles

Safety Study

NTSB/SS-17/01
PB2017-102341

National Transportation Safety Board

NTSB/SS-17/01
PB2017-102341
Notation 56821
Adopted July 25, 2017

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National Transportation Safety Board

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National Transportation Safety Board. 2017. *Reducing Speeding-Related Crashes Involving Passenger Vehicles*. Safety Study NTSB/SS-17/01. Washington, DC.

Abstract: In this safety study, the National Transportation Safety Board (NTSB) examines causes of and trends in speeding-related passenger vehicle crashes and countermeasures to prevent these crashes. The countermeasures presented represent several, of many, potential solutions to the issue of speeding-related crashes. They do not address every cause of speeding or type of speeding-related crash, but they are intended to be widely applicable to a significant portion of these crashes.

The NTSB focused on the following five safety issues pertaining to the effective application of proven and emerging countermeasures for speeding: (1) speed limits, (2) data-driven approaches for speed enforcement, (3) automated speed enforcement, (4) intelligent speed adaptation, and (5) national leadership.

As a result of this safety study, the NTSB makes recommendations to the US Department of Transportation, the National Highway Traffic Safety Administration, the Federal Highway Administration, 50 states, the Governors Highway Safety Association, the International Association of Chiefs of Police, and the National Sheriffs' Association.

The National Transportation Safety Board (NTSB) is an independent federal agency dedicated to promoting aviation, railroad, highway, marine, and pipeline safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ASE	automated speed enforcement
BAC	blood alcohol concentration
CFR	*Code of Federal Regulations*
DDACTS	Data-Driven Approaches to Crime and Traffic Safety
DOT	US Department of Transportation
FARS	Fatality Analysis Reporting System
FAST Act	Fixing America’s Surface Transportation Act
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GES	General Estimates System
GHSA	Governors Highway Safety Association
GIS	geographic information system
GPS	global positioning system
HVE	high-visibility enforcement
IACP	International Association of Chiefs of Police
IIHS	Insurance Institute for Highway Safety
ISA	intelligent speed adaptation
ITE	Institute of Transportation Engineers
km/h	kilometers per hour
LIDAR	light detection and ranging
MADD	Mothers Against Drunk Driving
MAP-21	Moving Ahead for Progress in the 21st Century Act
MMUCC	*Model Minimum Uniform Crash Criteria*

MUTCD	*Manual on Uniform Traffic Control Devices*
MV PICCS	Motor Vehicle Prioritizing Interventions and Cost Calculator for States
NASS	National Automotive Sampling System
NCAP	New Car Assessment Program
NHTSA	National Highway Traffic Safety Administration
NSA	National Sheriffs' Association
NSC	National Safety Council
NTSB	National Transportation Safety Board
RITA	Research and Innovative Technology Administration
SCOHTS	Standing Committee on Highway Traffic Safety
TSM	Traffic Safety Marketing
USC	*United States Code*
VMT	vehicle miles traveled

Executive Summary

Speeding—exceeding a speed limit or driving too fast for conditions—is one of the most common factors in motor vehicle crashes in the United States. In this safety study, the National Transportation Safety Board (NTSB) examines causes of and trends in speeding-related passenger vehicle crashes and countermeasures to prevent these crashes.

Why the NTSB Did This Study

From 2005 through 2014, crashes in which a law enforcement officer indicated a vehicle's speed was a factor resulted in 112,580 fatalities, representing 31% of all traffic fatalities. Speeding or speed has been cited as a safety issue, or a causal or contributing factor in 49 major NTSB highway accident investigations since 1967. Although recent speeding-related NTSB investigations have primarily involved large trucks and buses, most speeding-related crashes involve speeding passenger vehicles. In 2014, passenger vehicles constituted 77% of speeding vehicles involved in fatal crashes, and 78% of all speeding-related fatalities involved a speeding passenger vehicle. This study leverages prior NTSB investigations, together with other research, to address the national safety issue of speeding among passenger vehicle drivers.

In this study, the NTSB used a combination of quantitative and qualitative methods to summarize the risks of speeding, describe the scope of the problem, and promote the use of proven and emerging speeding countermeasures. This included a literature survey; analyses of speeding-related crash data; and interviews with national, state, and local traffic safety stakeholders. The stakeholders were representatives from transportation and highway safety agencies, law enforcement agencies, automobile manufacturers, research institutions, advocacy groups, equipment vendors, personal auto insurance providers, and professional associations.

This study assessed speeding among passenger vehicle drivers in a broad sense, as a factor that contributes to crashes and injury severity. Several, of many, potential solutions to the issue of speeding-related crashes are discussed. The solutions do not address every cause of speeding or type of speeding-related crash, but they are intended to be widely applicable to a significant portion of these crashes.

What the NTSB Found

Speed—and therefore speeding—increases crash risk in two ways: (1) it increases the likelihood of being involved in a crash, and (2) it increases the severity of injuries sustained by all road users in a crash.

The relationship between speed and crash involvement is complex, and it is affected by factors such as road type, driver age, alcohol impairment, and roadway characteristics like curvature, grade, width, and adjacent land use. In contrast, the relationship between speed and injury severity is consistent and direct. Higher vehicle speeds lead to larger changes in velocity in a crash, and these velocity changes are closely linked to injury severity. This relationship is especially critical for pedestrians involved in a motor vehicle crash, due to their lack of protection.

Typically, speed limits are set by statute, but adjustments to statutory speed limits are generally based on the observed operating speeds for each road segment—specifically, the 85th percentile speed of free-flowing traffic. Raising speed limits to match the 85th percentile speed can result in unintended consequences. It may lead to higher operating speeds, and thus a higher 85th percentile speed. In general, there is not strong evidence that the 85th percentile speed within a given traffic flow equates to the speed with the lowest crash involvement rate for all road types. Alternative approaches and expert systems for setting speed limits are available, which incorporate factors such as crash history and the presence of vulnerable road users such as pedestrians.

Speed limits must be enforced to be effective, and data-driven, high-visibility enforcement is an efficient way to use law enforcement resources. The success of data-driven speed enforcement programs depends on the ability to measure and communicate their effectiveness. However, law enforcement reporting of speeding-related crashes is inconsistent, which leads to underreporting of speeding-related crashes. This underreporting leads stakeholders and the public to underestimate the overall scope of speeding as a traffic safety issue nationally and hinders the effective implementation of data-driven speed enforcement programs locally.

Automated speed enforcement (ASE) is also widely acknowledged as an effective countermeasure to reduce speeding-related crashes, fatalities, and injuries. However, only 14 states and the District of Columbia use it. Many states have laws that prohibit or place operational restrictions on ASE, and federal guidelines for ASE are outdated and not well known among ASE program administrators. Point-to-point enforcement, which is based on the average speed of a vehicle between two points, can be used on roadway segments many miles long. This type of ASE has had recent success in other countries, but it is not currently used in the United States.

Vehicle technologies can also be effective at reducing speeding. Intelligent speed adaptation (ISA) uses an onboard global positioning system or road sign-detecting camera to determine the speed limit; it then warns drivers when they exceed the speed limit, or prevents drivers from exceeding the speed limit by electronically limiting the speed of the vehicle. Although passenger vehicle manufacturers are increasingly equipping their vehicles with technologies relevant to speeding, these technologies often are not standard features and require the purchase of certain option packages. New car safety rating systems are one effective way to incentivize the manufacture and purchase of passenger vehicles with advanced safety systems such as ISA.

Finally, the current level of emphasis on speeding as a national traffic safety issue is lower than warranted. Current federal-aid programs do not ensure that states fund speed management activities at a level commensurate with the national impact of speeding on fatalities and injuries. Also, unlike other traffic safety issues with a similar impact (such as alcohol-impaired driving) there are no nationwide programs to increase public awareness of the risks of speeding. Although the US Department of Transportation (DOT) has established a multi-agency team to coordinate speeding-related work throughout the DOT, this team’s work plan does not include means to ensure that the planned actions are completed in a timely manner.

Recommendations

As a result of this safety study, the NTSB makes recommendations to the US Department of Transportation, the National Highway Traffic Safety Administration, the Federal Highway Administration, 50 states, the Governors Highway Safety Association, the International Association of Chiefs of Police, and the National Sheriffs' Association.

1 Introduction

Speeding—exceeding a speed limit or driving too fast for conditions—is one of the most common factors in motor vehicle crashes in the United States (Blincoe and others 2015). Over the past 15 years, the National Transportation Safety Board (NTSB) has identified speeding as a safety issue among drivers of heavy vehicles (NTSB 2012), in work zones (NTSB 2015), and at locations with site specific hazards (NTSB 2006; NTSB 2005a; NTSB 2005b). However, the NTSB has not often addressed this pervasive safety issue among passenger vehicle drivers.[1] This study examines speeding-related crashes involving passenger vehicles and countermeasures to prevent these crashes in the United States.[2]

1.1 Goals

The goals of this study are to summarize the risks of speeding, describe the scope of the problem, and promote the use of proven and emerging speeding countermeasures. In particular, this study focuses on countermeasures addressing passenger vehicle driver behavior.

1.2 Scope of the Study

This study assessed speeding among passenger vehicle drivers in a broad sense, as a factor that contributes to crashes and injury severity. Other crash factors, environmental conditions, and driver characteristics are known to be associated with speeding-related crashes, such as alcohol impairment, nighttime driving, and young male drivers (Council and others 2010; Neuner and others 2016). Some of these features of speeding-related crashes are discussed to highlight misconceptions about speeding and to illustrate the complexity of the relationship between speed and crash risk, but this study generally does not consider the many other factors that cause crashes and crash-related injuries, such as distraction or drug impairment. The countermeasures presented in this study represent several, of many, potential solutions to the issue of speeding-related crashes. They do not address every cause of speeding or type of speeding-related crash, but they are intended to be widely applicable to a significant portion of these crashes.

1.3 Methodology

The NTSB used a combination of quantitative and qualitative methods for this study, including a literature survey; analyses of speeding-related crash data; and interviews with national, state, and local traffic safety stakeholders.

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[1] As defined by the National Highway Traffic Safety Administration (NHTSA), *passenger vehicles* include automobiles, utility vehicles, and trucks with a gross vehicle weight rating less than or equal to 10,000 pounds. For a detailed list of vehicle types, refer to appendix C of the *FARS Analytical User's Manual* (NHTSA 2015a).

[2] As defined by NHTSA, a *speeding-related crash* is a crash in which the speed of at least one vehicle was related to the crash, as indicated "by the police issuing a citation for a speed offense, by their indicating a related or contributing factor, or through a description in the narrative" (NHTSA 2016a). The national crash databases used for this study do not indicate the probable cause of a crash.

1.3.1 Literature Survey

To identify speeding countermeasures with demonstrated effectiveness, the NTSB conducted a literature survey of relevant recent and foundational US studies. The NTSB also reviewed recent studies performed in other countries to identify successful speeding countermeasures. Information gathered from the literature survey also helped the NTSB develop topics for discussion with stakeholders.

1.3.2 Data Analysis

The NTSB analyzed data from the following national databases to summarize the scope of the speeding problem, illustrate the variability of speeding-related crashes, and confirm viewpoints expressed in stakeholder interviews:

- The Fatality Analysis Reporting System (FARS) is a census of fatal motor vehicle crashes occurring on US public roads since 1975, which is maintained by the National Highway Traffic Safety Administration (NHTSA) and based on data extracted from police crash reports (NHTSA 2015a).
- The National Automotive Sampling System (NASS) General Estimates System (GES) is a nationally representative sample of fatal and nonfatal motor vehicle crashes occurring on US public roads since 1988. Like FARS, NASS GES is also maintained by NHTSA and based on police crash reports (NHTSA 2015b).

The majority of the analyses in section 2 used 2014 FARS data, as these were the most recent data available when the NTSB conducted this study.

1.3.3 Stakeholder Interviews

The NTSB conducted semi-structured interviews with representatives from the following traffic safety stakeholder organizations.[3] The purpose of these interviews was to identify areas of common concern among stakeholders, including obstacles to the effective implementation of speeding countermeasures.

- **Federal Government**: The NTSB interviewed members of the US Department of Transportation (DOT) Speed Management Team (which consists of subject matter experts within NHTSA, the Federal Highway Administration [FHWA], and the Federal Motor Carrier Safety Administration [FMCSA]) and the NHTSA Office of Impaired Driving and Occupant Protection. Interview topics included current and recently completed speeding-related research projects, public awareness programs, and the federal role in addressing speeding.
- **State Government**: The NTSB interviewed employees of five state transportation departments, seven state highway safety offices, one office of the attorney general, and one public health department. Interview topics included methods for setting speed limits, engineering countermeasures, enforcement, federal and state highway safety grant program

[3] *Semi-structured interviews* primarily consist of open-ended questions. Interview topics and potential questions are developed beforehand. However, the order and wording of the questions may vary among interview subjects, and questions may be added as the interview progresses to explore topics in greater detail (Britten 2006, 12-20).

administration, the role of the courts, and procedures for recording and analyzing crash data.

- **State Law Enforcement**: The NTSB interviewed officers from five different state law enforcement agencies.[4] Most of the officers were in a supervisory role and were familiar with statewide speed enforcement activities. Interview topics included in-person and automated speed enforcement (ASE); the use of data to target enforcement; and coordination with other state agencies, states, and localities.
- **Local Government**: The NTSB interviewed employees of seven city transportation departments, one planning and zoning department, and one public health department. Interview topics included methods for setting speed limits, engineering countermeasures, enforcement, coordination with state and federal agencies, the impact of speeding on vulnerable road users such as bicyclists and pedestrians, and local initiatives to reduce traffic fatalities.
- **Local Law Enforcement**: The NTSB interviewed officers from nine city and county law enforcement agencies. The interviews included supervisors of traffic enforcement divisions (for those departments with discrete traffic enforcement divisions), officers responsible for traffic enforcement, and data analysts. Interview topics included in-person enforcement and ASE, the use of data to target enforcement, the role of speed enforcement within other law enforcement duties, and coordination with other state and local agencies.
- **Automobile Manufacturers**: The NTSB interviewed four US automobile manufacturers. Interview topics included speeding-related vehicle technologies and technologies designed to prevent unsafe behaviors by teen drivers.

The NTSB also interviewed representatives from traffic safety research institutions, advocacy groups, equipment vendors, personal auto insurance providers, and professional associations.

The NTSB selected stakeholders for interviews with a goal of gathering varied input, in terms of both geography (urban, suburban, and rural) and the types of countermeasures used. For example, some cities had extensive automated enforcement programs, whereas others had a strong focus on engineering countermeasures. Likewise, the automobile manufacturers selected for interviews offered varying levels of automation and driver support systems in their vehicles. Information gathered from the stakeholder interviews helped the NTSB identify the safety issues examined in this study.

1.4 Previous NTSB Investigations and Recommendations

Speeding or speed has been cited as a safety issue, or a causal or contributing factor in 49 major NTSB highway accident investigations, including the NTSB's first highway accident investigation, which involved a series of collisions among 11 vehicles in dense fog in Joliet, Illinois, on August 12, 1967 (NTSB 1967).[5] The NTSB conducts major highway accident investigations when the accident involves an issue related to a current NTSB safety study or special

[4] Throughout the remainder of this report, the term *officer* will be used to refer to law enforcement officers in local police, county sheriff, constable, state police, state patrol, and highway patrol agencies.

[5] Appendix A provides a complete list of NTSB major highway accident investigations in which speeding or speed was found to be a safety issue, or a causal or contributing factor.

investigation, has a significant impact on the public confidence or highway safety, or is determined by the NTSB to be catastrophic. Generally, NTSB highway investigations focus on commercial vehicles; as a result, most of the recent speeding-related NTSB investigations have primarily involved large trucks and buses. The following are examples of recent NTSB accident investigations that resulted in speeding-related safety recommendations. Each of these safety recommendations is currently classified by the NTSB as having an acceptable status, indicating that planned or completed actions satisfy the intent of the recommendation.

On March 12, 2011, in New York City, New York, a motorcoach departed from interstate highway travel lanes, struck a guardrail, overturned, and struck a highway signpost, resulting in 15 fatalities. The motorcoach was traveling 64 mph on a highway with a posted speed limit of 50 mph. As a result of its investigation, the NTSB identified heavy vehicle speed limiters as a safety issue and issued recommendations to NHTSA to develop performance standards for advanced speed limiting technology for heavy vehicles and to require this technology on newly manufactured heavy vehicles (NTSB 2012).[6] These recommendations were later reiterated in the NTSB's investigative report on a June 7, 2014, accident in Cranbury, New Jersey, in which a tractor-trailer struck the rear of a limo van at the end of a work zone traffic queue, resulting in one fatality. The NTSB found that the tractor-trailer was traveling 65 mph in a work zone with a posted speed limit of 45 mph, and the traffic in the queue had slowed to less than 10 mph. The NTSB identified reducing vehicle speeds in work zones as a safety issue in this accident (NTSB 2015).

On May 1, 2003, a Mercedes Benz CLK320 crossed a raised highway median in Linden, New Jersey, and struck a Ford Taurus head-on, resulting in six fatalities. The NTSB identified speed enforcement as a safety issue and issued a recommendation to the city of Linden to develop a speed enforcement plan for the road segment on which the accident occurred (NTSB 2006).[7]

On February 14, 2003, in Hewitt, Texas, the driver of a motorcoach was unable to maintain control of the vehicle while traveling on Interstate 35 in overcast weather with reduced visibility and heavy rain. The motorcoach crossed the interstate highway median and collided with a Chevrolet Suburban, resulting in seven fatalities. Among the safety issues identified in the NTSB investigation were (1) sight distance and speed as they relate to roadway design, and (2) the need to better identify areas with a high risk of wet weather accidents and implement the necessary roadway improvements. The NTSB recommended that the FHWA issue guidance for the use of variable speed limits in wet weather at locations where the operating speed exceeds the design speed and the stopping distance exceeds the available sight distance. The NTSB also recommended

[6] The motorcoach in this accident was equipped with a fixed speed limiter, but because it was set to 78 mph, it was ineffective at limiting the speed of the motorcoach to the posted speed limit at the accident location. NTSB Safety Recommendations H-12-20 (to develop performance standards) and H-12-21 (to require speed limiters) are currently classified "Open—Acceptable Response." These recommendations and all NTSB recommendations referenced in this report as well as relevant excerpts of associated correspondence are available via the NTSB safety recommendations database.

[7] NTSB Safety Recommendation H-06-14 is classified "Closed—Acceptable Action."

that the Texas Department of Transportation install variable speed limit signs at such locations (NTSB 2005a).[8]

These examples illustrate that the NTSB has a long history of investigating individual speeding-related accidents, particularly involving bus and truck drivers. This study extends that prior work by addressing the national safety issue of speeding among passenger vehicle drivers. As shown in section 2, these drivers are involved in the majority of speeding-related fatal crashes.[9]

[8] NTSB Safety Recommendation H-05-14 (for the FHWA to issue guidance) is classified "Closed—Acceptable Action" and Safety Recommendation H-05-20 (for the Texas Department of Transportation to install variable speed limit signs) is currently classified "Open—Acceptable Response."

[9] A *fatal crash* is a crash in which there was at least one fatality.

2 Speeding

This section provides definitions of speeding, describes the scope of speeding as a traffic safety issue, examines the risks of speeding, and describes the characteristics of speeding-related crashes that are relevant to effective speeding countermeasures. Public attitudes toward speeding and the roles federal, state, and local governments play in addressing speeding are also discussed.

2.1 Definitions

The traffic safety community, including NHTSA, considers drivers to be speeding if their vehicles are traveling at a speed that (1) exceeds the speed limit or (2) is too fast for conditions (NHTSA 2013).[10] The first definition (exceeds the speed limit) refers to legal speed limits—known as *statutory speed limits*—established by states for each road type.[11] These limits generally apply to all roads of a given type even if no physical speed limit signage is present, but they can be superseded by speed limits posted for specific road segments. The second definition (too fast for conditions) is based on the *basic speed law*.[12] All states have a variation of this law, which typically requires drivers to operate at a speed that is reasonable and prudent, taking into account weather, road conditions, traffic, visibility, and other environmental conditions (Goodwin and others 2015).

[10] The third category is racing (Goodwin and others 2015). *Racing* (on a roadway) is defined as "driving any vehicle in any race, speed competition or contest, drag race or acceleration contest, test of physical endurance, exhibition of speed or acceleration, or for the purpose of making a speed record" (NHTSA 2013).

[11] (a) Some states may set statutory speed limits for cars and trucks differently. (b) Examples of road types include rural interstates, urban freeways, urban collectors, and local residential streets. These road types are also referred to as road (or highway) function classes. Appendix B provides descriptions of the FHWA road function classifications.

[12] *Basic speed law* is also known as the basic speed rule. "This rule requires vehicle operators to drive at a speed that is reasonable and prudent. As a corollary to this rule, State laws usually provide that every person shall drive at a safe and appropriate speed when approaching and crossing an intersection or railroad grade crossing, when approaching and going around a curve, when approaching a hill crest, when traveling upon any narrow or winding roadway, and when special hazards exist with respect to pedestrians or other traffic, or by reason of weather or highway conditions" (NHTSA 2013).

2.2 Scope of the Problem

From 2005 through 2014, FARS data show that speeding-related crashes accounted for 112,580 fatalities (see table 1). Although the annual numbers of total traffic fatalities and speeding-related fatalities both decreased during this period, speeding-related fatalities have consistently accounted for about 31% of all traffic fatalities (NCSA 2016a; NCSA 2017). During the same period, there were 112,948 traffic fatalities involving alcohol-impaired driving, which represents 31% of all traffic fatalities (NCSA 2015; NCSA 2016b).[13] Thus, speeding-related fatalities represent a large portion of the total traffic fatalities in the United States; this portion is comparable to that attributed to alcohol-impaired driving.

Table 1. Total and speeding-related traffic fatalities, 2005-2014

Year	Total Fatalities	Speeding-Related Fatalities	% Speeding Related
2005	43,510	13,583	31.2
2006	42,708	13,609	31.9
2007	41,259	13,140	31.8
2008	37,423	11,767	31.4
2009	33,808	10,664	31.5
2010	32,999	10,508	31.8
2011	32,479	10,001	30.8
2012	33,782	10,329	30.6
2013	32,894	9,696	29.5
2014	32,744	9,283	28.4
Total	**363,606**	**112,580**	**31.0**

Sources: NCSA 2016a; NCSA 2017

[13] (a) The crash categories of "speeding-related" and "alcohol-impaired driving" are not mutually exclusive. From 2005 through 2014, FARS data show that 49,023 traffic fatalities involved both speeding and alcohol-impaired driving. The overlap of these two categories is addressed in section 2.4.2. (b) The analyses presented in this study used NHTSA data, in which drivers are considered to be alcohol-impaired when their blood alcohol concentrations (BACs) are 0.08 gram per deciliter or higher.

2.2.1 Fatalities and Injuries

Of the 9,283 speeding-related fatalities in 2014, 5,933 (64%) were the drivers of the speeding vehicles; 1,835 (20%) were passengers in the speeding vehicles; 1,136 (12%) were occupants in other vehicles; 314 (3%) were pedestrians; and 46 (0.5%) were bicyclists, as shown in table 2. This table also includes NASS GES data indicating that an estimated 336,742 people sustained nonfatal injuries due to speeding in 2014. More than 40% of the people injured were occupants of non-speeding vehicles, pedestrians, or bicyclists. Therefore, speeding poses a significant risk of death and injury to not only the drivers and passengers of speeding vehicles but also other road users.

Table 2. Estimated injuries in speeding-related crashes, by person type and injury severity, 2014

Person Type	Fatal[a]		Serious[b]		Possible/Minor[b]		Total Nonfatal Injuries	
	Number	%	Number	%	Number	%	Number	%
Drivers in speeding vehicles	5,933	63.9	18,745	62.3	128,466	41.9	147,211	43.7
Passengers in speeding vehicles	1,835	19.8	5,499	18.3	43,310	14.1	48,809	14.5
Occupants in other vehicles	1,136	12.2	5,171	17.2	132,408	43.2	137,579	40.9
Pedestrians	314	3.4	510	1.7	1,285	0.4	1,795	0.5
Bicyclists	46	0.5	134	0.4	555	0.2	689	0.2
Other/Unknown[c]	19	0.2	24	0.1	633	0.2	657	0.2
Total	**9,283**	**100.0**	**30,084**	**100.0**	**306,658**	**100.0**	**336,742**	**100.0**

[a] Source: FARS
[b] Source: GES
[c] The fatal injuries category includes other non-occupants. The serious and possible/minor injuries categories include occupants of a motor vehicle not in transport, persons on personal conveyances, and persons in or on buildings.

2.2.2 Vehicle Types

In 2014, 8,393 speeding vehicles were involved in fatal crashes. Figure 1 shows the distribution of these vehicles by type. Of these speeding vehicles, 6,422 (77%) were passenger vehicles, which were involved in 6,369 fatal crashes, resulting in 7,273 fatalities. These fatalities represented 78% of all speeding-related fatalities in 2014. According to the FHWA, there were about 240 million registered passenger vehicles and 8 million motorcycles in 2014, which respectively represented 92% and 3% of the total number of registered vehicles. Buses and trucks represented 0.3% and 4% of the total, respectively. Figure 1 also shows that 1,548 speeding motorcycles (18% of all speeding vehicles) were involved in fatal crashes in 2014. This safety study focused on passenger vehicles, which constitute the majority of vehicles involved in speeding-related fatal crashes. Some of the countermeasures examined in this study are applicable to both passenger vehicles and other types of motor vehicles, including motorcycles.

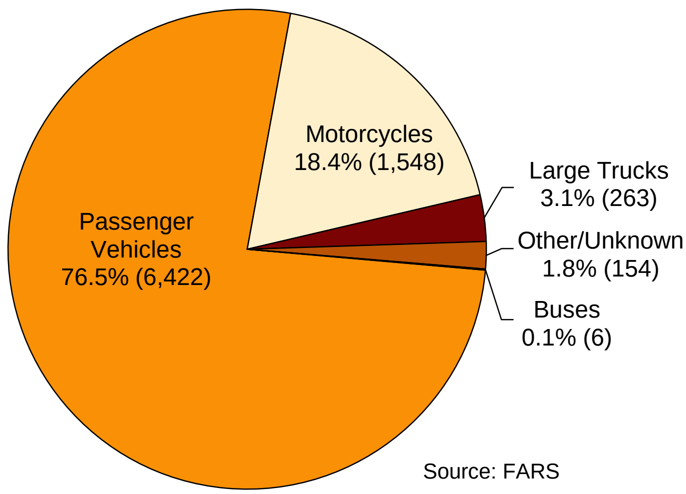

Figure 1. Speeding vehicles involved in speeding-related fatal crashes, by type, 2014

2.3 Risks

Risk is quantified as the product of the likelihood of exposure to an adverse event and the consequence of such exposure. Countermeasures to improve traffic safety are used to reduce the likelihood of exposure (that is, crash involvement rates) and to mitigate the consequence (that is, injury severity).

2.3.1 Injury Severity

The severity of a crash, as typically measured in injury severity, is linked to the velocity change in a crash.[14] As the speed prior to a crash increases, the velocity change in a crash also increases (TRB 1998). Therefore, higher vehicle speeds lead to larger changes in velocity, which, in turn, lead to higher injury severity in a crash. This relationship can be seen in figure 2, which uses 2014 NASS GES data to show the estimated percentage of passenger vehicle occupants involved in non-pedestrian single vehicle crashes who died or sustained serious injuries, as a function of reported vehicle speed.[15] The slopes of the two curves shown in figure 2 indicate that occupants were more likely to experience serious injury at higher vehicle speeds when they were reported as speeding.

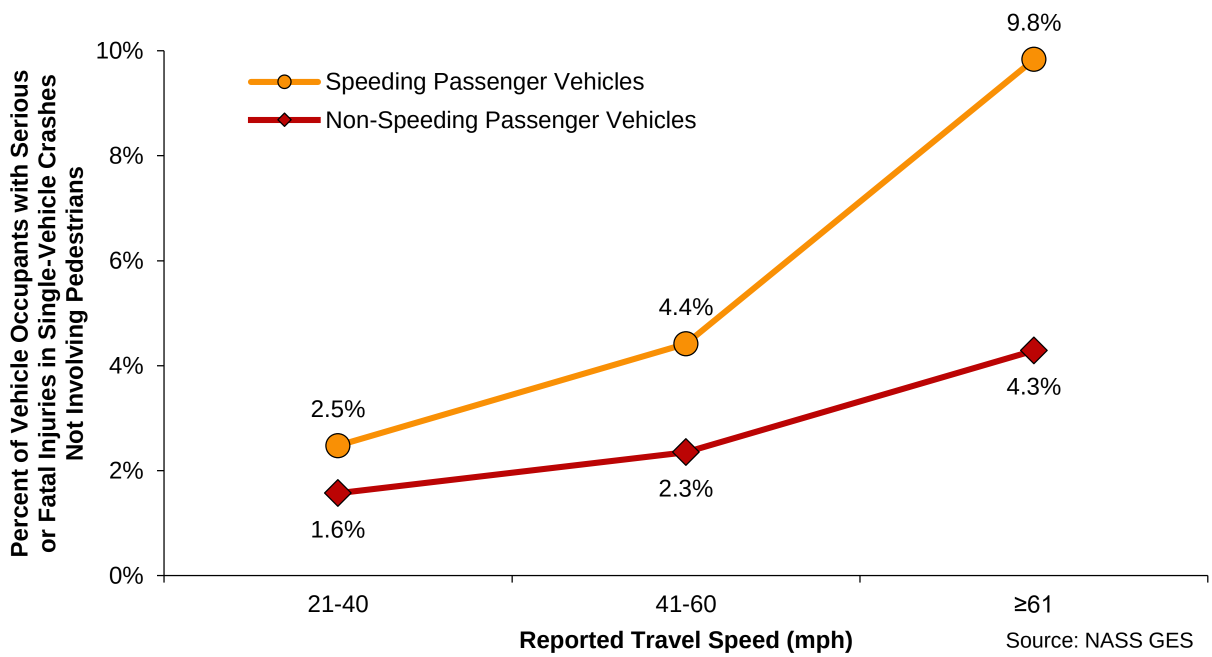

Figure 2. Percent of passenger vehicle occupants sustaining serious or fatal injuries in speeding-related and all crashes, by reported travel speed, 2014

[14] Velocity change in a crash is also known as Delta V.

[15] *Vehicle speed* in the NASS GES refers to the vehicle traveling speed prior to the crash as reported by the investigating officer. Therefore, it is reported, not measured, speed prior to the crash. This serves as the best estimate available of potential velocity change in a crash.

Other studies have also confirmed that as speed increases, so does injury severity. A study of sample crashes between 1980 and 1986 using NASS data (limited to passenger cars of model years 1980 and later) showed a statistically significant relationship between the fatality risk of drivers and velocity change in a crash. This relationship showed that as the velocity change in a crash increases, the fatality risk increases, and the rate at which the risk increases also increases (Joksch 1993). More recently, using crash data between 1983 and 2010, a United Kingdom study examined the fatality risk of belted drivers in non-rollover, frontal- and side-impact crashes. The study established that the estimated fatality risk in a frontal impact crash was 3%, 17%, and 60% at 30 mph, 40 mph, and 50 mph velocity change in a crash, respectively. For side-impact crashes, the estimated fatality risk was 25% and 85% at 30 mph and 40 mph velocity change, respectively (Richards 2010).

Further, the link between injury severity and speed extends to pedestrians involved in a motor vehicle crash. According to the European Transport Safety Council, 5% of pedestrians struck by a vehicle at 20 mph are fatally injured. This likelihood increases to 45% at 30 mph, and 85% at 40 mph (ETSC 1995). The AAA Foundation for Traffic Safety similarly found that the average risk of severe injury to a pedestrian increased from 10% at 16 mph, to 25% at 23 mph, 50% at 31 mph, 75% at 39 mph, and 90% at 46 mph (Tefft 2011).

2.3.2 Crash Involvement

Unlike the straightforward relationship between speed and injury severity, the association between speed and crash involvement is more complex, often leading to conflicting results. However, research has generally shown that the crash involvement rate increases with speed (Baruya and Finch 1994; Fildes, Rumbold, and Leening 1991; Kloeden, McLean, and Glonek 2002; Taylor, Lynam, and Baruya 2000). A comprehensive analysis of 98 studies confirmed the statistical relationship between speed and crash involvement; the speed-crash relationship was consistent among crashes of all injury severity levels (Elvik, Christensen, and Amundsen 2004). A driver-based study that combined on-road observation and questionnaire surveys of over 10,000 drivers in the United Kingdom in the 1990s showed that "drivers who habitually travel faster than average are involved in more accidents in a year's driving" (Taylor, Lynam, and Baruya 2000).

The relationship that the crash involvement rate increases with speed can be explained by the fact that increased speed reduces the available time for the driver to receive and process information (AASHTO 2011). Further, the stopping distance of a vehicle and the chance of a vehicle being driven off the road while negotiating a curve both increase with vehicle speed (Srinivasan and others 2006).

Some older research has illustrated that the crash involvement rate decreases with speed (Baruya 1998; Garber and Gadirau 1988), whereas other research has not demonstrated a statistically significant relationship between speed and crash involvement (Kockelman and Ma 2007; Quddus 2013). There are many reasons for these contradicting results. The relationship between speed and crash involvement can be affected by traffic flow and roadway geometry, such as curvature, grade, and width (Milton and Mannering 1998; Abdel-Aty and Radwan 2000; Chang 2005; Anastasopoulos and Mannering 2009). Other factors may include geography, road type, land use, driver age, and alcohol-impairment. Further, different research methodologies may contribute to the inconsistency of the relationship found between speed and crash involvement. For example, one study found that the crash involvement rate decreases with speed using distance-based measures (for example, crashes per vehicle mile), but it also found that the crash involvement rate increases with speed using time-based measures (for example, crashes per vehicle hour) (Pei, Wong, and Sze 2012).

More recently, based on an analysis of the naturalistic driving data of 3,500 participants, researchers showed that the odds ratio of speeding was 12.8, meaning speeding increased the odds of crash involvement by a factor of almost 13 relative to control situations (Dingus and others 2016).

Another factor that contributes to the complexity of the relationship between speed and crash involvement is speed variance.[16] Two studies from the 1960s showed that vehicles traveling at much lower and higher speeds than average contributed to increased rates of crash involvement (Solomon 1964; Cirillo 1968). In the 1980s, another study showed that it was speed variance, not speed, that contributed to fatalities (Lave 1985). However, there were several limitations in these studies. The speed data and crash data were not collected during the same time period; crashes involving turning vehicles were included in the crash analysis; and speed prior to the crash was self-reported by the driver (TRB 1998). Research has also shown that "when turning vehicles were removed from the analysis only those driving at speeds significantly above the traffic speed remained over-involved in crashes" (Fildes and Lee 1993). Another often cited study was conducted in Virginia in the 1980s and demonstrated that the crash involvement rate increased with speed variance on all road types (Garber and Gadirau 1988). However, this study and later research pointed out that speed variance increases as the difference between roadway design speeds and speed limits increases (Garber and Gadirau 1989; Stuster, Coffman, and Warren 1998).[17] These studies generally provided consistent evidence that driving faster than the surrounding traffic increased crash involvement rates; the evidence was less conclusive with respect to driving slower than the surrounding traffic (Aarts and van Schagen 2006).

There are numerous interrelated factors that complicate the relationship between speed and crash involvement. Although speed variance within a traffic flow exists and is often cited as a concern, the degree to which speed variance contributes to crash involvement is inconclusive. However, the link between speed and injury severity in a crash is consistent and direct.

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[16] *Speed variance* refers to the variability of individual vehicle speeds within the overall traffic flow. Similar terms include speed dispersion and speed variation.

[17] See section 3.1.1 for further discussion of design speeds and speed limits.

2.4 Characteristics of Speeding-Related Crashes

In this section, the NTSB focuses on fatal crashes in 2014 to highlight some characteristics of speeding-related crashes, including how they vary by road type, land use, alcohol-impairment, and driver age. The purpose of these analyses is not to describe in detail all factors associated with speeding, but to address some common misconceptions and illustrate the complexity of the relationship between speed and crash involvement.[18]

2.4.1 Road Types and Land Use

Different road types serve different functions and they have different characteristics, such as traffic volume, access, geometry, and speed limits.[19] Table 3 illustrates that the percentage of fatal crashes that involved a speeding passenger vehicle in 2014 varied among the different road and land use types. One misconception about speeding-related crashes is that they primarily occur on high-speed roads such as interstate highways. However, local roads had the highest percentage (30%) of fatal crashes involving speeding passenger vehicles. Collector roads had the second-highest percentage (29%). Twenty-six percent of fatal crashes that occurred on freeways involved a speeding passenger vehicle. Table 3 also shows that a higher percentage of fatal crashes involved speeding passenger vehicles on rural roads (27%) than on urban roads (22%) in 2014. Local roads experienced the largest difference by land use; 35% of fatal crashes on rural local roads involved speeding passenger vehicles, whereas 25% of fatal crashes on urban local roads involved speeding passenger vehicles.

Table 3. Number and percent of fatal crashes involving speeding passenger vehicles, by road type and land use, 2014

Road Type	Rural		Urban		All	
	Number	%	Number	%	Number	%
Interstate and Freeway	316	24.9	711	26.6	1,027	26.1
Other Principal Arterial	598	18.9	699	16.6	1,297	17.6
Minor Arterial	687	25.6	551	21.3	1,238	23.5
Collector	1,019	29.3	282	28.2	1,301	29.0
Local	808	35.2	626	25.4	1,434	30.1
Total	**3,469**	**26.7**	**2,892**	**22.2**	**6,369**	**24.4**

Source: FARS

[18] For more detailed discussions of crash characteristics related to speeding, see the FHWA reports *Development of a Speeding-Related Crash Typology* (Council and others 2010) and *Integrating Speed Management within Roadway Departure, Intersections, and Pedestrian and Bicyclist Safety Focus Areas* (Neuner and others 2016).

[19] Appendix B provides descriptions of the FHWA road function classifications (road types). NHTSA also uses this classification system to tally fatality statistics.

Further, of the 6,369 fatal crashes involving speeding passenger vehicles, 3,469 occurred on rural roads (55%). According to the FHWA, 920 million vehicle miles traveled (VMT) occurred on rural roads, which represented 30% of the total VMT in 2014 in the United States. Among all of the rural road types, 18% of fatal crashes involving speeding passenger vehicles occurred on local roads while such roads comprised only 14% of all rural VMT. Similarly, in urban areas, it was local roads that had the largest over-involvement of speeding passenger vehicles (22% of fatal crashes involving passenger vehicles versus 15% of all urban VMT). These observations indicate that the risk attributed to speeding among passenger vehicles varies among road types and land uses.

Figure 3 shows the distribution of fatal crashes involving speeding passenger vehicles by land use and reported speed limit.[20] On rural roads, most of these crashes occurred on roads with reported speed limits of 55 to 60 mph, whereas in urban areas most occurred on roads with reported speed limits of 35 to 40 mph. Eighty-two percent of all fatal crashes involving speeding passenger vehicles on rural roads (2,796 of 3,418) occurred at locations with reported speed limits of 45 mph and above. In contrast, these reported speed limits accounted for 40% of all urban fatal crashes involving speeding passenger vehicles, a total of 1,383 such crashes. Therefore, speeding as a contributing factor represented different percentages of fatal crashes involving passenger vehicles on roads that serve different functions, with different speed limits, and in different land use areas.

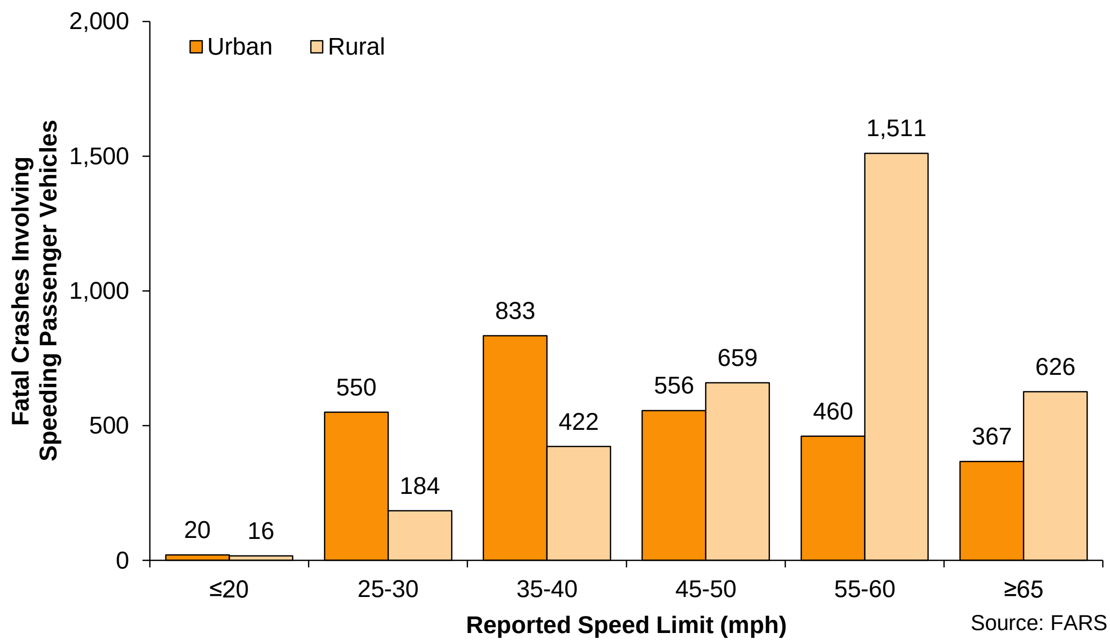

Figure 3. Fatal crashes involving speeding passenger vehicles, by reported speed limit and land use, 2014

[20] Speed limit is reported in FARS data at the vehicle level. This variable represents the speed limit of the road on which the vehicle was traveling before the crash.

2.4.2 Alcohol-Impaired Driving

Another misconception about speeding is that it is a problem that can be largely solved by focusing on alcohol impairment. The NTSB examined alcohol-impairment information for 6,409 speeding passenger vehicle drivers involved in fatal crashes in 2014 and found that 2,739 (43%) were alcohol-impaired.[21] The remaining 3,670 speeding passenger vehicle drivers (57%) were not alcohol-impaired. For comparison, among all passenger vehicle drivers involved in fatal crashes, 22% were alcohol-impaired. Thus, although there is considerable overlap between alcohol impairment and speeding, more speeding drivers in fatal crashes are not alcohol-impaired than impaired. Figure 4 illustrates the distribution of fatalities in crashes involving passenger vehicles by speeding and alcohol-impairment categories. In 2014, 28,615 fatalities involved passenger vehicles. Of these, 3,958 fatalities (14%) were attributed to crashes in which speeding was identified as a factor while alcohol impairment was not. Fatalities involving speeding passenger vehicles represent a pervasive and complex safety issue that cannot be mitigated by reducing alcohol-impaired driving alone.

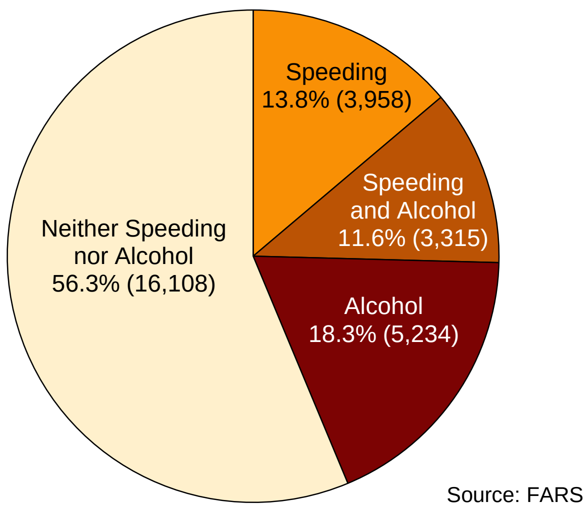

Figure 4. Fatalities involving passenger vehicles, by crash factors, 2014

[21] Because a large number of drivers do not have their BAC level reported in FARS, NHTSA uses a statistical algorithm known as *multiple imputation* to estimate the BAC level. Ten BAC estimates are produced for each driver. The NTSB performed the same analysis 10 times using each set of imputed BAC estimates. The counts and percentages reported here are the average values of the 10 analyses. In addition, of the 6,422 speeding passenger vehicle drivers involved in fatal crashes in 2014, 13 drivers had no person-level information (such as imputed BAC), so the results presented here are based on 6,409 drivers.

2.4.3 Driver Age

Driver age is also an important factor in speeding-related crashes. Figure 5 illustrates the age distribution of speeding passenger vehicle drivers in fatal crashes, passenger vehicle drivers in fatal crashes, and driver license counts. The three age groups with the most speeding passenger vehicle drivers in fatal crashes are under 20, 20- to 24-year-olds, and 25- to 29-year-olds. Just these three groups include 3,167 drivers, representing 50% of all speeding passenger vehicle drivers in fatal crashes. For comparison, these three age groups comprised 33% of crash involvement in all fatal crashes and 21% of licensed drivers. These observations indicate that the risk of speeding is higher among younger drivers.

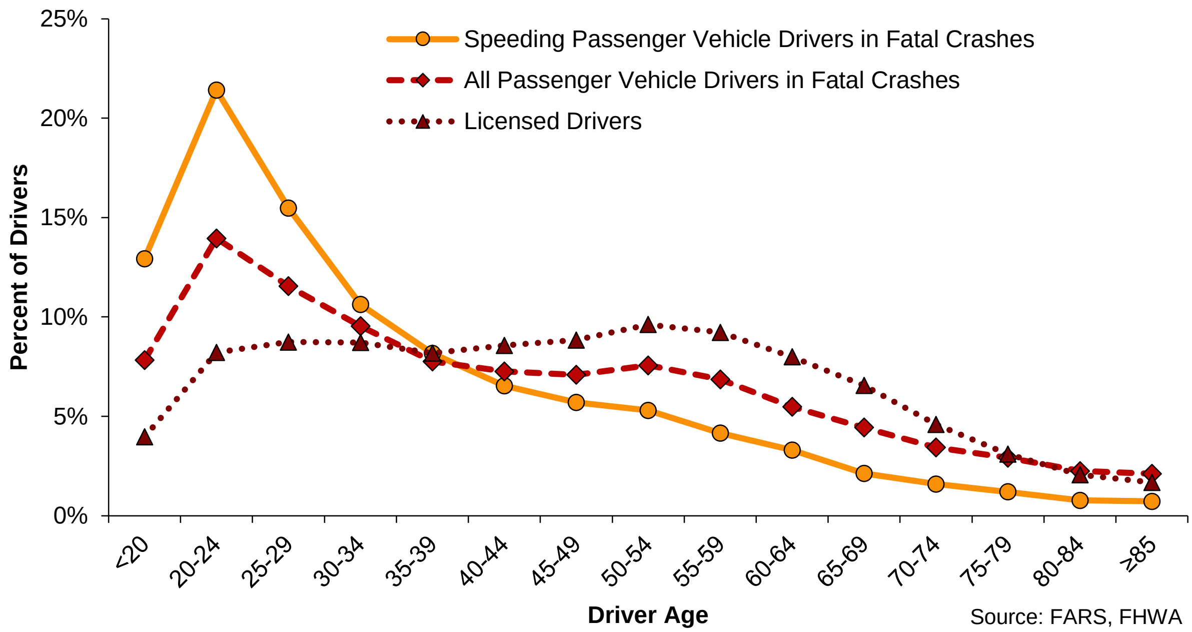

Figure 5. Age distribution of speeding passenger vehicle drivers in fatal crashes, all passenger vehicle drivers in fatal crashes, and licensed drivers, 2014

Although factors such as speed variance, road type, land use, alcohol impairment, and driver age affect the specific relationship between speed and crash involvement, there is strong evidence indicating that fatal and serious injury crash involvement rates increase with speed. Therefore, the NTSB concludes that speed increases the likelihood of serious and fatal crash involvement, although the exact relationship is complex due to many factors. In comparison, existing research literature and crash data illustrate a more straightforward and direct relationship between speed and crash severity. Therefore, the NTSB further concludes that speed increases the injury severity of a crash.

2.5 Attitudes Toward Speeding

The NTSB reviewed two large-scale, periodic surveys of individual attitudes toward speeding in the United States. In both surveys, participants consisted of a nationally representative sample of drivers. The first survey, the *National Survey of Speeding Attitudes and Behavior*, was most recently conducted by NHTSA in 2011.[22] This self-reporting survey examines several aspects of speeding, including drivers' attitudes about speeding and various speeding countermeasures (Schroeder, Kostyniuk, and Mack 2013). The survey results reveal a general contradiction among US drivers between what is considered acceptable in society and individual behavior. For example, most drivers (91%) agreed (either strongly or somewhat) that everyone should obey the speed limits because it is the law, and 87% agreed that it is unacceptable to exceed speed limits by more than 20 mph. Yet, 27% of respondents agreed that speeding is something they do without thinking, and 42% agreed that driving at or near the speed limit makes it difficult to keep up with traffic.

The second survey, the *Traffic Safety Culture Index*, has been conducted annually since 2008 by the AAA Foundation for Traffic Safety. The NTSB examined the results for the most recent survey, conducted in 2015 (AAA Foundation for Traffic Safety 2016).[23] Figure 6 illustrates that 70% and 80% of respondents stated their opinion that drivers speeding on freeways and residential streets, respectively, are a very serious or somewhat serious threat to their personal safety.

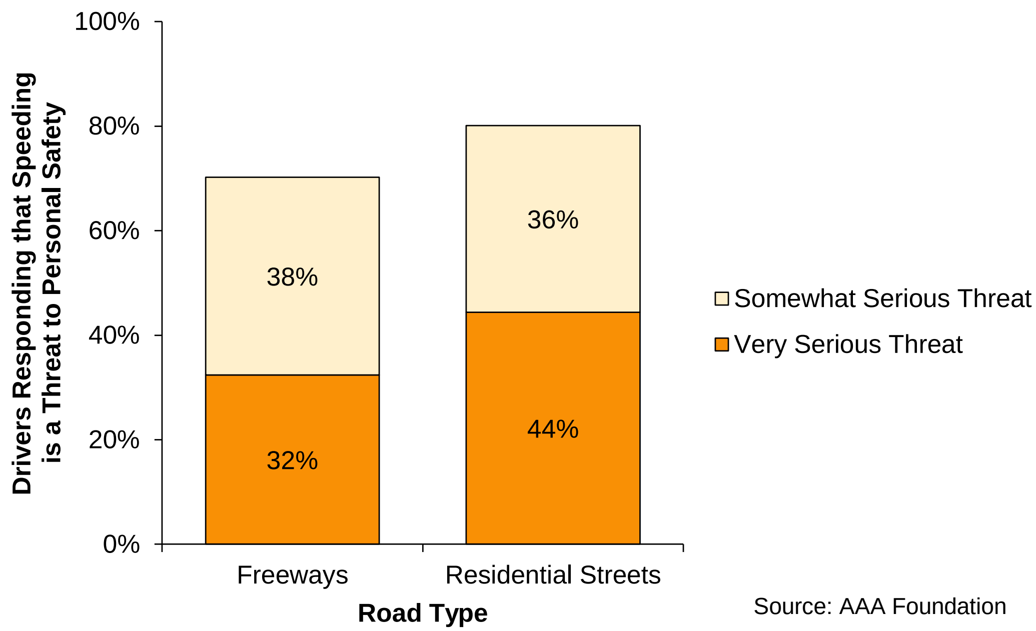

Figure 6. Drivers responding that speeding is a threat to personal safety, by road type, 2015

[22] This survey was previously conducted in 2002 and 1997.

[23] The surveys for 2011 through 2014 were also examined; the speeding-related responses showed little year-to-year variation.

However, the perceived risks and acceptance of speeding were not reflected in the drivers' own behaviors. For example, 89% of respondents considered it unacceptable to drive 10 mph over the speed limit on a residential street, yet 45% reported having done so in the past 30 days. Similarly, 74% of respondents considered it unacceptable to drive 15 mph over the speed limit on freeways, yet 48% admitted to having done so in the past 30 days. Therefore, the NTSB concludes that drivers report understanding that speeding is a threat to safety but acknowledge it is a common driving behavior in the United States.

2.6 Countermeasures

Strategies for improving traffic safety in general, and addressing speeding in particular, have traditionally been grouped into three categories: engineering, enforcement, and education (Donnell and others 2009).[24] Engineering refers to roadway infrastructure changes. Enforcement refers to strategies to ensure drivers obey existing laws. Education refers to efforts to inform drivers and other stakeholders about traffic safety laws and the consequences of risky behavior. Table 4 lists examples of speeding countermeasures in these three categories. Some emerging speeding countermeasures researched for this study expand these three categories beyond their current definitions. For example, vehicle technologies are becoming available to prevent drivers from speeding, which may be considered an engineering countermeasure.

Table 4. Examples of speeding countermeasures

Countermeasure Type	Examples
Engineering	Variable speed limits Speed feedback signs Roundabouts Speed humps Road diets[a]
Enforcement	Regular traffic patrols High-visibility enforcement Automated enforcement
Education	Driver education courses Public awareness campaigns Judicial education

[a] Road diets "reallocate travel lanes and utilize the space for other uses and travel modes," for example, by converting a four-lane roadway to one with two through lanes and a center left-turn lane (FHWA 2016).

A comprehensive approach to speeding typically involves multiple countermeasures. For example, NHTSA states that "no single strategy will be appropriate for all locations, and combinations of treatments may be needed to obtain speed limit compliance and achieve crash reduction goals" (Goodwin and others 2015).

[24] Some organizations add other categories, such as emergency medical services, evaluation, and encouragement (Cambridge Systematics 2010; State of Vermont 2016).

2.7 National, State, and Local Roles

National, state, and local organizations all play roles in addressing speeding-related crashes. Speeding countermeasures are typically implemented at the state and local level, while federal government agencies conduct research, issue guidance material, set standards, and coordinate activities among states. Three DOT agencies play critical roles in addressing speeding-related issues: the FHWA, NHTSA, and the FMCSA.[25] The FHWA's responsibilities include engineering and roadway infrastructure topics, NHTSA's responsibilities include driver behavior research and vehicle safety, and the FMCSA's responsibilities include large truck and bus operations.[26]

To coordinate speeding-related work across these agencies, the DOT established a Speed Management Team in 2000, composed of representatives from the FHWA, NHTSA, and the FMCSA. The Speed Management Team works to "reduce speeding-related fatalities, injuries, and crashes through the application and promotion of enforcement, engineering, educational, and evaluative approaches in a collaborative manner among member agencies in support of the US DOT goal of reducing the number of traffic fatalities" (DOT 2011).

Congress establishes and provides funding for traffic safety programs through legislation. Most recently, the Fixing America's Surface Transportation (FAST) Act (Public Law 114-94), was signed into law in December 2015. This law superseded the Moving Ahead for Progress in the 21st Century Act (MAP-21) (Public Law 112-141), which was signed into law in July 2012. DOT agencies are responsible for implementing these traffic safety programs, including the following federal-aid programs designed to encourage traffic safety activities at the state and local levels:

- **Highway Safety Improvement Program**: The FHWA administers this program in conjunction with state departments of transportation; it provides grants to states for engineering countermeasures (Title 23 *United States Code* (*USC*) section 148).
- **Highway Safety Program**: NHTSA administers this program in conjunction with state highway safety offices; it provides grants to states for behavioral (that is, non-engineering) countermeasures in 10 areas, including projects "to reduce injuries and deaths resulting from motor vehicles being driven in excess of posted speed limits" (23 *USC* section 402).
- **National Priority Safety Programs**: NHTSA also administers this program in conjunction with state highway safety offices; it provides incentive grants to states for non-engineering projects in seven priority areas, each of which is specified in legislation along with a funding amount (23 *USC* section 405).[27] Speeding is not one of the seven priority areas.

Funds distributed under these federal-aid programs are then awarded by the state departments of transportation and highway safety offices to individual state and local projects

[25] The Research and Innovative Technology Administration (RITA) also provides research support to these and other DOT agencies.

[26] Because the FMCSA does not focus on passenger vehicles, its speeding-related activities were not examined in detail for this study.

[27] The seven priority areas are impaired driving, occupant protection, state traffic safety information system improvement, motorcycle safety, distracted driving, graduated driver licensing, and nonmotorized safety.

through selection committees and competitive application processes. Table 5 summarizes the federal-aid traffic safety programs.

Table 5. Federal-aid programs for traffic safety

Program	Type of Projects Funded	Responsible Federal Agency	Responsible State Agency	Funds Speeding-Related Projects?
Highway Safety Improvement Program	Engineering-based countermeasures	FHWA	Department of Transportation	Yes
Highway Safety Program	Non-engineering countermeasures	NHTSA	Highway Safety Office	Yes
National Priority Safety Programs	Non-engineering countermeasures in seven priority areas	NHTSA	Highway Safety Office	No

In addition, several non-governmental organizations play significant roles in setting standards and providing guidance. For example, the Governors Highway Safety Association (GHSA), which represents state highway safety offices, works with NHTSA to produce standards for states to report crash data (GHSA and NHTSA 2012). The American Association of State Highway and Transportation Officials (AASHTO), which represents state departments of transportation, produces standards for roadway design, and provides guidance for predicting crash frequency and the effects of engineering countermeasures on roadway segments (AASHTO 2011; AASHTO 2010). The Institute of Transportation Engineers (ITE), which is an international association of transportation professionals, publishes guidance on traffic engineering studies (ITE 2016).

3 Safety Issues

The NTSB focused on the following five safety issues pertaining to the effective application of proven and emerging countermeasures for speeding: (1) speed limits, (2) data-driven approaches for speed enforcement, (3) ASE, (4) intelligent speed adaptation, and (5) national leadership. The NTSB identified these issues in part because stakeholders repeatedly and consistently expressed concerns about them during study interviews.[28]

3.1 Speed Limits

NHTSA states that speed limits are an effective way to control driving speeds (Goodwin and others 2015). Speed limits represent the driving speeds above which the risk is deemed by transportation officials as unacceptable, and the act of driving above those speeds is discouraged. Such limits form the legal basis upon which speed enforcement activities are implemented. Despite being recognized as an effective method to control driving speeds, there is no standard approach to setting or adjusting speed limits in the United States. In practice, the operating speed of free-flowing traffic is the most prominent factor used. Other factors, such as crash experience and the risk of injury to vulnerable road users, are not given similar emphasis as operating speed.

3.1.1 Background

This section provides a general discussion of the relationship among design speed, operating speed, and speed limits. The publication *Speed Concepts: Informational Guide* provides explanations of many terms and concepts used in this study (Donnell and others 2009).

Speed is an important consideration in the design phase of a road. Design speed refers to a selected speed for a road upon which all geometric design features are based, and it is selected according to anticipated traffic characteristics, such as operating speed and traffic volume, along with topography, adjacent land use, and road type (AASHTO 2011).[29] Because many of these factors are based on anticipated use, a design speed does not always match the actual operating speed of a road. Table 6 shows the ranges of minimum design speeds for level roads by road type according to the AASHTO publication *A Policy on Geometric Design for Highways and Streets* and examples of posted speed limits provided by the FHWA (AASHTO 2011; FHWA 2000). These minimum design speeds range from 20 mph for local urban streets to 75 mph for rural

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[28] The NTSB examined other countermeasures, but stakeholder concerns about their implementation were not as substantial. For example, there are many engineering countermeasures for speeding, including roundabouts, speed bumps, and road diets. However, the effectiveness of these countermeasures is well established and information about them is available in several sources, including the AASHTO *Highway Safety Manual* (AASHTO 2010) and the FHWA's online Crash Modification Factors Clearinghouse. Engineering countermeasures for speeding are also promoted in the National Association of City Transportation Planners' *Urban Street Design Guide* (NACTO 2017) and are increasingly being adopted by state and local transportation departments. For instance, about $96 million in Highway Safety Improvement Project funds were used for 70 projects to convert intersections to roundabouts in 2014; this increased to $103 million for 91 projects in 2015 (Smith 2015; Smith and Signor 2016).

[29] Title 23 *CFR* Part 625 provides design standards for highways. Design speed is 1 of 10 "controlling criteria" for which state transportation departments are required to evaluate and document any decision to deviate from the standard. The FHWA's May 5, 2016, memorandum, Revisions to the Controlling Criteria for Design and Documentation for Design Exceptions, provides a detailed listing of these criteria.

arterial roads. These are called minimum design speeds because AASHTO encourages road designers to select design speeds equal to or greater than the design speed values (AASHTO 2011). Once the design speed is selected for a new road, various design criteria (such as minimum sight distances, maximum grade, and minimum horizontal curve radii) for geometric features of a roadway are determined. AASHTO recommends using above-minimum criteria when practical (AASHTO 2011; Donnell and others 2009). Thus, a road designer often selects a design speed above the minimum design speed associated with the road type, its function, and predicted traffic volume, and then uses design criteria above the minimum criteria associated with the selected design speed. Therefore, some roads are built to accommodate traffic flows and speeds above what was originally anticipated.

Table 6. AASHTO's recommended minimum design speeds and typical posted speed limits, by road type

Road Type	Minimum Design Speeds (mph)[a]	Typical Posted Speed Limits (mph)[b]
Freeway[c]	50–70	55–75
Rural arterial	40–75	50–70
Urban arterial	30–60	50–70
Rural collector	40–60	35–55
Urban collector	30	35–55
Local rural road	30–50	20–45
Local urban street	20–30	20–45

[a] Minimum design speeds are dependent upon design volume. High design speed values are typically associated with anticipated volume greater than 2,000 vehicles per day; other factors may include available right of way, terrain, likely pedestrian presence, adjacent development, and other area control (AASHTO 2011). In this table, only those values for level roads are used.
[b] Source: FHWA 2000
[c] Freeways include interstate highways and expressways.

Once a road is built, speed limits are established by state or local authorities. For example, a state may have a statutory speed limit of 65 mph for all rural freeways (such as interstates) and 55 mph for all rural undivided arterial roads. Ideally these statutory speed limits are lower than the design speeds established during the design phase. However, some road segments may have speed limits that are higher or lower than the statutory speed limits. These road segments are generally known as *speed zones*, and their speed limits, which can be higher or lower than the statutory speed limits, are commonly known as *posted speed limits*.[30]

Once a newly built road is open for traffic, over time a traffic flow develops with diverse vehicle types and drivers. Each driver is influenced by the geometric characteristics of a roadway (for example, curvature and width), roadside development, the surrounding traffic flow, topography, and the posted speed limit, and they individually choose operating speeds. Because each driver is different, driver operating speeds vary, which results in a speed distribution (that is, a range of operating speeds). The range of operating speeds may not match the anticipated

[30] The FHWA *Speed Concepts: Informational Guide* provides an in-depth discussion of these terms (Donnell and others 2009).

operating speeds. When a mismatch occurs, an adjustment of the posted speed limit may be appropriate.

3.1.2 Engineering Studies, Speed Surveys, and the 85th Percentile Speed

Stakeholders can request adjustments to speed limits. Requests can come from private citizens, from local or state transportation officials, or as a result of legislation. When such a request is made (that is, to set up a speed zone, whether it is above or below the statutory speed limit), state and local transportation departments typically require that an engineering study of the road segment be conducted to determine if raising or lowering the speed limit is appropriate. Although the specific procedures may vary, state and local transportation departments typically refer to the FHWA's *Manual on Uniform Traffic Control Devices* (*MUTCD*), which states that "speed zones shall only be established on the basis of an engineering study that has been performed in accordance with traffic engineering practices. The engineering study shall include an analysis of the current speed distribution of free-flowing vehicles" (FHWA 2012a).[31] The ITE publication *Manual of Transportation Studies* provides guidance on conducting an engineering study and the ITE *Traffic Engineering Handbook* outlines the professional practices of traffic engineering studies (ITE 2010; ITE 2016). Although there is guidance on conducting engineering studies, "a universal process for conducting these studies does not exist" (Donnell and other 2009). Still, FHWA guidance states that "when a speed limit within a speed zone is posted, it should be within 5 mph of the 85th percentile speed of free-flowing traffic" (FHWA 2012a). As a result, the predominant factor used in establishing posted speed limits remains the 85th percentile speed of free-flowing traffic (Donnell and others 2009; TRB 1998).

The 85th percentile speed refers to the speed at or below which 85% of vehicles are traveling (FHWA 2012a). This measurement is obtained by conducting a speed survey, which is part of an engineering study. Each state transportation department has its own procedure for conducting a speed survey.[32] However, it generally consists of measuring a sample of vehicles representative of the overall traffic along the road segment for which a proposed speed limit change is requested. The locations where speed measurements are made must represent free-flowing speeds (that is, avoiding intersections or narrowing road segments), and they must be appropriately spaced along the proposed segment. The 85th percentile speed is then computed by analyzing the speed measurements of the sample vehicles at these locations.

The use of the operating speed, more specifically the 85th percentile speed, is based on the assumption that the majority of drivers (1) are capable of selecting appropriate speeds according to weather conditions, traffic, road geometry, and roadside development; and (2) operate at reasonable and prudent speeds (Krammes and others 1996). The use of the 85th percentile speed for adjusting speed limits emerged as early as the 1940s (TRB 1998). Support for its use came from empirical research of self-reported crashes on 2- or 4-lane rural highways in the late 1950s. This research showed that drivers operating at much lower and much higher speeds than the majority of drivers were involved in a disproportionately high number of crashes (Solomon 1964). Focusing on higher speeds, the research therefore indicated that a small group of drivers traveling

[31] Appendix C provides the relevant sections of the *MUTCD*.

[32] For example, Chapter 3 of the *California Manual for Setting Speed Limits* provides a detailed description of what an engineering study and speed survey include (California Department of Transportation 2014).

at speeds much higher than average were responsible for more crashes. By definition, 15% of all drivers were traveling above the 85th percentile speed. This small fraction of drivers was considered to be operating at unsafe speeds that disproportionately contributed to crash risk. "The 85th percentile speed not only represents the upper bound of the preferred driving speed of most drivers, but, according to some studies, for some roads it also corresponds to the upper bound of a speed range where crash involvement rates are lowest" (TRB 1998). Over time, setting the speed limit near the 85th percentile speed has become common practice and is considered "the traffic engineers' traditional rule of thumb" (Shinar 2017). However, it is unclear whether this relationship between crash involvement rates and the 85th percentile speed applies to all road types (TRB 1998). Further, "the original research between speed and safety which purported that the safest travel speed is the 85th percentile speed is dated research and may not be valid under scrutiny" (Forbes, Gardner, McGee, and Srinivasan 2012). Therefore, the NTSB concludes that the *MUTCD* guidance for setting speed limits in speed zones is based on the 85th percentile speed, but there is not strong evidence that, within a given traffic flow, the 85th percentile speed equates to the speed with the lowest crash involvement rate on all road types.

3.1.3 Unintended Consequences of Using the 85th Percentile Speed

Using the 85th percentile speed to set speed limits on road segments may have unintended consequences. Raising the speed limit to match the 85th percentile speed may lead to higher operating speeds, and hence a higher 85th percentile speed. This generates an undesirable cycle of speed escalation and reduced safety (Donnell and others 2009). As a 2016 Insurance Institute for Highway Safety (IIHS) report stated, "The 85th percentile speed is not a stationary point. It is, rather, a moving target that increases when speed limits are raised" (Farmer 2016).

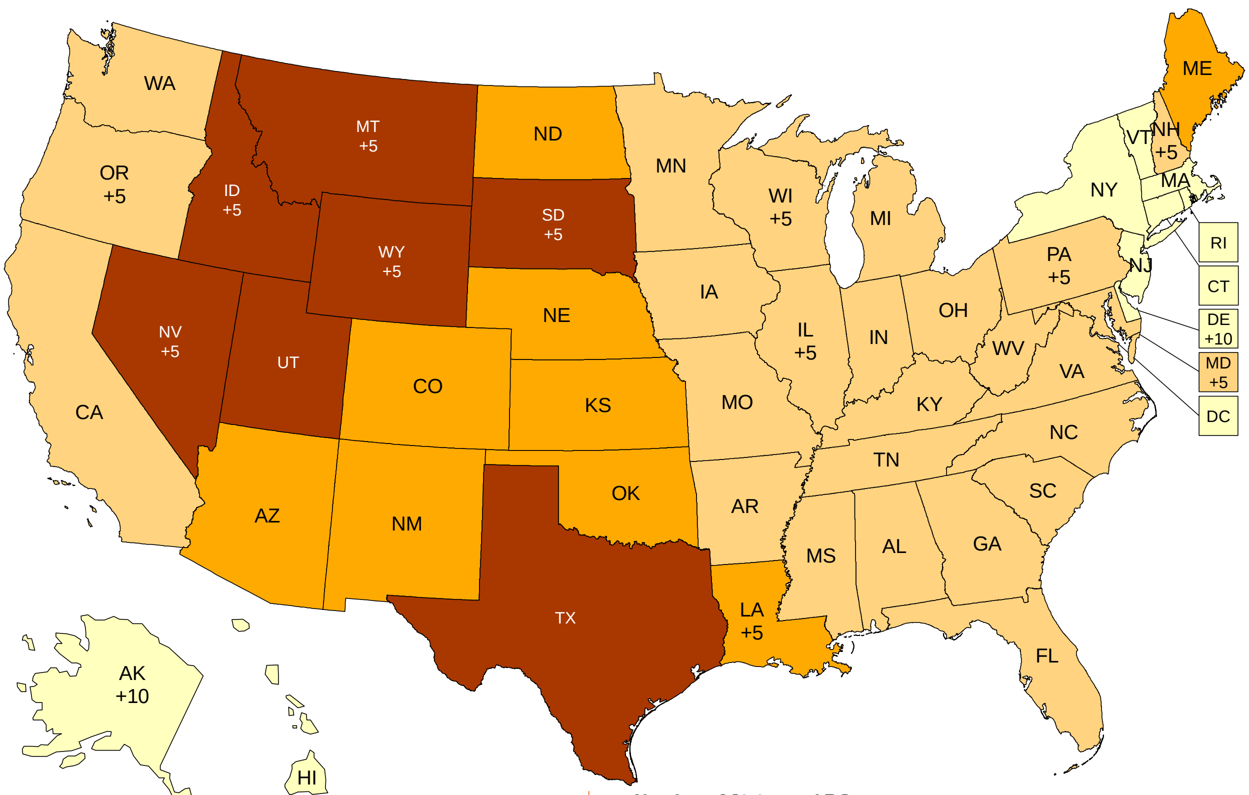
In recent years, several western US states have raised speed limits in segments of their rural interstate highways. For example, the Texas Transportation Code states that the speed limit is 70 mph for a highway numbered by Texas (for example, State Highway 130) or the United States (for example, Interstate 10) outside an urban area.[33] It also gives authority to the Texas Department of Transportation to increase or reduce the posted speed limit as long as it is supported by an engineering study.[34] The Texas Transportation Code requires that such engineering studies follow the "Procedures for Establishing Speed Zones," which emphasizes the use of the 85th percentile speed (Texas Department of Transportation 2015).[35] In 2011, Texas raised the posted speed limit from 70 to 75 mph on a 45-mile long segment of State Highway 130. One year later in 2012, the limit was increased to 80 mph on the same segment (Texas Department of Transportation 2017). Currently, the toll portion of this segment has a posted speed limit of 85 mph, the highest posted speed limit in the United States.

[33] See Texas Transportation Code, Title 7, Subtitle C, Chapter 545, Section 352.

[34] See Texas Transportation Code, Title 7, Subtitle C, Chapter 545, Section 353.

[35] Specifically, the "Procedures for Establishing Speed Zones" states "speed limits on all roadways should be set based on spot speed studies and the 85th percentile operating speed" (Texas Department of Transportation 2015).

The trend of raising speed limits is not limited to Texas. In 2012, 35 states had maximum speed limits at or above 70 mph (GHSA 2012).[36] By 2016, the number of states with maximum speed limits at or above 70 mph had increased to 41. Figure 7 shows the maximum speed limits by state in 2016, along with the respective increases in maximum speed limits from 2012 to 2016. There are seven states with maximum speed limits at or above 80 mph; they are all located in the western half of the United States. Texas and Utah, which are highlighted in figure 7, already had maximum speed limits at or above 80 mph in 2012. The remaining five states all had 5 mph increases between 2012 and 2016. Figure 7 also highlights the regional trend of maximum speed limit increases in the Northwest.



Maximum Speed Limit (mph)[a]	Number of States and DC 2012	2014	2016
≤ 65	16	13	10
70	20	23	25
75	13	11	9
≥ 80	2	4	7

[a] Maximum speed limit refers to day time speed limit on rural interstates and may apply only to specified segments on the interstates.

Figure 7. Maximum speed limits by state and the District of Columbia in 2016 and changes in maximum speed limits from 2012 to 2016

[36] *Maximum speed limit* refers to the maximum posted daytime speed limit on any segment of any road within a state. Such segments are most likely located on rural interstates and the speed limit is applied to passenger cars only. For example, Texas has a maximum speed limit of 85 mph and it is limited to the 41-mile toll portion of State Highway 130. The IIHS maintains a regularly updated summary of maximum posted speed limits by state (IIHS 2017).

When speed limits are raised along segments of roads, such as those in rural Texas and Utah, the overall impact on vehicle speeds may not be limited to those segments. Impacts to road segments adjacent to the speed zones are known as spillover effects. These effects are supported by the theory of speed adaptation, which suggests that a driver perceives a lower traveling speed after operating the vehicle at a higher speed earlier (Schmidt and Tiffin 1969; Matthews 1978). A case control study of the effects of raising the speed limit from 75 to 80 mph on segments of rural interstate highways in Utah found that passenger vehicle speeds within the 80 mph speed zones increased by an average of 3.1 mph, and the probability of passenger vehicles exceeding 80 mph was 122% higher after the speed limit increase than would have been expected without it. The study also illustrated spillover effects because passenger vehicle speeds increased by 2.6 mph, and the probability of passenger vehicles exceeding 80 mph was 89% higher at three nearby locations where speed limits remained 75 mph (Hu 2016). Therefore, there is often an unintended increase in operating speeds in areas outside of the speed zones where the speed limit has been raised. Further, California raised the speed limit on some rural interstates from 55 mph to 65 mph in 1987. Researchers found that higher vehicle speeds were observed in both the freeway and the connecting road locations in 1988, compared to 1985. However, the freeways used in the studies were not eligible for the speed limit increase and the nearest rural interstates with an increased speed limit of 65 mph were 2 hours driving distance away. This research showed that speed limit increases on roads in highly rural areas may have significant impacts on other roads that are geographically distant and disconnected (Casey and Lund 1992). The NTSB concludes that unintended consequences of the reliance on using the 85th percentile speed for changing speed limits in speed zones include higher operating speeds and new, higher 85th percentile speeds in the speed zones, and an increase in operating speeds outside the speed zones.

3.1.4 Expert System

Although the 85th percentile speed is the predominant factor used in establishing speed limits, the *MUTCD* indicates several additional factors that may be considered. Specifically, it includes the following factors as options to the standard engineering study: "(A) road characteristics, shoulder condition, grade, alignment, and sight distance; (B) the pace; (C) roadside development and environment; (D) parking practices and pedestrian activity; and (E) reported crash experience for at least a 12-month period" (FHWA 2012a). However, the *MUTCD* does not provide any specific guidance on how these factors are to be considered. Engineers typically rely on their experience and judgement, which may lead to inconsistent practices in setting speed limits.

The transportation research community recognized the need to provide a systematic and consistent method for setting speed limits that incorporates factors other than operating speed (National Research Council 1998; Srinivasan and others 2006). An expert system is a software program that simulates the decision-making process of an expert in solving complex problems (Srinivasan and others 2006). In the United States, the FHWA developed a web-based expert system, known as USLIMITS2, for recommending credible and enforceable speed limits in speed zones (Forbes and others 2012).[37] The FHWA and AASHTO approved USLIMITS2 as a "priority,

[37] The USLIMITS2 expert system can be accessed via its website page. USLIMITS2 is the second version of an expert system (the first version was named USLIMITS) that was built on the lessons learned from the XLIMITS expert system of Australia in the 1980s. Input from an expert panel consisting of traffic engineers, officers, decision makers, and researchers across the United States improved upon the first version (FHWA 2012b).

market-ready technology and innovation" in 2008, and the FHWA began hosting USLIMITS2 and promoting its use to state and local agencies in 2012 (FHWA 2017).

USLIMITS2 can be used as a complementary tool to validate the results of engineering studies described in section 3.1.2. One advantage of USLIMITS2 is that crash statistics are listed as required input data.[38] In contrast, the *MUTCD* includes crash statistics as an optional factor. Therefore, in USLIMITS2, crash statistics, along with other factors such as road geometry characteristics, roadside characteristics, and traffic volume, are used to adjust the posted speed limits between the 50th and 85th percentile speeds (FHWA 2012b). The NTSB concludes that expert systems such as USLIMITS2 can improve the setting of speed limits by allowing traffic engineers to systematically incorporate crash statistics and other factors in addition to the 85th percentile speed, and to validate their engineering studies.

3.1.5 Vulnerable Road Users on Urban Roads

In highly populated urban areas, there are more interactions between vehicular traffic and vulnerable road users such as pedestrians and bicyclists. In 2014, 314 pedestrians and 46 bicyclists died in speeding-related crashes in the United States; 275 of these fatalities (76%) occurred in urban areas. Pedestrians and bicyclists are especially vulnerable because of their lack of protection. The direct relationship between vehicle speed and injury severity adversely affects pedestrians. The likelihood of pedestrian death increases from 5% at a vehicle impact speed of 20 mph, to 45% at 30 mph, and 85% at 40 mph (ETSC 1995). Similarly, the AAA Foundation for Traffic Safety analyzed NHTSA's NASS Pedestrian Crash Data Study data (July 1994 through December 1998), which showed that the average risk of severe injury for a pedestrian increased from 10% at a 16 mph vehicle impact speed, to 25% at 23 mph, 50% at 31 mph, 75% at 39 mph, and 90% at 46 mph (Tefft 2011). Although local residential streets typically have a 25 mph speed limit, there are many connecting roads in urban areas where speed limits are set at 35 to 45 mph, such as urban collectors and minor arterials.

The vulnerability of pedestrians in urban areas is a main reason why some municipalities have adopted a strategy called Vision Zero. This strategy was first developed and implemented in the 1990s in Sweden. It acknowledges that traffic fatalities and serious injuries are preventable and sets the goal of eliminating both in a specific time period. Vision Zero uses a multi-disciplinary approach that involves diverse stakeholders (ITE 2017). According to the Vision Zero Network, as of March 2017, there are 26 Vision Zero cities in the United States.[39]

Research has found that lowering speed limits can lead to sustained traveling speed reductions (Kloeden and Woolley 2012; De Pauw and others 2014) and crash reductions in urban areas (Islam, El-Basyouny, and Ibrahim 2014; D'Elia, Newstead, and Cameron 2007). Several transportation officials from Vision Zero cities interviewed by the NTSB for this study stressed

[38] It is possible to use USLIMITS2 to generate a speed limit recommendation without crash statistics even though it is listed as a required input variable in USLIMITS2 (FHWA 2012b). However, a warning statement is displayed recommending the input of crash statistics to regenerate the recommendation.

[39] To be considered a Vision Zero city, a city must meet the following criteria: "(1) sets clear goal of eliminating traffic fatalities and severe injuries, (2) mayor has publicly, officially committed to Vision Zero, (3) Vision Zero plan or strategy is in place, or mayor has committed to doing so in clear time frame, and (4) key city departments (including police, transportation, and public health) are engaged" (Vision Zero Network 2017).

the importance of lowering speed limits to minimize the injury risk for vulnerable users, but they indicated this was often difficult because state transportation department policies emphasize the use of the 85th percentile speed.

The growth of the Vision Zero strategy in the United States reflects the emergence of the safe system approach in traffic safety. The safe system approach is a holistic approach to prevent crashes, or to at least prevent serious injuries resulting from crashes. Setting an appropriate speed limit is one aspect of the safe system approach. It recognizes that the responsibility for crash prevention resides not only with drivers but also with all stakeholders of the road system. These include those who design, manage, and use the road; those who set and enforce the speed limit; and those who provide emergency response. Therefore, how the road is designed and how the speed limit is set both play a role in crash prevention. It calls for the strengthening of all elements so that road users are still protected if one of these elements fails (ITF 2016). Road users, such as drivers and pedestrians, are viewed in the safe system approach as the "weakest link" (OECD 2008).

The safe system approach to speed limits differs from the traditional view that drivers choose reasonable and safe speeds. In the safe system approach, speed limits are set according to the likely crash types, the resulting impact forces, and the human body's ability to withstand these forces (Forbes and others 2012). It allows for human errors (that is, accepting humans will make mistakes) and acknowledges that humans are physically vulnerable (that is, physical tolerance to impact is limited). Therefore, in this approach, speed limits are set to minimize death and serious injury as a consequence of a crash (Jurewicz and others 2014). This approach is far more commonly applied outside of the United States, such as in Sweden (where it is called Vision Zero), the Netherlands (where it is called Sustainable Safety), and several jurisdictions in Australia (OECD 2008). However, it is now gaining acceptance in the United States, particularly in Vision Zero cities and municipalities.

The safe system approach calls for road designers to move from the conventional design (in which the posted speed limit is determined by the anticipated operating speed) to a proactive urban street design approach (in which the posted speed limit is determined by a target speed based on a desired safety result). The safe-system-approach-recommended maximum target speeds for urban roads are typically near the low end of the AASHTO minimum design speeds shown in Table 6. For example, the target speed for urban arterial roads is 35 mph compared to a 30 to 60 mph minimum design speed; for urban collector roads, the safe system target speed and the AASHTO minimum design speed are both 30 mph (NACTO 2017).

Based on an analysis of 3,603 speeding-related fatal crashes that occurred in cities in 2015, the NTSB estimated that 49% of these fatal crashes occurred on state-operated roads.[40] Therefore, although these roads pass through cities, local jurisdictions have no direct authority to adjust their speed limits. Although local officials may wish to incorporate the safe system approach by proposing speed zones with lower limits in urban areas with vulnerable road users, they may be unable to do so because state transportation departments require engineering studies that are driven

[40] Starting in 2015, FARS data include a variable that identifies road ownership. The NTSB used a geographic information system (GIS) analysis to estimate that 3,603 speeding-related fatal crashes occurred within city limits in 2015.

by the 85th percentile speed. The NTSB concludes that the safe system approach to setting speed limits in urban areas is an improvement over conventional approaches because it considers the vulnerability of all road users.

3.1.6 Rethinking How to Set Speed Limits

Section 2B.13 of the FHWA's *MUTCD* serves as the standard for setting speed limits in speed zones. It requires the use of engineering studies that emphasize the use of the 85th percentile speed.[41] The *MUTCD* also lists crash experience as one of several optional factors to be considered, but it lacks specific guidance on how to include these optional factors. In practice, most state transportation departments use the 85th percentile speed as the primary factor in setting speed limits in speed zones (Parker 1985; Fitzpatrick and others 1995; ITE 2001). The FHWA has developed, adopted, and promoted an expert system, USLIMITS2, that requires the use of crash statistics. USLIMITS2 is a valuable validation tool for engineering studies when setting speed limits, but its methods are not included in the FHWA's *MUTCD*.

Therefore, the NTSB recommends that the FHWA revise Section 2B.13 of the *MUTCD* so that the factors currently listed as optional for all engineering studies are required, require that an expert system such as USLIMITS2 be used as a validation tool, and remove the guidance that speed limits in speed zones should be within 5 mph of the 85th percentile speed.

The relationship between speed and injury severity affects more than just speeding vehicle occupants. This is particularly true in urban areas where the interaction between vehicles and vulnerable road users such as pedestrians is considerably higher. A safe system approach to setting speed limits emphasizes the consideration of human biomechanical tolerances and shifts the focus from vehicles to all road users. Especially in urban areas, it has emerged as an alternative to the use of the 85th percentile speed in setting speed limits in speed zones.

Transportation officials in cities, such as those represented by National Association of City Transportation Officials, are already engaged in the discussion of a shift of emphasis from vehicle-based practices to multi-modal approaches to traffic safety. The AASHTO Subcommittee on Traffic Engineering, the National Committee on Uniform Control Devices, and the Institute of Transportation Engineers are active participants in the research and development of best practices. These organizations may be well equipped to assist the FHWA in assessing the current practices of setting and adjusting speed limits, including but not limited to examining the use of the 85th percentile speed and incorporating the safe system approach. Therefore, the NTSB recommends that the FHWA revise Section 2B.13 of the *MUTCD* to, at a minimum, incorporate the safe system approach for urban roads to strengthen protection for vulnerable road users.

[41] As discussed in section 3.1.2, the ITE provides general guidance for engineering studies, which is commonly used by traffic engineers (ITE 2010; ITE 2016).

3.2 Data-Driven Approaches for Speed Enforcement

Appropriately set speed limits must be enforced to be optimally effective. However, speed limit enforcement is only one of the duties of an officer. Several of the law enforcement agencies the NTSB interviewed indicated that staffing levels have been reduced, and that they have had difficulty recruiting and retaining officers. Further, according to the International Association of Chiefs of Police (IACP), a speed enforcement program involves many costs; they include staffing, procuring speed measurement equipment, equipment servicing, development or improvement of data processing systems, and increased court time and its associated staffing requirements (IACP 2004). Therefore, to adequately manage such staffing and cost issues, law enforcement agencies must efficiently allocate their resources.

One approach that law enforcement agencies use to promote traffic safety is high-visibility enforcement (HVE), in which conspicuous enforcement activities are conducted in areas with a high risk of crashes.[42] This method has proven effective in detecting alcohol-impairment and ensuring seat belt use (Goodwin and others 2015). The most recognized type of HVE is accompanied by nationwide, large scale public media campaigns. HVE can also be integrated into the daily patrol routine, thereby indicating to the public that traffic enforcement is a law enforcement priority.

3.2.1 Data-Driven Approaches to Crime and Traffic Safety

Stakeholders interviewed for this study repeatedly stated that HVE is more effective when data are used to target the locations for enforcement. For example, in 2008, NHTSA and the US Department of Justice partnered to start an initiative known as Data-Driven Approaches to Crime and Traffic Safety (DDACTS) (National Institute of Justice 2014). Under this initiative, law enforcement agencies use geographic information systems (GIS) to analyze location-based crash and crime data to effectively deploy HVE to targeted areas known as *hot spots*, where both criminal activities and traffic incidents frequently occur (Kerrigan 2011; Hardy 2010). DDACTS specifically emphasizes data collection and analysis; disseminating information and outreach; using data to monitor, evaluate, and make adjustments; and measuring outcomes (NHTSA 2014; Hardy 2010).

Many local law enforcement agencies have reported that they effectively used DDACTS to allocate enforcement resources to reduce crashes and crime. The Metropolitan Nashville Police Department implemented an HVE program in 2004 that was based on DDACTS. The program collected traffic and crime data across the city, produced multilayered crime maps overlaying traffic violations with criminal activities, and used statistics-driven methods to identify hot spots down to specific street corners. The department then used HVE in those identified areas. Between 2003 and 2009, the Nashville metropolitan area experienced 16% and 31% decreases in fatal and injury crashes, respectively (Perry and others 2013).

In 2008, the Baltimore County Police Department launched a DDACTS-based HVE program called the Crash-Crime Project. GIS mapping tools were used to build multilayered maps detailing crime, traffic violations, and crash patterns. These maps helped the police department

[42] Another term for HVE is highly visible traffic enforcement.

identify neighborhoods and street segments to which they should deploy high-visibility patrols and conduct vehicle stops (Hall and Puls 2010; Perry and others 2013). On December 4, 2012, the background and results of this DDACTS-based HVE program were presented at the NTSB "Geographic Information Systems (GIS) in Transportation Safety" forum (Wilson and others 2012). The Baltimore County Police Department reported 6% and 15% decreases in all crashes and injury crashes, respectively, between 2007 and 2008 (Perry and others 2013).

In 2010, the Shawnee Police Department of Kansas deployed a DDACTS-based HVE program. Officers were assigned to conduct HVE in hot spots during specific times based on analysis of crime and crash data. Comparing data from the 3 years before and after the 2010 implementation of the Shawnee program, vehicle crashes decreased by 24% (Bryant, Collins, and White 2015).

Although some evidence suggests that data-driven, HVE programs such as DDACTS can be effective in improving traffic safety, there has been no systematic assessment of these programs. All of the reports the NTSB reviewed used aggregate performance measures such as crash counts, traffic stops, and citation issuances (Bryant, Collins, and White 2015; Perry and others 2013; Wilson and others 2012). Although these measures have some merit, an evaluation with performance measures specific to speeding would be useful for identifying best practices for law enforcement agencies when conducting speeding-related, data-driven, HVE and for communicating the benefits of these programs. Speeding-related performance measures may include the numbers and locations of speeding-related crashes, citations, warnings, and the injury severity of speeding-related crashes. Consistent evaluation methods may require the use of minimum before and after time periods for comparison. The *DDACTS Operational Guide* recommends using specific types of crashes and 3 to 5 years of crash data when conducting evaluations (NHTSA 2014). In addition, the guide highlights that "the findings from the data analysis are an important tool for garnering internal and external support for DDACTS implementation within identified hot spots" (NHTSA 2014). Officers interviewed by the NTSB also stated that the ability of senior officers to communicate the value of data-driven enforcement both within their agency and to the public was essential to the success of data-driven, HVE programs.

Therefore, the NTSB concludes that speeding-related performance measures are needed to determine the effectiveness of data-driven, HVE programs and to communicate the value of these programs to law enforcement officers and the public. The NTSB recommends that NHTSA identify speeding-related performance measures to be used by local law enforcement agencies, including—but not limited to—the numbers and locations of speeding-related crashes of different injury severity levels, speeding citations, and warnings, and establish a consistent method for evaluating data-driven, HVE programs to reduce speeding. Disseminate the performance measures and evaluation method to local law enforcement agencies. The NTSB further recommends that NHTSA identify best practices for communicating with law enforcement officers and the public about the effectiveness of data-driven, HVE programs to reduce speeding, and disseminate the best practices to local law enforcement agencies.

3.2.2 Limitations of Speeding-Related Crash Data

FARS uses seven categories to describe the type of speeding in fatal crashes: "exceeded speed limit," "too fast for conditions," "racing," "speeding but specifics unknown," "unknown if it is speeding-related," "no driver present," and "not speeding related" (NHTSA 2015a).[43] Each vehicle involved in a fatal crash is assigned one of these categories.[44] The assignment of these categories is based on analysts' interpretations of police crash reports. There were 35,055 passenger vehicles involved in fatal crashes in 2014; figure 8 shows how they were distributed among the 7 speeding categories. The two most common types of speeding—"exceeded speed limit" and "too fast for conditions"—each represent 8% of all passenger vehicles involved in fatal crashes. A very small portion (less than 1%) of vehicles were categorized as racing. There were also 888 passenger vehicles (3%) identified as speeding, but it was not possible to assign them to specific categories. In total, 6,422 passenger vehicles were identified as speeding.

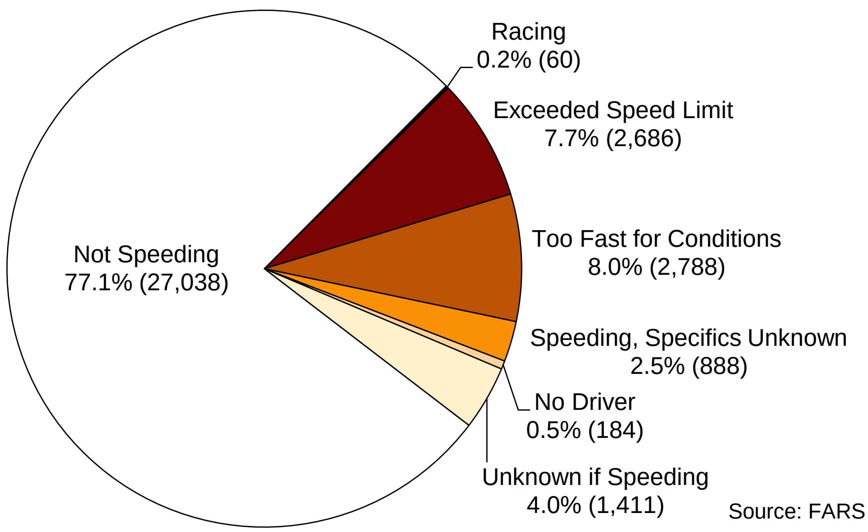


Figure 8. Passenger vehicles in fatal crashes, by speeding category, 2014

Whether the vehicles were speeding could not be determined for 1,411 passenger vehicles (4%), and 27,038 passenger vehicles (77%) were categorized as not speeding. The NTSB further examined these vehicles using travel speed and posted speed limit data in FARS. Among the 27,038 vehicles categorized as not speeding, 918 were traveling at least 10 mph above the posted speed limit prior to the crash. In addition, 57 passenger vehicles categorized as "unknown if speeding" were traveling at least 10 mph above the posted speed limit. This indicates that some vehicles categorized as "not speeding" or "unknown if speeding" were traveling at speeds above the posted speed limit prior to the crash. Therefore, the NTSB concludes that the involvement of speeding passenger vehicles in fatal crashes is underestimated.

[43] The category "no driver present" is used when "there is no person who was controlling the associated vehicle at the time of the crash" or "when it is unknown if there was a driver present in the vehicle at the time of the crash" (NHTSA 2016a).

[44] Appendix D provides definitions for each FARS speeding category.

Crashes involving the speeding types "exceeded speed limit" and "too fast for conditions" are used in analyzing speeding as a safety issue and formulating strategies to address it. The numbers of vehicles for the two speeding types are comparable, yet they deal with different aspects of speeding. Although the first speeding type is objectively defined by speed limits, the second is subject to the interpretation of officers. There is a large degree of variation among states in the way they apply these definitions. For example, 85% of all speeding-related passenger vehicles involved in fatal crashes were assigned "exceeded speed limit" in Massachusetts, whereas 7% of these vehicles were assigned this category in Arkansas (for comparison, the average was 42% for the United States). Although this variation can potentially be explained by posted speed limits and the physical characteristics of the states, it is unclear how much of the variation is due to inconsistencies in police crash reporting.

In some states, there is little distinction between "exceeded speed limit" and "too fast for conditions." For example, although Michigan and New Mexico use these two categories in their crash report forms, 63% and 52% of all speeding-related vehicles were simply categorized as "speeding, specifics unknown" in these states, respectively. The NTSB examined all state police crash report forms and found that 14 states do not have the category "exceeded speed limit" and 7 states do not have the category "too fast for conditions." In addition, six states' police crash report forms only have the category "unsafe speed."

There are three issues concerning crash reporting at the national level: (1) inconsistent categorization of "exceeded speed limit" and "too fast for conditions," (2) a lack of detailed categorization of speeding type, and (3) crashes for which speeding involvement is unknown. To develop a national strategy to address speeding as a traffic safety issue, it is essential to identify the types of speeding-related crashes (requiring consistent, detailed categorization of speeding) and to determine the scope of the problem (requiring known speeding involvement). Therefore, the NTSB concludes that the lack of consistent law enforcement reporting of speeding-related crashes hinders the effective implementation of data-driven speed enforcement programs.

NHTSA and the GHSA jointly publish the *Model Minimum Uniform Crash Criteria* (*MMUCC*) *Guideline*, which contains standards for state crash reporting (GHSA and NHTSA 2012). The guideline is periodically updated and serves as a key document used to "generate the information necessary to improve highway safety within each State and nationally" (GHSA and NHTSA 2012). Regarding speeding, it includes five attributes: "exceeded speed limit," "too fast for conditions," "racing," "unknown," and "no speeding." However, adoption of the *MMUCC Guideline* by states is voluntary. Even if all state crash report forms were compliant with *MMUCC Guideline* standards, the NTSB interviews with law enforcement agencies indicated that there would continue to be inconsistencies among officers in how the crash forms are filled out. The National Sheriffs' Association (NSA) and the IACP are professional associations that provide training and model policies to law enforcement agencies; as such, they may be well positioned to assist NHTSA in improving the quality of speeding-related crash data to help law enforcement agencies more effectively implement data-driven enforcement programs. Therefore, the NTSB recommends that NHTSA work with the GHSA, the IACP, and the NSA to develop and implement a program to increase the adoption of speeding-related *MMUCC Guideline* data elements and improve consistency in law enforcement reporting of speeding-related crashes. Further, the NTSB recommends that the GHSA, the IACP, and the NSA work with NHTSA to develop and implement a program to increase the adoption of speeding-related *MMUCC Guideline* data elements and improve consistency in law enforcement reporting of speeding-related crashes.

3.3 Automated Speed Enforcement

To use limited resources efficiently, some law enforcement agencies are employing data-driven, technology-based solutions for speed enforcement in addition to using data-driven approaches for in-person speed enforcement.

ASE refers to the use of a vehicle speed detection system coupled with a camera to identify speeding vehicles.[45] When a speeding vehicle is detected, the camera system is triggered to automatically take photographs of the vehicle, including the license plate and, in some implementations, the driver. Law enforcement and ASE vendor personnel then review the photographic evidence (typically off site and at a later time) to confirm that a speeding violation occurred, and state motor vehicle administration records are used to determine where to mail a speeding citation (Roadway Safety Consortium 2012). In some jurisdictions, the vehicle owner may be cited and assessed a fine (similar to a parking ticket); in others, the vehicle driver may be cited and be assessed a fine and license points (similar to a speeding citation issued in person by an officer).[46]

ASE has some advantages over in-person speed enforcement by an officer. It provides a force multiplier effect that can free up limited law enforcement resources to be used for other purposes. ASE can operate in locations and under conditions that would make traffic stops dangerous or impractical, and it may reduce congestion from other drivers distracted by traffic stops. Finally, its high rate of speeding detection may provide a higher general deterrence effect (FHWA and NHTSA 2008).[47]

Several limitations of ASE have also been noted. Because ASE does not stop a driver at the time of the speeding offense, the driver may continue to speed and be unaware of the offense. Also, the time lag between committing a violation and receiving an ASE penalty may have a lower specific deterrence effect (FHWA and NHTSA 2008).

ASE has been, and continues to be, challenged on several constitutional grounds, including that it violates rights of due process, equal protection (because penalties may differ between ASE citations and in-person citations), and privacy, but courts have consistently found ASE to be constitutional (FHWA and NHTSA 2008). ASE has also been criticized by the public as a tool to generate revenue rather than increase safety. This concern appears to stem from well-publicized cases of automated red light and speed enforcement programs not following best practices, such

[45] The speed detection system typically uses radar or light detection and ranging (LIDAR) technology, similar to handheld devices used by officers for speed enforcement.

[46] Many states use a point system to account for moving violations, in which greater points are assigned to more severe violations; the accumulation of a particular number of points within a set time period can lead to higher insurance premiums or license suspension.

[47] In traffic law enforcement, general deterrence refers to "the impact of the threat of legal punishment on the public at large…result[ing] from a belief in the community that traffic laws are being enforced and that a real risk of detection and punishment exists." In contrast, specific deterrence is "the influence of enforcement on the road user behaviour of convicted offenders, due to previous detection, prosecution, and punishment experiences" (Zaal 1994).

as paying vendors on a per-citation basis, giving vendors responsibility for site selection, and not ensuring that yellow lights are appropriately timed (Farmer 2017). Some states have passed laws designed to increase public acceptance of ASE. For example, Maryland requires local jurisdictions to hold a public hearing prior to authorizing ASE and to designate an employee to respond to citizen concerns and review contested citations. Local jurisdictions in Maryland are also prohibited from paying ASE vendors on a per-citation basis (see Maryland Code, Transportation, Section 21-809).

The concern about ASE as a revenue-generation tool was also raised at the most recent congressional hearings on automated enforcement in 2010.[48] MAP-21 made it illegal for states to use federal funds to "carry out a program to purchase, operate, or maintain an automated traffic enforcement system" (Title 23 *Code of Federal Regulations* (*CFR*) 1200.13(b)).[49] This was a change from previous legislation, which stated that "the [DOT] Secretary may encourage States to use technologically advanced traffic enforcement devices (including the use of automatic speed detection devices such as photo-radar) by law enforcement officers" (Highway Safety Act of 1991, Public Law 102-240).

3.3.1 Historical and Current Usage

Friendswood and La Marque, Texas, became the first US communities to use modern ASE systems when they conducted short-lived trials in 1986.[50] The next year, Paradise Valley, Arizona, started the first sustained ASE program, which is still active (Town of Paradise Valley 2017).

As illustrated in figure 9, in the first 20 years of ASE operations, usage grew slowly; by January 2006, 26 ASE programs were active but over one quarter of the 36 programs that had been started up to this point had been discontinued. Between 2006 and 2013, ASE usage increased dramatically, peaking at 148 active programs in 2013. Since then, ASE usage has declined slightly, with 141 active programs as of April 2017, including statewide work zone programs in Illinois, Maryland, and Oregon (IIHS 2016a). These programs are concentrated in 14 states and the District of Columbia. For example, communities in Maryland account for 46 of the ASE programs.

[48] *Utilization and Impacts of Automated Traffic Enforcement: Hearing Before the Subcommittee on Highways and Transit of the Committee on Transportation and Infrastructure*, House of Representatives, 111th Congress, 2nd session, June 30, 2010.

[49] Title 23 *USC* section 402 defines an automated traffic enforcement system as "any camera which captures an image of a vehicle for the purposes only of red light and speed enforcement, and does not include hand held radar and other devices operated by law enforcement officers to make an on-the-scene traffic stop, issue a traffic citation, or other enforcement action at the time of the violation."

[50] The IIHS provided the NTSB with historical data on ASE programs, including locations, start dates, and (if applicable) end dates, covering the period from March 1986 to April 2017.

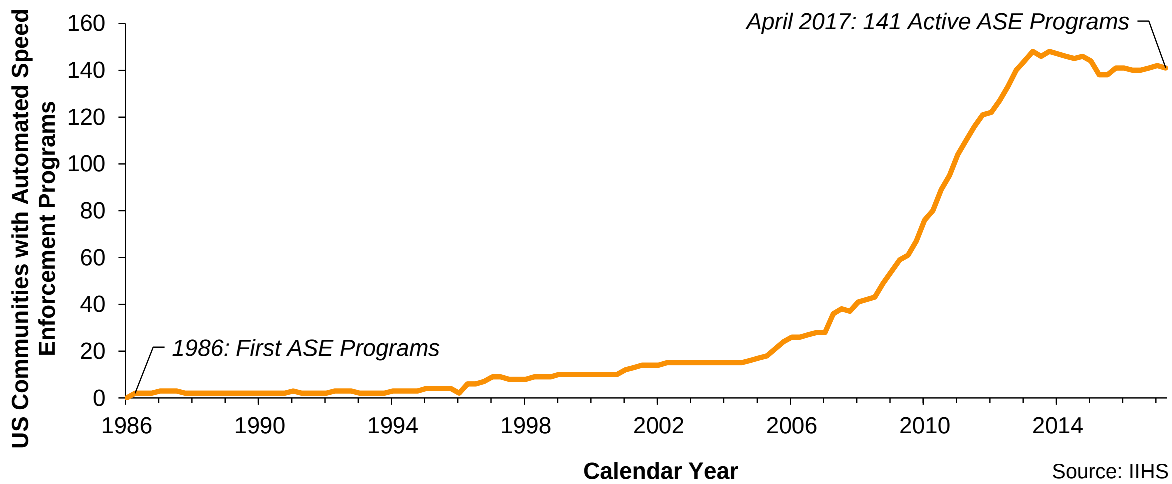


Figure 9. US communities with ASE programs, by year

There are four general types of ASE units (Miller and others 2016):

- **Fixed**: These ASE units are permanently mounted in fixed locations.
- **Speed-on-green**: These fixed units are primarily designed to detect red light violations at intersections, but they can also be used for ASE.
- **Semi-fixed**: These units use fixed housings with removable cameras. With fewer cameras than housings, cameras are rotated among the housings to maintain a deterrent effect at a lower cost, as drivers do not know which housings have cameras at any given time.
- **Mobile**: These units are mounted inside a vehicle (which may be occupied by law enforcement or ASE vendor personnel) or on a towed trailer, and they can be moved to different locations as needed.

3.3.2 Effectiveness

A 2005 systematic review of 14 studies of ASE programs in Canada, Europe, Australia, and New Zealand found crash reductions of 5 to 69%, injury reductions of 12 to 65%, and fatality reductions of 17 to 71% at ASE locations after ASE program implementation (Pilkington and Kinra 2005).

In 2007, NHTSA published a review of 13 studies of ASE programs (including 1 US program). Four of the 13 studies examined fixed ASE programs and generally found that injury crashes at fixed ASE locations declined between 20 and 25% after ASE implementation. The other 9 studies examined mobile ASE programs and found that injury crashes in mobile ASE zones declined between 21 and 51%. Two of the studies in the NHTSA review looked at the wider effects of ASE; one Canadian study found a provincewide 25% reduction in daytime speeding-related crashes, and the other, a US study, found a statewide 30% reduction in daytime crashes resulting in injuries (Decina and others 2007).

A 2010 review of 28 studies of ASE in the United States, Canada, Europe, Australia, and New Zealand determined that all 28 studies had found a lower number of crashes in ASE areas after ASE implementation. These studies reported reductions of 8 to 49% for all crashes and reductions of 11 to 44% for crashes causing serious injuries or fatalities (Wilson and others 2010).

Most recently, in 2015, the IIHS published a study of the ASE program in Montgomery County, Maryland, which first began in 2007. Montgomery County operates an ASE program on residential streets and in school zones, via a combination of fixed, semi-fixed, and mobile units. Starting in 2012, some cameras were used in a corridor approach, in which semi-fixed units were rotated among various locations on signed road segments to encourage speed limit compliance along the entire segment. The IIHS study found that, 7.5 years after the program began, ASE was associated with a 10% reduction in mean speeds and a 62% reduction in the likelihood of speeding more than 10 mph over the posted speed limit at ASE sites. The likelihood that a crash involved an incapacitating injury or fatality decreased by 39% on ASE-eligible roads, and the corridor approach further reduced this likelihood by 30% compared to what would have been expected without the corridor approach.[51] The likelihood that a crash was speeding-related decreased by 8%. The IIHS also found that, on similar but ASE-ineligible roads in Montgomery County, the likelihood that a crash involved an incapacitating injury or fatality decreased by 27% and the likelihood that a crash was speeding-related decreased by 22%.[52] This demonstrated a positive spillover effect, in which the benefits of ASE extended beyond ASE sites (Hu and McCartt 2016).

Several federal agencies consider ASE to be one of the most effective speeding countermeasures. NHTSA evaluated eight speeding countermeasures and gave ASE their highest rating for effectiveness (Goodwin and others 2015).[53] In addition, the Centers for Disease Control and Prevention notes that ASE "can reduce crashes substantially" and includes ASE as the only speeding-related countermeasure in their Motor Vehicle Prioritizing Interventions and Cost Calculator for States (MV PICCS), an online tool for states to choose cost-effective interventions to prevent motor vehicle related casualties (CDC 2015a; CDC 2015b).[54] Based on studies of operational ASE programs in the United States and other countries, the NTSB concludes that ASE is an effective countermeasure to reduce speeding-related crashes, fatalities, and injuries.

[51] To analyze the effects of ASE on crashes, the IIHS study compared the crash experience of Montgomery County residential roads eligible for ASE (that is, those with speed limits from 25 to 35 mph, whether ASE cameras were actually installed) to the crash experience of similar roads in nearby Fairfax County, Virginia, which did not operate an ASE program.

[52] To analyze spillover effects on crashes, the IIHS study compared the crash experience of Montgomery County residential roads with similar characteristics as the ASE-eligible roads (aside from having a higher, 40 mph speed limit) to residential roads in Fairfax County, Virginia, with 40 mph speed limits.

[53] This rating indicates a countermeasure is "demonstrated to be effective by several high-quality evaluations with consistent results" (Goodwin and others 2015).

[54] Each intervention included in MV PICCS is chosen based on (1) empirical evidence that it can substantially reduce motor-vehicle-related injuries and fatalities; (2) currently low usage across the 50 states, with a corresponding potential for additional impact through wider adoption; and (3) the ability of states to implement the intervention.

3.3.3 Stakeholder Perceptions

The GHSA has advocated for ASE programs since 2005, calling for (1) states to enact enabling legislation for ASE, (2) a federal incentive grant program to encourage the use of ASE, and (3) the promotion of ASE best practices by NHTSA (GHSA 2005; GHSA 2012; GHSA 2013; GHSA 2016).

AASHTO has supported the use of ASE since 2004, when it called for all states to build public support for ASE, to promote the enactment of ASE laws, and to support the use of ASE (AASHTO 2004). In 2006, the AASHTO Standing Committee on Highway Traffic Safety (SCOHTS) adopted a policy resolution to further support automated traffic law enforcement, including ASE. Citing the high percentage of crashes involving traffic law violations, the limited resources and staffing difficulties of law enforcement agencies, and the demonstrated effectiveness of automated enforcement in reducing deaths and injuries, SCOHTS encouraged "a top-down leadership approach by the executive and legislative branches of the federal government to implement automated enforcement throughout the country," including incentives for states to enact enabling legislation (AASHTO 2006).

The IACP, in a 2007 resolution, cited some of the same reasons as AASHTO in calling for the use of ASE in high-crash locations in conjunction with in-person traffic enforcement (IACP 2007). The IACP also included ASE as an effective enforcement strategy in its *Traffic Safety Strategies for Law Enforcement* guide (IACP 2003).

The National Association of City Transportation Officials, in its 2016 policy document, noted that automated traffic enforcement "is a crucial tool in preventing crashes that result in serious injuries and fatalities," called for the federal government to allow states to use federal-aid grant funds for automated traffic enforcement, and encouraged states to authorize the use of ASE (NACTO 2016).

The positions of these national associations are in line with the statements made during stakeholder interviews the NTSB conducted for this study. Nearly all of the representatives from state and local transportation departments expressed a positive view of their ASE programs (for those with active programs) or a desire to use ASE (for those without ASE programs). Opinions from officers were more varied. Several officers mentioned the benefits of in-person traffic stops, including the ability to discover other illegal behaviors and outstanding warrants, the ability to apply discretion and take into account mitigating factors, and the opportunity to educate drivers about traffic laws and the risks of speeding. However, only officers in communities without active ASE programs mentioned the benefits of in-person traffic stops as reasons for not implementing ASE. The NTSB interviewed representatives of five law enforcement agencies operating ASE programs. With one exception, every law enforcement representative in a community with ASE expressed the view that their programs should be maintained or expanded, and stated that they did not see ASE as limiting their ability to conduct in-person speed enforcement.[55]

[55] The ASE program in question (which has since been discontinued) operated in about six school zones throughout a county, with two mobile vans that rotated among the schools on a daily basis. The officer responsible for the program indicated that the daily process of moving, configuring, and removing the mobile units was too time consuming for his small force of seven officers, given their other required duties in addition to traffic enforcement.

Driver surveys have shown that public support varies depending on the roadway environment for which ASE is used and driver characteristics. In a nationally representative survey conducted by the AAA Foundation for Traffic Safety in 2015, 35% of respondents stated they supported ASE on freeways, 41% supported ASE in urban areas, 45% supported it on residential streets, and 56% supported it in school zones. These figures have not changed substantially since 2012, when the AAA Foundation started surveying drivers about this topic (AAA Foundation for Traffic Safety 2016).[56] Also, in a 2009 national public opinion survey conducted by the University of Minnesota, 64% of respondents said they were very or somewhat supportive of ASE in general. When asked about particular locations for ASE, support was higher for roads near schools (87%), roads where many people have died (81%), and roads where many people violate speed limits (75%). However, support for ASE on all roads was lower (43%). ASE support was also higher among women and older drivers, which are groups that are less likely than males and younger drivers to be involved in speeding-related fatal crashes. In addition, 73% of all survey respondents said that ASE would be an effective way to improve road safety (Munnich and Loveland 2011).

Several studies have shown maintained or increased public support for ASE after program implementation (Retting 2003). In Montgomery County, Maryland, a survey taken 6 months before the county's ASE program began in 2007 showed that 58% of drivers were in favor of ASE on residential streets. This level of support has been sustained, with followup surveys taken 6 months after the program began and again in 2014, showing 62% of drivers supporting the program (Retting, Farmer, and McCartt 2008; Hu and McCartt 2016). Surveys of drivers in Scottsdale, Arizona, in 2005 and 2006, showed that the percentage of drivers favoring ASE increased from 62% before an ASE program began to 77% after 8 months of operation (Retting, Kyrychenko, and McCartt 2008).

Although most ASE public opinion surveys the NTSB reviewed were directed to drivers, non-drivers are also affected by speeding, especially in urban areas with large numbers of pedestrians and bicyclists. A 2012 survey of District of Columbia residents found support for ASE even higher among non-drivers (90% support) than drivers (71% support) (Cicchino, Wells, and McCartt 2014).

3.3.4 Enabling Legislation

Table 7 shows, as of August 2016, the number of states with laws authorizing or prohibiting ASE, and whether these states have active ASE programs operating within the state.[57] Of the 14 states with ASE programs, most of these programs are operating with state legislation explicitly authorizing the use of ASE; very few ASE programs operate in states where laws are silent on the topic. This indicates that state-level enabling legislation is an important criterion for local communities to implement ASE programs.

[56] It should be noted that the ASE survey questions specifically asked about citing vehicle drivers, an increasingly rare practice since newer ASE programs issue a fine to the vehicle owner. Survey respondents were asked if they support strongly, support somewhat, oppose somewhat, or oppose strongly "using cameras to automatically ticket drivers who drive more than 10 mph over the speed limit" on freeways, residential streets, urban areas, and school zones.

[57] Appendix E provides a complete summary of ASE laws by state.

Table 7. ASE state laws and active programs as of April 2017

	States Authorizing ASE	States Authorizing ASE with Restrictions	States without ASE Laws	States Prohibiting ASE	Total
States with ASE Programs	0[a]	10	4	0	14
States without ASE Programs	0	5	24	7	36
Total	**0**	**15**	**28**	**7**	**50**

Source: GHSA and IIHS
[a] The District of Columbia allows ASE throughout its jurisdiction and operates an ASE program.

The importance of state-level ASE-enabling legislation is supported by interviews the NTSB conducted with state and local transportation departments. Representatives from every state and local transportation department in a state without ASE-enabling legislation mentioned that they would like to implement an ASE program, but they were unwilling to do so without laws in place authorizing its use. The most common reason given for not implementing ASE programs without enabling legislation was that the citations issued by such a program, or the program itself, would be subject to significant legal challenges. For example, several Texas counties operated ASE programs only in unincorporated areas because state law prohibits ASE within Texas municipalities. As of April 2017, these programs have all been discontinued, and the law enforcement agency responsible for administering one such program reported a 50% dismissal rate for all ASE citations challenged in court.

However, even among the states with ASE-enabling legislation, significant restrictions on its use often prevent ASE from effectively reducing speeding-related deaths and injuries in these states. In the 15 states (and the District of Columbia) that authorize ASE, every state places some limitations on the specific municipalities or roadway environments in which ASE can be used; only the District of Columbia allows ASE throughout its jurisdiction. Several states limit the use of ASE to school zones, work zones, roads adjacent to parks, or some combination of these. Other states limit ASE programs to particular cities. For example, outside of school zones, the state of Washington effectively limits ASE to a single camera in the city of Tacoma.[58] Further, five states require that an officer or government employee be present at the time when the ASE unit captures the speeding violation.

Although it may be easier to garner community and legislative support for the use of ASE in locations such as school zones, those are generally not the locations most at risk for speeding-related deaths and injuries. For example, FARS data show that only seven US speeding-related fatalities occurred in school zones in 2014. The NTSB interviewed representatives from several agencies with active ASE programs who stated that the locations where ASE was authorized did not adequately address the speeding-related crash hot spots in their

[58] Any city "west of the Cascade mountains with a population of more than one hundred ninety-five thousand located in a county with a population of fewer than one million five hundred thousand" may operate a single ASE camera, and the specific site "must have first been authorized by the Washington state legislature as a pilot project for at least one full year" (see Revised Code of Washington 46.63.170).

communities, and that they would like the ability to place ASE equipment at the locations most susceptible to speeding-related crashes. The NTSB concludes that the lack of state-level ASE-enabling legislation, and restrictions on the use of ASE in states where legislation exists, have led to underuse of this effective speeding countermeasure. However, the NTSB acknowledges that some restrictions on ASE operations (such as the Maryland prohibition against paying vendors on a per-citation basis) may reflect best practices and are intended to increase public acceptance of ASE without limiting its safety benefits. Therefore, the NTSB recommends that the seven states prohibiting ASE amend current laws to authorize state and local agencies to use ASE.[59] The NTSB further recommends that the 28 states without ASE laws authorize state and local agencies to use ASE.[60] Finally, the NTSB recommends that the 15 states with ASE restrictions amend current laws to remove operational and location restrictions on the use of ASE, except where such restrictions are necessary to align with best practices.[61]

3.3.5 Best Practices

At the federal level, the primary source of best practices for establishing, operating, and evaluating ASE programs is the *Speed Enforcement Camera Systems Operational Guidelines* (FHWA and NHTSA 2008). These guidelines are designed to be a resource for "program managers, administrators, law enforcement, traffic engineers, program evaluators, and other individuals responsible for the planning and operation of the program" and contain best practices in over 40 topic areas related to ASE, such as legal authorities, site selection, marketing, operator training, equipment maintenance, violation processing and adjudication, and program evaluation.

However, NHTSA has found that these guidelines are neither well known, nor well adhered to, by ASE program managers. In 2011, NHTSA conducted a survey of all 107 communities identified at that time as current or recent operators of ASE programs (Miller and others 2016). The objectives of the study were to determine how aligned the ASE programs were with the federal guidelines. However, 63% of the survey respondents indicated that they were not even aware of the federal ASE guidelines.[62]

To determine these programs' degree of alignment to the guidelines, survey questions were developed for 35 topic areas in which the guidelines provided "clear guidance terms such as 'shall,' 'should,' 'critical,' and 'must.'" In only 7 of the 35 areas did 80% or more of the surveyed

[59] These seven states are Maine, Mississippi, New Hampshire, New Jersey, Texas, West Virginia, and Wisconsin. See appendix E.

[60] These 28 states are Alabama, Alaska, California, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Indiana, Iowa, Kansas, Kentucky, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Mexico, North Carolina, North Dakota, Oklahoma, Pennsylvania, South Dakota, Vermont, Virginia, and Wyoming. See appendix E.

[61] These 15 states are Arizona, Arkansas, Colorado, Illinois, Louisiana, Maryland, Nevada, New York, Ohio, Oregon, Rhode Island, South Carolina, Tennessee, Utah, and Washington. See appendix E.

[62] Survey respondents included representatives from current and recently discontinued ASE programs at the time the survey was conducted and representatives from programs that began before and after the ASE guidelines were published. Programs starting before the ASE guidelines were published in 2008 reported 7% higher awareness of the guidelines (34%) than those programs starting in 2008 or later (27%). The survey was mailed to the head of the agency responsible for ASE within each community. NHTSA stated that "it appears that most of the agency staff assigned to complete the survey had operational responsibilities and/or oversight for ASE" but "the person assigned to complete the survey may not have been involved when the program was first established" (Miller and others 2016).

programs align with the guidelines. Further, in 11 of these 35 areas, less than 40% of the surveyed ASE programs aligned with the guidelines. For example, 31% of ASE programs aligned with the guideline to treat speeding violations by government vehicles the same as violations by the general public, and 27% of ASE programs aligned with the guideline to establish a stakeholder committee to guide program development (Miller and others 2016).

The NHTSA survey acknowledges that some of the low alignment to federal ASE guidelines may be due to changes in technology and operations that the 2008 guidelines do not reflect. For example, the guidelines recommend that the vehicle driver be identified and cited. However, in accordance with state and local laws, most recently established ASE programs send citations to the vehicle owner, a practice which has been shown to be effective (Hu and McCartt 2016). In addition, the survey noted that the increased use of unstaffed mobile units—a technology not available when the guidelines were written—could affect how an ASE program is operated and perceived.

The NTSB concludes that federal guidelines for ASE programs do not reflect the latest technologies and operating practices and are not very effective because their existence is not well known among the ASE program administrators. The NTSB therefore recommends that the FHWA work with NHTSA to update the *Speed Enforcement Camera Systems Operational Guidelines* to reflect the latest ASE technologies and operating practices, and promote the updated guidelines among ASE program administrators.

3.3.6 Point-to-Point Enforcement

One particular ASE technology that is relatively new is point-to-point enforcement (also referred to as average speed enforcement or section control). The first use of point-to-point enforcement was in the Netherlands in 1997; since then, its use has spread to other European countries, Australia, and New Zealand, but such systems have not yet been implemented in the United States (Soole, Fleiter, and Watson 2012).

Point-to-point enforcement uses the times a vehicle passes two points to calculate an average speed over the length of road between the points. Continuous visual observation of a vehicle is not necessary over the entire section of roadway, as a time-synchronized camera system captures vehicle images at the section endpoints and then uses automatic license plate recognition technology to match the images and determine which vehicles exceeded the posted speed limit. Thus, point-to-point enforcement can be used on highway segments many miles long, with multiple measurement points as necessary.

Point-to-point enforcement technology is best suited for limited-access highways with few entry or exit points on the designated highway section, for which the designated section is the fastest route between the section endpoints. This is a road type for which ASE in general has not been used extensively in the United States, despite interstate highways and non-interstate freeways and expressways accounting for 17% of speeding-related fatalities in 2014 (NCSA 2016a).

Several benefits of point-to-point enforcement have been noted in relation to fixed or mobile ASE implementations. By enforcing the speed limit over a longer segment of roadway rather than at discrete points, drivers are encouraged to drive the speed limit over longer distances.

In addition, point-to-point enforcement avoids the problem of drivers slowing prior to a known ASE site and then resuming an excessive speed after passing the camera (Lahrmann and others 2016).

Although it has not been evaluated as extensively as other types of ASE, studies have shown that point-to-point enforcement provides safety benefits, including some advantages over fixed ASE units. A 2013 review of studies in Europe and Australia found that point-to-point enforcement generally reduces average speeds, 85th percentile speeds, speed variability, fatal crashes, and serious injury crashes (Soole, Watson, and Fleiter 2013). A 2014 review of 15 fixed ASE studies and 4 point-to-point enforcement studies found that point-to-point enforcement was slightly more effective in reducing crashes than fixed ASE, with fatal and serious injury crashes declining by 51% for fixed ASE and 56% for point-to-point enforcement (Høye 2014).

Based on the experience of implementing point-to-point enforcement in Europe, Australia, and New Zealand, Austroads (the association of Australian and New Zealand transportation agencies) has developed best practices for point-to-point enforcement, which address operational, technological, legislative, evidentiary, public education, evaluation, and privacy considerations (Soole, Fleiter, and Watson 2012). However, this guidance may not be completely appropriate in the United States, where point-to-point enforcement would potentially be subject to the same types of legal arguments that have been made against other types of automated enforcement. Best practices for point-to-point enforcement in the United States would help ensure that enforcement operations are conducted in a legally appropriate manner, but US federal guidelines for ASE do not include any information on point-to-point enforcement (FHWA and NHTSA 2008).

The NTSB concludes that point-to-point speed enforcement has been shown to be an effective speeding countermeasure internationally, but it is not currently used in the United States. Therefore, the NTSB recommends that the FHWA work with NHTSA to assess the effectiveness of point-to-point speed enforcement in the United States and, based on the results of that assessment, update the *Speed Enforcement Camera Systems Operational Guidelines*, as appropriate.

3.4 Intelligent Speed Adaptation

Intelligent speed adaptation (ISA) is a vehicle technology that studies have shown is effective at reducing speeding. ISA systems determine the speed limit in effect by comparing a vehicle's global positioning system (GPS) location against a database of posted speed limits and using onboard cameras to recognize speed limit signs (Goodwin and others 2015).

The European Commission defines three levels of ISA (European Commission 2015):

- **Open ISA**: An advisory system that issues visual or aural alerts to the driver when the speed limit is exceeded; the driver is responsible for slowing the vehicle.
- **Half-Open ISA**: A system that increases back pressure on the accelerator when the speed limit is exceeded, making it more difficult (but not impossible) to exceed the speed limit.
- **Closed ISA**: A system that electronically limits the speed of a vehicle, preventing drivers from exceeding the speed limit.

The primary advantage of ISA compared to conventional speed limiters (also known as speed governors) is that the limiting speed is the posted speed limit in effect at a particular location, rather than a single, fixed speed. Conventional speed limiters have been voluntarily used by US commercial truck and bus fleets for their safety and fuel efficiency benefits, and other countries have required their use on trucks and buses since the 1990s (NTSB 2012). However, because conventional speed limiters cannot prevent speeding in locations where the speed limit is lower than the governed speed, the NTSB has previously recommended that heavy vehicles, including trucks, buses, and motorcoaches, be equipped with advanced speed-limiting technology such as ISA (NTSB 2012; NTSB 2015).[63]

3.4.1 Current Passenger Vehicle Implementations

Many manufacturers offer Open ISA capabilities for the US passenger vehicle market. The earliest and most common implementations show the current speed limit on the vehicle's navigation display. Some of these systems also change the display when the speed limit is exceeded (for example, highlighting the speed limit in amber or red). More recently, manufacturers have started displaying these speed limit alerts within the driver's instrument cluster, or projecting the information onto the windshield on a head-up display. Third-party Open ISA systems are available for retrofit (Mobileye 2017). In addition, drivers may use portable electronic devices as their source of navigation and speed limit data. Increasingly, these devices can interface directly with passenger vehicles through capabilities such as Android Auto and Apple CarPlay (Google 2017; Apple 2017).

Examples of currently available US vehicle capabilities related to ISA include the following:

- On General Motors vehicles with a navigation system, the current GPS-derived speed limit can be displayed on the navigation display, within the instrument cluster, or on a head-up display if so equipped, but no warnings are issued when exceeding the limit. In addition, as part of General Motors' Teen Driver system, many General Motors vehicles can issue a visual warning and chime when a user-set speed (between 40 and 75 mph) is exceeded, and owners can also enable a speed limiter fixed to 85 mph (Chevrolet 2016).
- On Toyota vehicles with a navigation system, the current GPS-derived speed limit can be displayed on the navigation display or in the instrument cluster. Drivers can also enable a yellow caution indicator that is displayed in the instrument cluster when the speed limit is exceeded (Toyota Motor Sales 2016).
- Tesla vehicles equipped with the Autopilot driver assistance system include an ISA capability called Speed Assist (Tesla Motors 2016). Speed Assist uses sign detection and GPS data (where no signs are present) to determine the current speed limit. If the driver has enabled Speed Assist, a speed limit sign is displayed on the instrument panel whenever a speed limit can be determined; when the speed limit (plus or minus a driver-specified offset) is exceeded, this speed limit sign enlarges and a chime optionally sounds.[64] Speed Assist is also integrated with Tesla's Traffic-Aware Cruise Control; when the driver pulls

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[63] NTSB Safety Recommendation H-12-21 to NHTSA is currently classified "Open—Acceptable Response."

[64] Instead of basing the speed alerts on the posted speed limit, a driver can also manually specify a fixed speed between 20 and 140 mph for alerting.

and holds the cruise control lever, the cruising speed will be set to the Speed Assist speed. However, changes in posted speed limits are not automatically followed; the driver must pull the cruise lever again for the cruising speed to match a new speed limit.

- On Ford and Lincoln vehicles equipped with the MyKey feature, drivers can activate a set of user-configured restricted driving modes when starting the vehicle with a MyKey. These modes include visual and aural warnings when a user-set speed is exceeded, and fixed speed limits of 65, 70, 75, or 80 mph, which are also accompanied by visual and aural warnings. Ford and Lincoln vehicles equipped with GPS can also display the current GPS-derived speed limit in the instrument cluster (Ford Motor Company 2016).
- Audi vehicles equipped with GPS, sign-detecting cameras, and adaptive cruise control include a capability called Predictive Control. When Predictive Control is activated, the adaptive cruise control will adjust the vehicle's speed to match the currently detected speed limit, and it will automatically accelerate or decelerate the vehicle when a new speed limit is detected (Audi 2017).

These features are often marketed toward teen drivers and their parents. Automobile manufacturers typically only make these features available for a subset of their models, and the purchase of certain option packages (such as those that include a GPS navigation system) may be required.

The systems offered by automobile manufacturers in the United States do not yet meet the definitions of Half-Open or Closed ISA. However, third-party products are available for retrofit (Speedshield Technologies 2012). In addition, Half-Open ISA capabilities are offered by automobile manufacturers in other countries. For example, since 2015, the Ford S-Max has been sold in Europe with an optional Intelligent Speed Limiter. When activated by the driver using controls on the steering wheel, the vehicle is limited to speed limits detected via sign recognition.[65] If the driver fully depresses the accelerator, the speed limiter will turn off until the vehicle speed is again below the speed limit (Ford Motor Company 2015).

3.4.2 Effectiveness

ISA has been studied extensively internationally, and to a lesser degree in the United States (Blomberg and others 2015; De Leonardis, Huey, and Robinson 2014; Regan and others 2006; Várhelyi and others 2004). These studies have generally found ISA to be effective in reducing speeding.

For example, in a 2014 NHTSA study, 78 "chronic speeders" in Maryland drove with an Open ISA system for 4 weeks (De Leonardis, Huey, and Robinson 2014).[66] The mean percentage of each trip that study participants drove over 8 mph above the posted speed limit decreased from 18% to 13% when the Open ISA system was used.

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[65] The driver can also specify an offset above or below the speed limit, so that the Intelligent Speed Limiter will, for example, limit the vehicle speed to the posted speed limit plus 5 mph.

[66] Study participants had received at least three speeding violations in the 3 years before the study.

In Lund, Sweden, 284 vehicles were equipped with a Half-Open ISA system for 5 to 11 months in 2000 (Várhelyi and others 2004). ISA usage resulted in statistically significant changes in mean speeds (decreasing between 0.9 and 3.7 kilometers per hour (km/h)) on four of the six road types examined in the study.[67] Eighty-fifth percentile speeds on these road types decreased between 1.0 and 7.6 km/h, and speed variance also decreased.

In a study published by NHTSA in 2015, a Half-Open ISA system was tested with 18- to 24-year-olds in Kalamazoo, Michigan, using a fixed course of six road segments with different speed limits (Blomberg and others 2015). The Half-Open ISA system showed statistically significant reductions in both speeding 5 or more mph over the speed limit and speed variance for five of the six segments.[68] The NTSB concludes that ISA is an effective vehicle technology to reduce speeding.

3.4.3 Stakeholder Perceptions

Most of the automobile manufacturers the NTSB interviewed for this study did not collect usage data for their Open ISA implementations. However, one manufacturer that offers an Open ISA system with visual warnings as a standard feature (defaulted to be active) reported that 3% of vehicle owners disable the feature. Another automobile manufacturer noted that a primary motivation for developing its Open ISA system capability was customer interest.

When asked about equipping vehicles with more restrictive Half-Open or Closed ISA systems, the automobile manufacturers interviewed for this study all indicated that it was technically feasible. However, they also expressed several concerns, including limitations of sign-detection cameras and speed limit databases, a desire to retain the ability to exceed the speed limit in emergency situations, and the need to support customers who operate their vehicles off public roads (for example, people who use their vehicles for racing).

3.4.4 Performance and Equipage

The effectiveness of a particular ISA system depends on its underlying speed limit detection technology. For those systems that rely on GPS maps, the speed limit data must be complete, accurate, and timely. However, many vehicle map databases are updated infrequently and typically require owners to take action to purchase updated data. For example, navigation maps for Honda vehicles are typically updated once per year, and these updates cost about $150 (HERE 2016). Although the automobile manufacturers interviewed for this study could not provide quantitative data, they all estimated that the number of vehicle owners regularly purchasing map updates is quite low.

For those systems that rely on sign-detecting cameras, performance is dependent on weather conditions, lighting conditions, obstructions (such as vegetation or other vehicles), speed limit sign format, and sign placement. However, the impact of these factors on the performance of

[67] The four road types with statistically significant changes were arterials with speed limits between 50 and 70 km/h, and a "main street" with a speed limit of 50 km/h. The remaining two road types (a "main street, mixed traffic" with a 50 km/h speed limit and a "central street" with a 30 km/h speed limit) did not show significant differences between ISA-active and inactive test conditions.

[68] Traffic congestion on the sixth segment limited the opportunities to speed.

ISA systems is difficult to quantitatively assess, because ISA performance standards do not exist. Most manufacturers only provide a list of qualitative ISA performance disclaimers in their owner's manuals. For example, the Tesla Model S owner's manual states that owners should "not rely on Speed Assist to determine the appropriate speed limit" (Tesla Motors 2016).

Finally, ISA must actively be used to be effective. Several studies that measured driving behavior before, during, and after the ISA test phase have found that speeding reverts to (or close to) pre-ISA levels once the system is turned off (Blomberg and others 2015; De Leonardis, Huey, and Robinson 2014). In addition, several subjects in a Half-Open ISA study were able to speed by pushing harder on the accelerator pedal, accelerating beyond the speed limit, and then coasting above the speed limit (Blomberg and others 2015). These observations highlight the importance of defaulting any passenger vehicle ISA implementations to be activated/on and of limiting the ability of drivers to disable or defeat the system.

One way to incentivize manufacturers to include advanced safety capabilities that satisfy minimum performance standards in their vehicles is through crash testing and safety rating programs. In the United States, these include NHTSA's New Car Assessment Program (NCAP) (NHTSA 2016b) and the IIHS "Top Safety Pick" awards (IIHS 2016b).

The European NCAP includes ISA as a rating factor and provides test protocols for evaluating a manufacturer's ISA implementation (Euro NCAP 2015). However, ISA is not incorporated into the US NCAP. One automobile manufacturer interviewed for this study stated that the inclusion of ISA in the European NCAP was a primary reason why an ISA capability was developed for its vehicles sold in Europe. In addition, safety ratings programs like the NCAP have been shown to increase sales of high-rated vehicles relative to lower-rated vehicles (IIHS 2013). The NTSB concludes that new car safety ratings are effective in incentivizing consumers to purchase passenger vehicles with advanced safety systems. The NTSB therefore recommends that NHTSA incentivize passenger vehicle manufacturers and consumers to adopt ISA systems by, for example, including ISA in the NCAP.

3.5 National Leadership

In interviews the NTSB conducted, national, state, and local traffic safety stakeholders repeatedly mentioned that—unlike other crash factors such as alcohol impairment or unbelted occupants—speeding has few negative social consequences associated with it, and it does not have a leader campaigning to increase public awareness about the issue at the national level. Stakeholders further stated that they thought the dangers of speeding are not well-publicized, that society therefore underappreciates the risks of speeding, and that the resulting complacency among drivers has led to speeding becoming a common behavior even though surveys indicate that drivers generally disapprove of other drivers speeding. Stakeholders also expressed the belief that, to gradually change public perceptions of speeding, a coordinated effort among safety advocacy groups, with strong leadership from the federal government, is needed. This section describes several ways that national organizations can take a greater leadership role in addressing speeding.

3.5.1 Traffic Safety Campaigns and Public Awareness

Traffic safety campaigns use communications and outreach to increase public awareness of a traffic safety topic. When campaigns also include increased enforcement, they have been shown to be highly effective countermeasures for several traffic safety issues, such as impaired driving and occupant protection (Goodwin and others 2015). For example, a key component of the NHTSA-coordinated campaign to increase seat belt usage is “Click It or Ticket,” an annual, 2-week enforcement mobilization that has been conducted nationally since 2003 (Hinch, Solomon, and Tison 2014).

NHTSA has stated that traffic safety campaigns for speeding show promise; however, the safety benefits have varied greatly among campaigns that have been studied (Goodwin and others 2015). For example, pilot tests of two campaigns in Peoria and Phoenix, Arizona, showed 17 and 31% increases, respectively, in the proportion of drivers complying with the posted speed limit, and 14 and 29% decreases, respectively, in the proportion of drivers exceeding the speed limit by 7 mph or more (Blomberg and Cleven 2006). Also, a 4-week trial of increased speeding enforcement in London in 2008 found that 85th percentile speeds decreased by 1.9 mph on the targeted section of roadway, and 1.1 mph at nearby sites not subject to increased enforcement. There were also greater reductions at those sites where pre-trial mean speeds were highest, and the reductions persisted for 2 weeks after the trial concluded (Walter, Broughton, and Knowles 2011). In contrast, a study of two 6-month campaigns focusing on aggressive driving in Tucson, Arizona, and Marion County, Indiana, found that the proportion of crashes related to aggressive driving decreased by 8% during the Tucson campaign but increased by 6% during the Marion County campaign (Stuster 2004).

The varying benefits of these traffic safety campaigns for speeding can be explained by two factors: inconsistent implementations and low levels of awareness of the campaigns among drivers. For example, the Marion County campaign relied on overtime hours by 42 officers from six different law enforcement agencies, operating on average 1 out of every 3 days, whereas the Tucson campaign used two full-time and two part-time officers who operated almost every day. These two campaigns also differed in their relative expenditures for labor, equipment, and publicity, and in their focus on single or multiple traffic violations. In a survey conducted after the Peoria and Phoenix campaigns, 26% of neighborhood residents mentioned the campaigns’ “Heed the Speed” slogan. In contrast, a 2012 survey of the long-running national occupant protection campaign found that 85% of respondents were aware of its “Click It or Ticket” slogan (Hinch, Solomon, and Tison 2014).

Research has shown that the communications component of a traffic safety campaign increases safety benefits. One review of 67 studies on traffic safety campaigns in 12 countries found that public information and education reduced crashes by 9% on average (Phillips, Ulleberg, and Vaa 2011). A study of an ASE program in North Carolina likewise found that 8 to 9% of the crash reduction effects were due to media coverage of the program (Moon and Hummer 2010). These results highlight the importance of public media efforts to the success of traffic safety campaigns.

NHTSA, through its Traffic Safety Marketing (TSM) group, provides marketing materials and advice for states to use in developing traffic safety campaigns, and coordinates national traffic safety events (NHTSA 2016c). Table 8 shows the traffic safety events that NHTSA sponsored in 2016, including three national enforcement mobilizations, which addressed distraction, occupant protection, and alcohol impairment. None of the events addressed speeding.

Table 8. 2016 NHTSA Traffic Safety Marketing events

Event Type	Date(s)	Description (Slogan)
Official Month	April	National Distracted Driving Awareness Month Bicycle Safety Month
	May	Motorcycle Safety Awareness Month
	July	Vehicle Theft Prevention Month
	August	Back to School Safety Month
Official Week	May 29-June 4	Tire Safety Week
	September 18-24	Child Passenger Safety Week
	October 16-22	National Teen Driver Safety Week
National Enforcement Mobilization	April 8-13	Distracted Driving (*U Drive. U Text. U Pay.*)
	May 16-30	Occupant Protection (*Click It or Ticket*)
	August 17-September 5	Impaired Driving (*Drive Sober or Get Pulled Over*)
Holiday with Traffic Safety Emphasis	Super Bowl, St. Patrick's Day, Cinco de Mayo, Fourth of July, Halloween, Holiday Season (November 25-Jan 1)	Impaired Driving
	Thanksgiving	Occupant Protection

Although NHTSA does not currently coordinate any national activities related to speeding, TSM does make available marketing materials that state and local agencies can use in their own campaigns, using the slogans "Stop Speeding Before It Stops You" and "Obey the Sign or Pay the Fine" (NHTSA 2016c). However, in the absence of a national speeding campaign, there is incomplete participation among states, and little consistency among the individual state campaigns. A 2011 study found that 32 states funded public awareness efforts for speeding; 25 of these states reported using a total of 30 different campaign slogans, and 8 states used the NHTSA slogans (GHSA 2012). In contrast, all 50 states participate in the national occupant protection campaign, and they all use the campaign's "Click It or Ticket" slogan.

Participation in the NHTSA-coordinated, national traffic safety campaigns is high because states are required to participate in order to receive some federal highway safety grant funds. For example, under the Highway Safety Program, each state must "provide satisfactory assurances" that the state will implement all "national law enforcement mobilizations and high-visibility law enforcement mobilizations coordinated by the Secretary" of Transportation (23 *USC* section 402). In addition, a state is only eligible to receive National Priority Safety Programs occupant protection grants if it "participates in the Click It or Ticket national mobilization" (23 *USC* section 405).

During NTSB interviews with stakeholders, including safety advocates, state transportation officials, and officers, the lack of a national traffic safety campaign was cited as a key issue hindering the effective implementation of speeding prevention programs in the United States. The GHSA has also called for NHTSA to "sponsor a national high visibility enforcement campaign and support public awareness efforts to address the issues of speed and aggressive driving" (GHSA 2012). The NTSB concludes that traffic safety campaigns that include highly publicized, increased enforcement can be an effective speeding countermeasure, but their inconsistent and infrequent use by states hinders their effectiveness.

Despite the lack of a national speeding campaign, recently developed national efforts to achieve zero US traffic fatalities (called Vision Zero or Toward Zero Deaths) recognize the impact of speeding on traffic safety. For example, the Toward Zero Deaths Steering Committee consists of eight "organizations and agencies that own, operate, enforce and maintain our nation's roads" with technical support from the FHWA, the FMCSA, and NHTSA.[69] The committee has developed *Toward Zero Deaths: A National Strategy on Highway Safety*, which identifies six strategies to move toward safer drivers and passengers: increasing seat belt use, reducing speeding-related fatalities, reducing impaired driving, reducing driver distraction, increasing the safety of teen drivers, and increasing the safety of older drivers (The Toward Zero Deaths Steering Committee 2014). Except for the topics of speeding and older drivers, all of these strategies have NHTSA-coordinated traffic safety events. The international traffic safety community has also recognized speeding as an important problem to address. For example, speeding is included in the United Nations' *Global Plan for the Decade of Action for Road Safety 2011-2020*, and the Fourth United Nations Global Road Safety Week (May 8-14, 2017) focused on speed management (WHO 2011; WHO 2017). However, this level of importance is not reflected in the schedule of national traffic safety events coordinated by NHTSA. The NTSB concludes that the current level of emphasis on speeding as a national traffic safety issue is lower than warranted and insufficient to achieve the goal of zero traffic fatalities in the United States.

In October 2016, NHTSA, along with the FHWA and FMCSA, joined the National Safety Council (NSC) to launch the "Road to Zero" initiative and coalition (NHTSA 2016d). The purpose of the initiative is "to eliminate traffic fatalities within 30 years" (National Safety Council 2017). This growing coalition has over 200 members with a steering committee that includes the three aforementioned DOT agencies, the NSC, AASHTO, Mothers Against Drunk Driving (MADD), and others. All of these organizations have their own diverse initiatives and programs to increase traffic safety in the United States. Also, safety advocacy organizations have had success in developing, launching, and implementing nationwide public awareness, education, and media efforts. Therefore, the NTSB recommends that NHTSA collaborate with other traffic safety stakeholders to develop and implement an ongoing program to increase public awareness of speeding as a national traffic safety issue. The program should include, but not be limited to, initiating an annual enforcement mobilization directed at speeding drivers.

[69] The eight organizations on the Toward Zero Deaths Steering Committee are the American Association of Motor Vehicle Administrators, AASHTO, the Commercial Vehicle Safety Alliance, the GHSA, the IACP, the National Association of County Engineers, the National Association of State Emergency Medical Service Officials, and the National Local Technical Assistance Program Association.

3.5.2 Funding for Speed Management Programs

Another way to increase public awareness of speeding as a traffic safety issue is by providing states incentives to be more engaged in addressing speeding. As discussed in section 2.7, the three primary federal-aid programs for traffic safety are the Highway Safety Improvement Program, Highway Safety Program, and National Priority Safety Programs. The latter two both fund non-engineering (that is, behavioral) countermeasures, but their funding methods differ in several important ways. Highway Safety Program grants are allocated based on the population and road miles in each state, and these funds can be spent on any of 10 different focus areas (of which speeding is one) according to a state's Highway Safety Plan. It is not possible to determine, at the national level, how these grants are designated for speeding. In contrast, National Priority Safety Programs funds are directed toward seven different priority areas, the funding level for each priority area (rather than the overall total) is established by Congress, and each priority area has specific eligibility requirements that incentivize states to conduct particular traffic safety activities.[70] Speeding is not one of the seven priority areas. Table 9 shows how funds for these programs were allocated in fiscal year 2016.

Table 9. Federal funds allocated to states for behavioral traffic safety programs, fiscal year 2016

Program	Focus/Priority Area	Allocated Funds[b]	
		Amount ($)	%
Highway Safety Program	(All Grants)	260,034,506	44.8
National Priority Safety Programs	Impaired Driving[a]	231,558,630	39.9
	Occupant Protection	43,136,833	7.4
	State Traffic Safety Information System Improvements	39,016,291	6.7
	Motorcycle Safety	4,075,075	0.7
	Distracted Driving	2,334,950	0.4
	Graduated Driver Licensing	0	0.0
	Nonmotorized Safety[c]	n/a	n/a
Total		**$580,156,285**	**100.0**

Source: GHSA

[a] Includes open container (23 *CFR* Part 154) and repeat offender (23 *CFR* Part 164) funds.

[b] Excludes Puerto Rico, Guam, American Samoa, US Virgin Islands, and Indian Nations.

[c] Nonmotorized Safety was added as a priority area with the passage of the FAST Act in 2015, and Nonmotorized Safety grants were first awarded in fiscal year 2017.

70 For example, to receive occupant protection funds, all states must meet certain criteria, including participating in the "Click It or Ticket" national campaign. However, states with lower rates of seat belt use must meet additional criteria and their use of the funds is restricted to particular activities involving enforcement, child safety seats, and information systems (23 *CFR* Part 405). Thereby, National Priority Safety Program grants encourage states with lower safety performance to take specific actions to improve their outcomes in each priority area.

The Highway Safety Program allows states significant leeway to spend funds according to their particular traffic safety priorities, including speeding; it does not provide a means to encourage states to focus on national priorities. In contrast, National Priority Safety Program grants are specifically designed to encourage states to focus additional traffic safety efforts in areas of national importance, but these funds currently cannot be used for speed management. The NTSB concludes that current federal-aid programs do not require or incentivize states to fund speed management activities at a level commensurate with the national impact of speeding on fatalities and injuries. Thus, the NTSB recommends that NHTSA establish a program to incentivize state and local speed management activities.

3.5.3 DOT Cross-Agency Coordination

In 2005, the DOT Speed Management Team produced a strategic plan to reduce speeding-related fatalities; that plan was updated in 2014 (DOT 2005; DOT 2014). The 2014 Speed Management Program Plan includes 71 planned actions to be completed within 5 years in the areas of data and data-driven approaches, research and evaluation, technology, enforcement and adjudication, engineering, and education and communications. Twenty-nine of the actions are in “priority areas that warrant immediate, more focused attention,” and 22 of the actions are carryovers from the 2005 plan (DOT 2014).

The focus areas in the Speed Management Program Plan address several of the same safety issues identified in this study, and the planned actions complement the recommendations the NTSB makes as a result. For example, actions related to ASE include developing a model contract for states and municipalities to use when working with a vendor, and identifying “practices that contribute to public acceptance and reinforce fairness” of ASE (DOT 2014). Additionally, actions related to a national traffic safety campaign for speeding include evaluating the existing communications materials, developing new creative concepts, and launching a new communications campaign.

However, progress on the Speed Management Program Plan actions has been slow. Table 10 shows the status of the 71 planned actions as of December 2016, which members of the Speed Management Team manually compiled in response to the NTSB’s request. Halfway through the 5-year plan timeline, 8 of the 71 planned actions have been completed, 35 are ongoing, 25 have yet to start, and 3 actions have been discontinued due to the MAP-21 prohibition on using federal grant funds for ASE.

Table 10. Status of DOT Speed Management Program Plan actions as of December 2016

Status	All Actions		Priority Actions	
	Number	%	Number	%
Discontinued	3	4.2	0	0.0
Pending	25	35.2	7	24.1
Ongoing	35	49.3	18	62.1
Completed	8	11.3	4	13.8
Total	**71**	**100.0**	**29**	**100.0**

Source: DOT Speed Management Team

Members of the DOT Speed Management Team stated that there is no one responsible for tracking the overall progress of the planned actions or ensuring that they are incorporated into DOT agency work plans. Therefore, the NTSB concludes that the DOT Speed Management Program Plan identifies important actions to reduce speeding-related fatalities, but the DOT has not tracked or ensured the timely implementation of these actions. Consequently, the NTSB recommends that the DOT complete the actions called for in its 2014 Speed Management Program Plan, and periodically publish status reports on the progress it has made.

4 Conclusions

4.1 Findings

1. Speed increases the likelihood of serious and fatal crash involvement, although the exact relationship is complex due to many factors.

2. Speed increases the injury severity of a crash.

3. Drivers report understanding that speeding is a threat to safety but acknowledge it is a common driving behavior in the United States.

4. The *Manual on Uniform Traffic Control Devices* guidance for setting speed limits in speed zones is based on the 85th percentile speed, but there is not strong evidence that, within a given traffic flow, the 85th percentile speed equates to the speed with the lowest crash involvement rate on all road types.

5. Unintended consequences of the reliance on using the 85th percentile speed for changing speed limits in speed zones include higher operating speeds and new, higher 85th percentile speeds in the speed zones, and an increase in operating speeds outside the speed zones.

6. Expert systems such as USLIMITS2 can improve the setting of speed limits by allowing traffic engineers to systematically incorporate crash statistics and other factors in addition to the 85th percentile speed, and to validate their engineering studies.

7. The safe system approach to setting speed limits in urban areas is an improvement over conventional approaches because it considers the vulnerability of all road users.

8. Speeding-related performance measures are needed to determine the effectiveness of data-driven, high-visibility enforcement programs and to communicate the value of these programs to law enforcement officers and the public.

9. The involvement of speeding passenger vehicles in fatal crashes is underestimated.

10. The lack of consistent law enforcement reporting of speeding-related crashes hinders the effective implementation of data-driven speed enforcement programs.

11. Automated speed enforcement is an effective countermeasure to reduce speeding-related crashes, fatalities, and injuries.

12. The lack of state-level automated speed enforcement (ASE) enabling legislation, and restrictions on the use of ASE in states where legislation exists, have led to underuse of this effective speeding countermeasure.

13. Federal guidelines for automated speed enforcement (ASE) programs do not reflect the latest technologies and operating practices and are not very effective because their existence is not well known among the ASE program administrators.

14. Point-to-point speed enforcement has been shown to be an effective speeding countermeasure internationally, but it is not currently used in the United States.

15. Intelligent speed adaptation is an effective vehicle technology to reduce speeding.

16. New car safety ratings are effective in incentivizing consumers to purchase passenger vehicles with advanced safety systems.

17. Traffic safety campaigns that include highly publicized, increased enforcement can be an effective speeding countermeasure, but their inconsistent and infrequent use by states hinders their effectiveness.

18. The current level of emphasis on speeding as a national traffic safety issue is lower than warranted and insufficient to achieve the goal of zero traffic fatalities in the United States.

19. Current federal-aid programs do not require or incentivize states to fund speed management activities at a level commensurate with the national impact of speeding on fatalities and injuries.

20. The US Department of Transportation (DOT) Speed Management Program Plan identifies important actions to reduce speeding-related fatalities, but the DOT has not tracked or ensured the timely implementation of these actions.

5 Recommendations

As a result of this safety study, the National Transportation Safety Board makes the following safety recommendations:

To the US Department of Transportation:

> Complete the actions called for in your 2014 Speed Management Program Plan, and periodically publish status reports on the progress you have made. (H-17-18)

To the National Highway Traffic Safety Administration:

> Identify speeding-related performance measures to be used by local law enforcement agencies, including—but not limited to—the numbers and locations of speeding-related crashes of different injury severity levels, speeding citations, and warnings, and establish a consistent method for evaluating data-driven, high-visibility enforcement programs to reduce speeding. Disseminate the performance measures and evaluation method to local law enforcement agencies. (H-17-19)

> Identify best practices for communicating with law enforcement officers and the public about the effectiveness of data-driven, high-visibility enforcement programs to reduce speeding, and disseminate the best practices to local law enforcement agencies. (H-17-20)

> Work with the Governors Highway Safety Association, the International Association of Chiefs of Police, and the National Sheriffs' Association to develop and implement a program to increase the adoption of speeding-related Model Minimum Uniform Crash Criteria Guideline data elements and improve consistency in law enforcement reporting of speeding-related crashes. (H-17-21)

> Work with the Federal Highway Administration to update the Speed Enforcement Camera Systems Operational Guidelines to reflect the latest automated speed enforcement (ASE) technologies and operating practices, and promote the updated guidelines among ASE program administrators. (H-17-22)

> Work with the Federal Highway Administration to assess the effectiveness of point-to-point speed enforcement in the United States and, based on the results of that assessment, update the Speed Enforcement Camera Systems Operational Guidelines, as appropriate. (H-17-23)

> Incentivize passenger vehicle manufacturers and consumers to adopt intelligent speed adaptation (ISA) systems by, for example, including ISA in the New Car Assessment Program. (H-17-24)

Collaborate with other traffic safety stakeholders to develop and implement an ongoing program to increase public awareness of speeding as a national traffic safety issue. The program should include, but not be limited to, initiating an annual enforcement mobilization directed at speeding drivers. (H-17-25)

Establish a program to incentivize state and local speed management activities. (H-17-26)

To the Federal Highway Administration:

Revise Section 2B.13 of the Manual on Uniform Traffic Control Devices so that the factors currently listed as optional for all engineering studies are required, require that an expert system such as USLIMITS2 be used as a validation tool, and remove the guidance that speed limits in speed zones should be within 5 mph of the 85th percentile speed. (H-17-27)

Revise Section 2B.13 of the Manual on Uniform Traffic Control Devices to, at a minimum, incorporate the safe system approach for urban roads to strengthen protection for vulnerable road users. (H-17-28)

Work with the National Highway Traffic Safety Administration to update the Speed Enforcement Camera Systems Operational Guidelines to reflect the latest automated speed enforcement (ASE) technologies and operating practices, and promote the updated guidelines among ASE program administrators. (H-17-29)

Work with the National Highway Traffic Safety Administration to assess the effectiveness of point-to-point speed enforcement in the United States and, based on the results of that assessment, update the Speed Enforcement Camera Systems Operational Guidelines, as appropriate. (H-17-30)

To the seven states prohibiting automated speed enforcement:

Amend current laws to authorize state and local agencies to use automated speed enforcement. (H-17-31)

To the 28 states without automated speed enforcement laws:

Authorize state and local agencies to use automated speed enforcement. (H-17-32)

To the 15 states with automated speed enforcement restrictions:

Amend current laws to remove operational and location restrictions on the use of automated speed enforcement, except where such restrictions are necessary to align with best practices. (H-17-33)

To the Governors Highway Safety Association:

Work with the National Highway Traffic Safety Administration, the International Association of Chiefs of Police, and the National Sheriffs' Association to develop and implement a program to increase the adoption of speeding-related Model Minimum Uniform Crash Criteria Guideline data elements and improve consistency in law enforcement reporting of speeding-related crashes. (H-17-34)

To the International Association of Chiefs of Police:

Work with the National Highway Traffic Safety Administration, the Governors Highway Safety Association, and the National Sheriffs' Association to develop and implement a program to increase the adoption of speeding-related Model Minimum Uniform Crash Criteria Guideline data elements and improve consistency in law enforcement reporting of speeding-related crashes. (H-17-35)

To the National Sheriffs' Association:

Work with the National Highway Traffic Safety Administration, the Governors Highway Safety Association, and the International Association of Chiefs of Police to develop and implement a program to increase the adoption of speeding-related Model Minimum Uniform Crash Criteria Guideline data elements and improve consistency in law enforcement reporting of speeding-related crashes. (H-17-36)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

ROBERT L. SUMWALT, III
Acting Chairman

CHRISTOPHER A. HART
Member

EARL F. WEENER
Member

T. BELLA DINH-ZARR
Member

Adopted: July 25, 2017

Board Member Statement

Member T. Bella Dinh-Zarr filed the following statement on August 1, 2017, concurring in part and dissenting in part:

Speeding has long been an important but difficult safety issue to address. This publication is the first study on speeding undertaken by the NTSB in our 50-year history. I commend staff for proposing and completing this study and for their careful analysis of current research. As staff explained in response to my questions during the Board Meeting, this study was meant to cover certain aspects of speeding and certain solutions. Nevertheless, although it does not appear in the Executive Summary and Conclusions, it is important to underscore that the full report does briefly review two topics of great interest and importance: road design and vulnerable road users. I would like to further discuss these issues and their importance to speeding and to preventing speeding-related deaths and injuries.

Road design is integral to the analysis of speeding and, while the report focuses on countermeasures that staff considered less widely accepted, it is important to note that road design to address speed-related crashes is not yet widely *implemented*, but should be. Some states (and other types of jurisdictions such as cities and counties) are already addressing speed-related crashes using road design, by using FARS data related to infrastructure and other data-driven measures. Other states can learn from them. Some states, as I have seen first-hand, are already including speed as an emphasis area in their Strategic Highway Safety Plans (SHSP). Some jurisdictions are using AASHTO's Green Book and other design manuals and some jurisdictions are using road design features that enhance compliance for lower speed limits rather than simply lowering speed limits. Federal government agencies can, and should, be given the ability to foster these types of best practices in which jurisdictions take a systemic approach to identifying locations prone to speeding-related crashes and correcting them in the manner they have determined is most effective using data.

Although this report focuses on passenger vehicles, current discussions about speeding must necessarily include people who walk and bike. The safe systems approach discussed in the report incorporates the needs of all road users, especially vulnerable ones. It is widely acknowledged among road safety professionals that interventions that prevent the deaths of the most vulnerable road users will benefit *all* road users. Some states and other jurisdictions have acknowledged this safety tenet by including pedestrians and cyclists in their SHSPs. Other jurisdictions should be encouraged to follow these best practice examples.

Overall, it is important to recognize that states, cities, and other jurisdictions already may be addressing speed in effective ways – even if we were not able to include it in our report due to the focus. Automated speed enforcement (ASE) was covered thoroughly in the report and three different recommendations were made to states, depending on the status of their laws related to ASE. I proposed, and still strongly believe, that combining the 3 recommendations into one recommendation to all 50 states and D.C. to examine current laws and implement ASE "to the fullest extent possible" would allow each state to advance ASE and safety most effectively, rather than focusing simply on reducing the prohibitions to ASE. By allowing states the freedom to be creative in implementing an effective technology (such as ASE), we are giving states a proven safety tool rather than prescriptively telling states how to use it. States (and other jurisdictions) know their communities best and our safety recommendations should give them the information and the freedom to advance safety in the manner they choose.

Appendixes

Appendix A: Speeding-Related National Transportation Safety Board Investigations

Table A-1 lists 49 National Transportation Safety Board (NTSB) major highway investigations in which speeding or speed was found to be a safety issue, or a causal or contributing factor.

Table A-1. Speeding-related NTSB major highway investigations

Date	Location	Description	Report Number
6/25/2015	Chattanooga, TN	Multivehicle Work Zone Crash on Interstate 75	HAR-16/01
6/7/2014	Cranbury, NJ	Multivehicle Work Zone Crash on Interstate 95	HAR-15/02
2/16/2012	Chesterfield, NJ	School Bus and Truck Collision at Intersection	HAR-13/01
3/12/2011	New York City, NY	Motorcoach Run-Off-the-Road and Collision with Vertical Highway Signpost, Interstate 95 Southbound	HAR-12/01
1/6/2008	Mexican Hat, UT	Motorcoach Rollover	HAR-09/01
10/1/2003	Hampshire, IL	Multivehicle Collision on Interstate 90, Hampshire-Marengo Toll Plaza	HAR-06/03
5/1/2003	Linden, NJ	Passenger Vehicle Median Crossover and Head-On with Another Passenger Vehicle	HAR-06/02
2/14/2003	Hewitt, TX	Motorcoach Median Crossover and Collision with Sport Utility Vehicle	HAR-05/02
1/17/2003	Fairfield, CT	Multiple Vehicle Collision on Interstate 95	HAR-05/03
2/1/2002	Largo, MD	Ford Explorer Sport Collision with Ford Windstar Minivan and Jeep Grand Cherokee on Interstate 95/495	HAR-03/02
10/13/2001	Omaha, NE	School Bus Run-Off-Bridge Accident	HAR-04/01
2/12/1997	Slinger, WI	Multiple Vehicle Crossover Accident	HAR-98/01
1/9/1995	Menifee, AR	Multiple Vehicle Collision with Fire During Fog near Milepost 118 on Interstate 40	HAR-95/03
12/11/1990	Calhoun, TN	Multiple-Vehicle Collisions and Fire During Limited Visibility on Interstate 75	HAR-92/02
7/26/1990	Sutton, WV	Multiple Vehicle Collision and Fire in a Work Zone on Interstate Highway 79	HAR-91/01
11/19/1988	Nashville, TN	Greyhound Lines, Inc., Intercity Bus Loss of Control and Overturn Interstate Highway 95	HAR-89/03
5/4/1987	Beaumont, TX	Tractor-Semitrailer/Intercity Bus Head-On Collision, Interstate 10	HAR-88/01
9/29/1986	Carney's Point, NJ	Charter Bus/Tractor-Semitrailer Rear-End Collision	HAR-87/03
7/14/1986	Brinkley, AR	Trailways Lines, Inc., Intercity Bus Collision with Rising Fast Trucking Company, Inc., Interstate Highway 40	HAR-87/05
5/30/1986	Walker, CA	Intercity Tour Bus Loss of Control and Rollover Into the West Walker River	HAR-87/04

Date	Location	Description	Report Number
11/11/1985	St. Louis County, MO	Schoolbus Loss of Control and Collision with Guard Rail and Sign Pillar, US Highway 70 near Lucas and Hunt Road	HAR-87/02
8/25/1985	Frederick, MD	Intercity Bus Loss of Control and Collision with Bridge Rail on Interstate 70	HAR-87/01
6/21/1985	Van Buren, AR	Tractor-Semitrailer/Station Wagon Runaway, Collision, and Fire	HAR-86/03
11/30/1983	Livingston, TX	Trailways Lines, Inc., Bus/E.A. Holder, Inc., Truck, Rear End Collision and Bus Run-Off-Bridge, US Route 59	HAR-84/04
4/5/1983	Holmesville, NY	Valley Supply Co. Truck Towing Farm Plow/Anchor Motor Freight Inc. Car Carrier Truck/New York State Association for Retarded Children Bus Collision and Fire, State Route 8	HAR-84/01
3/25/1983	Newport, AR	Jonesboro School District Schoolbus Run-Off-Road and Overturn, State Highway 214 at State Highway 18	HAR-83/03
2/28/1983	Ocala, FL	Multiple Vehicle Collisions and Fires Under Limited Visibility Conditions, Interstate Route 75	HAR-83/04
10/8/1982	Lemoore, CA	J.C. Sales, Inc., Tractor-Semi-Trailer/Calvary Baptist Church Van Collision, State Route 198 at 19th Avenue	HAR-83/02
4/7/1982	Oakland, CA	Multiple Vehicle Collisions and Fire, Caldecott Tunnel	HAR-83/01
11/14/1981	Canon City, UT	Pacific Intermountain Express Tractor Cargo Tank Semitrailer Eagle/F.B. Truck Lines, Inc., Tractor Lowboy Semitrailer Collision and Fire, US Route 50	HAR-82/03
2/18/1981	Frostburg, MD	Direct Transit Lines, Inc., Tractor-Semitrailer/Multiple Vehicle Collision and Fire, US Route 40	HAR-81/03
11/10/1980	San Bernardino, CA	Multiple Vehicle Collisions and Fire in Fog, Interstate 50	HAR-81/02
2/23/1980	Perry, OK	Head-On Collision of Auto and Pickup Truck, US Route 64	HAR-80/04
9/22/1979	Indiana, PA	Two-Vehicle Collision and Fire, US Route 422	HAR-80/03
8/22/1979	Laramie, WY	Multiple Vehicle Collision in a Construction Zone, US Interstate 80	HAR-80/01
6/8/1979	New York, NY	Multiple Vehicle Median Barrier Crossover and Collision, Grand Central Parkway	HAR-79/08
4/23/1979	Crofton, MD	Ford Courier Pickup Truck/Fixed Object Collision, Patuxent Road	HAR-79/06
11/11/1978	Alhambra, CA	Stationwagon Penetration of Bridgerail, I-10	HAR-79/05
8/22/1978	Littleton, NH	Ross Ambulance Service, Ambulance Overturn, State Route 116	HAR-79/04
9/25/1977	St. Louis, MO	Gateway Transportation Company, Inc., Tractor-Semitrailer Penetration of Median Barrier and Collision with Automobile, I-70	HAR-79/03
9/24/1977	Beattyville, KY	Usher Transport, Inc., Tractor-Cargo-Tank-Semitrailer Overturn and Fire, State Route 11	HAR-78/04
5/11/1976	Houston, TX	Transport Company of Texas, Tractor Semitrailer (Tank) Collision with Bridge Column and Sudden Dispersal of Anhydrous Ammonia Cargo	HAR-77/01

Date	Location	Description	Report Number
12/4/1975	Seattle, WA	Union Oil Company of California, Tank Truck and Full Trailer Overturn and Fire	HAR-76/07
6/6/1975	Hamilton, GA	Collision of Hubert Roten Trucking Company Truck and Skinner Corporation Bus	HAR-76/05
2/28/1975	Corona, CA	Multiple Vehicle Collisions in Fog	HAR-75/07
7/11/1970	San Francisco, CA	Two Car Collision, Southern Approach to Golden Gate Bridge	HAR-71/05
11/29/1969	New Jersey Turnpike, NJ	Multiple Vehicle Collisions Under Fog Conditions, Followed by Fires	HAR-71/03
11/24/1969	Petersburg, IN	Interstate Bus/Automobile Collision and Rollover on Indiana Route 57	HAR-71/04
8/12/1967	Joliet, IL	Motor Carrier Highway Accident	HAR-1967

Appendix B: Road Function Classifications

This appendix summarizes the Federal Highway Administration guidance on road function classification for arterial, collector, and local roads, and provides the corresponding attributes of the "road_fnc" data element in the Fatality Analysis Reporting System (FARS) database (FHWA 2013; NHTSA 2015a).

Arterials

Arterials are roadways that provide a high level of mobility, primarily serve long-distance travel, are typically designed as either access-controlled or partially access-controlled, and have higher posted speed limits than most other types of roads. Principal arterials and minor arterials are subcategories of arterials.

Principal arterials include interstates (which are access-controlled), other freeways and expressways (which look very similar to interstates and are also access-controlled), and other principal arterials (which are unlike interstates and other freeways and expressways in that abutting land uses can be served directly). Table B-1 shows roadway characteristics and FARS attributes of principal arterials by land use.

Table B-1. Roadway characteristics and FARS attributes for principal arterials, by land use

Principal Arterials	Land Use	
	Urban	Rural
Roadway Characteristics	• Serve major activity centers, highest traffic volume corridors and longest trip demands • Carry high proportion of total urban travel on minimum of mileage • Interconnect and provide continuity for major rural corridors to accommodate trips entering and leaving urban area and movements through the urban area • Serve demand for intra-area travel between the central business district and outlying residential areas	• Serve corridor movements having trip length and travel density characteristics indicative of substantial statewide or interstate travel • Connect all or nearly all urbanized areas and a large majority of urban clusters with 25,000 and over population • Provide an integrated network of continuous routes without stub connections (that is, dead ends)
FARS "road_fnc" Attributes	• Interstates (11) • Other freeways and expressways (12) • Other principal arterials (13)	• Interstates (1) • Other principal arterials (2)

Minor arterials provide service for trips of moderate length, serve geographic areas that are smaller than their principal arterial counterparts, and offer connectivity to the principal arterial system. Table B-2 shows roadway characteristics and FARS attributes of minor arterials by land use.

Table B-2. Roadway characteristics and FARS attributes for minor arterials, by land use

Minor Arterials	**Land Use**	
	Urban	**Rural**
Roadway Characteristics	• Interconnect and augment the higher-level arterials • Serve trips of moderate length at a somewhat lower level of travel mobility than principal arterials • Distribute traffic to smaller geographic areas than those served by higher-level arterials • Provide more land access than principal arterials without penetrating identifiable neighborhoods • Provide urban connections for rural collectors	• Link cities and larger towns (and other major destinations such as resorts capable of attracting travel over long distances) and form an integrated network providing interstate and inter-county service • Be spaced at intervals, consistent with population density, so that all developed areas within the state are within a reasonable distance of an arterial roadway • Provide service to corridors with trip lengths and travel density greater than those served by rural collectors and local roads and with relatively high travel speeds and minimum interference to through movement
FARS "road_fnc" Attributes	• Minor arterial (14)	• Minor arterial (3)

Collectors

Collectors provide a balanced blend of mobility and access; collect traffic from local roads; connect traffic to arterial roadways; and provide traffic circulation within residential neighborhoods and commercial, industrial, and civic districts. Major collectors and minor collectors are subcategories of collectors. Table B-3 shows roadway characteristics and FARS attributes for major collectors by land use. Table B-4 shows roadway characteristics and FARS attributes for minor collectors by land use.

Table B-3. Roadway characteristics and FARS attributes for major collectors, by land use

Major Collectors	Land Use	
	Urban	**Rural**
Roadway Characteristics	• Serve both land access and traffic circulation in higher density residential, and commercial/industrial areas • Penetrate residential neighborhoods, often for significant distances • Distribute and channel trips between local roads and arterials, usually over a distance of greater than three-quarters of a mile • Operating characteristics include higher speeds and more signalized intersections	• Provide service to any county seat not on an arterial route, to the larger towns not directly served by the higher systems and to other traffic generators of equivalent intra-county importance such as consolidated schools, shipping points, county parks, and important mining and agricultural areas • Link these places with nearby larger towns and cities or with arterial routes • Serve the most important intra-county travel corridors
FARS "road_fnc" Attributes	• Collector (15)	• Major collector (4)

Table B-4. Roadway characteristics and FARS attributes for minor collectors, by land use

Minor Collectors	Land Use	
	Urban	**Rural**
Roadway Characteristics	• Serve both land access and traffic circulation in lower density residential and commercial/industrial areas • Penetrate residential neighborhoods, often only for a short distance • Distribute and channel trips between local roads and arterials, usually over a distance of less than three-quarters of a mile • Operating characteristics include lower speeds and fewer signalized intersections	• Be spaced at intervals, consistent with population density, to collect traffic from local roads and bring all developed areas within reasonable distance of a collector • Provide service to smaller communities not served by a higher-class facility • Link locally important traffic generators with their rural hinterlands
FARS "road_fnc" Attributes	• Collector (15)	• Minor collector (5)

Locals

Local roadways provide a high level of accessibility and direct access to multiple properties. They are lined with intersecting access points and constitute the mileage not classified as part of the arterial or collector systems. Speed limits on local roads are kept low to promote safe traffic operations. Table B-5 shows roadway characteristics and FARS attributes of locals, by land use.

Table B-5. Roadway characteristics and FARS attributes of locals, by land use

Locals	Land Use	
	Urban	**Rural**
Roadway Characteristics	• Provide direct access to adjacent land • Provide access to higher systems • Carry no through traffic movement	• Serve primarily to provide access to adjacent land • Provide service to travel over short distances as compared to higher classification categories
FARS "road_fnc" Attributes	• Local road and street (16)	• Local road and street (6)

Appendix C: *Manual on Uniform Traffic Control Devices* Speed Limit Guidance

This appendix includes Section 2B.13 of the *Manual on Uniform Traffic Control Devices*, which serves as the standard for setting speed limits in speed zones (FHWA 2012a).

02 Highway agencies may develop and apply criteria for determining the applicability of In-Street Pedestrian Crossing signs.

Standard:

03 **If used, the In-Street Pedestrian Crossing sign shall be placed in the roadway at the crosswalk location on the center line, on a lane line, or on a median island. The In-Street Pedestrian Crossing sign shall not be post-mounted on the left-hand or right-hand side of the roadway.**

04 **If used, the Overhead Pedestrian Crossing sign shall be placed over the roadway at the crosswalk location.**

05 **An In-Street or Overhead Pedestrian Crossing sign shall not be placed in advance of the crosswalk to educate road users about the State law prior to reaching the crosswalk, nor shall it be installed as an educational display that is not near any crosswalk.**

Guidance:

06 *If an island (see Chapter 3I) is available, the In-Street Pedestrian Crossing sign, if used, should be placed on the island.*

Option:

07 If a Pedestrian Crossing (W11-2) warning sign is used in combination with an In-Street or an Overhead Pedestrian Crossing sign, the W11-2 sign with a diagonal downward pointing arrow (W16-7P) plaque may be post-mounted on the right-hand side of the roadway at the crosswalk location.

Standard:

08 **The In-Street Pedestrian Crossing sign and the Overhead Pedestrian Crossing sign shall not be used at signalized locations.**

09 **The STOP FOR legend shall only be used in States where the State law specifically requires that a driver must stop for a pedestrian in a crosswalk.**

10 **The In-Street Pedestrian Crossing sign shall have a black legend (except for the red STOP or YIELD sign symbols) and border on a white background, surrounded by an outer yellow or fluorescent yellow-green background area (see Figure 2B-2). The Overhead Pedestrian Crossing sign shall have a black legend and border on a yellow or fluorescent yellow-green background at the top of the sign and a black legend and border on a white background at the bottom of the sign (see Figure 2B-2).**

11 **Unless the In-Street Pedestrian Crossing sign is placed on a physical island, the sign support shall be designed to bend over and then bounce back to its normal vertical position when struck by a vehicle.**

Support:

12 The Provisions of Section 2A.18 concerning mounting height are not applicable for the In-Street Pedestrian Crossing sign.

Standard:

13 **The top of an In-Street Pedestrian Crossing sign shall be a maximum of 4 feet above the pavement surface. The top of an In-Street Pedestrian Crossing sign placed in an island shall be a maximum of 4 feet above the island surface.**

Option:

14 The In-Street Pedestrian Crossing sign may be used seasonably to prevent damage in winter because of plowing operations, and may be removed at night if the pedestrian activity at night is minimal.

15 In-Street Pedestrian Crossing signs, Overhead Pedestrian Crossing signs, and Yield Here To (Stop Here For) Pedestrians signs may be used together at the same crosswalk.

Section 2B.13 Speed Limit Sign (R2-1)

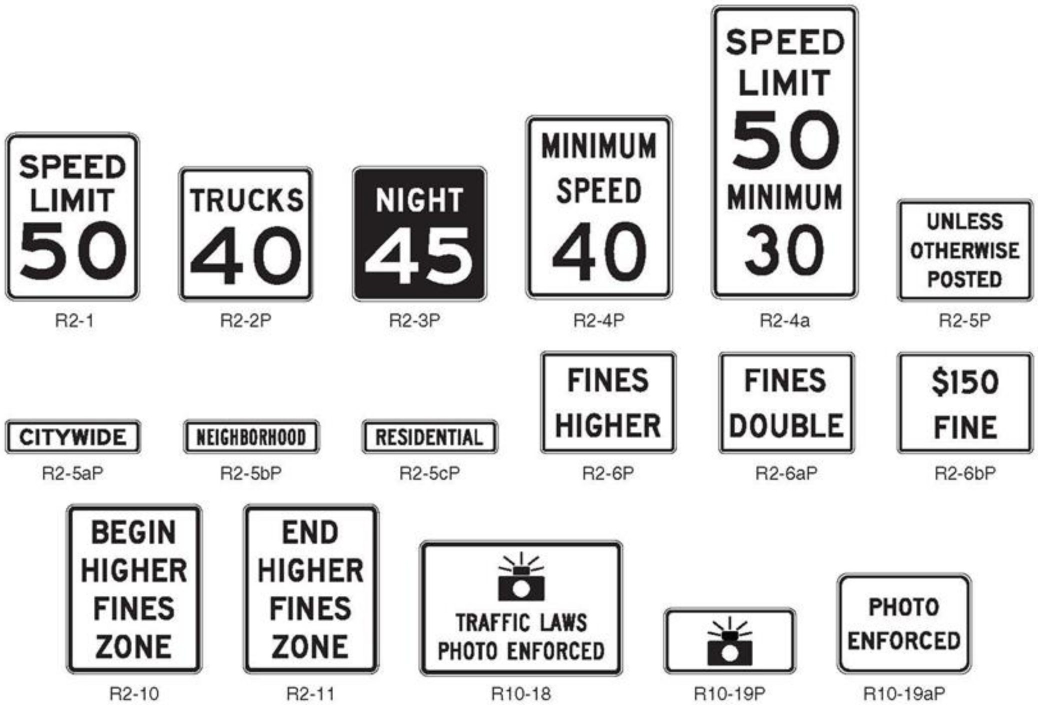
Standard:

01 **Speed zones (other than statutory speed limits) shall only be established on the basis of an engineering study that has been performed in accordance with traffic engineering practices. The engineering study shall include an analysis of the current speed distribution of free-flowing vehicles.**

02 **The Speed Limit (R2-1) sign (see Figure 2B-3) shall display the limit established by law, ordinance, regulation, or as adopted by the authorized agency based on the engineering study. The speed limits displayed shall be in multiples of 5 mph.**

03 **Speed Limit (R2-1) signs, indicating speed limits for which posting is required by law, shall be located at the points of change from one speed limit to another.**

Figure 2B-3. Speed Limit and Photo Enforcement Signs and Plaques



04 **At the downstream end of the section to which a speed limit applies, a Speed Limit sign showing the next speed limit shall be installed. Additional Speed Limit signs shall be installed beyond major intersections and at other locations where it is necessary to remind road users of the speed limit that is applicable.**

05 **Speed Limit signs indicating the statutory speed limits shall be installed at entrances to the State and, where appropriate, at jurisdictional boundaries in urban areas.**

Support:

06 In general, the maximum speed limits applicable to rural and urban roads are established:

A. Statutorily – a maximum speed limit applicable to a particular class of road, such as freeways or city streets, that is established by State law; or
B. As altered speed zones – based on engineering studies.

07 State statutory limits might restrict the maximum speed limit that can be established on a particular road, notwithstanding what an engineering study might indicate.

Option:

08 If a jurisdiction has a policy of installing Speed Limit signs in accordance with statutory requirements only on the streets that enter a city, neighborhood, or residential area to indicate the speed limit that is applicable to the entire city, neighborhood, or residential area unless otherwise posted, a CITYWIDE (R2-5aP), NEIGHBORHOOD (R2-5bP), or RESIDENTIAL (R2-5cP) plaque may be mounted above the Speed Limit sign and an UNLESS OTHERWISE POSTED (R2-5P) plaque may be mounted below the Speed Limit sign (see Figure 2B-3).

Guidance:

09 *A Reduced Speed Limit Ahead (W3-5 or W3-5a) sign (see Section 2C.38) should be used to inform road users of a reduced speed zone where the speed limit is being reduced by more than 10 mph, or where engineering judgment indicates the need for advance notice to comply with the posted speed limit ahead.*

10 *States and local agencies should conduct engineering studies to reevaluate non-statutory speed limits on segments of their roadways that have undergone significant changes since the last review, such as the addition or elimination of parking or driveways, changes in the number of travel lanes, changes in the configuration of bicycle lanes, changes in traffic control signal coordination, or significant changes in traffic volumes.*

11 *No more than three speed limits should be displayed on any one Speed Limit sign or assembly.*

12 *When a speed limit within a speed zone is posted, it should be within 5 mph of the 85th-percentile speed of free-flowing traffic.*

13 *Speed studies for signalized intersection approaches should be taken outside the influence area of the traffic control signal, which is generally considered to be approximately 1/2 mile, to avoid obtaining skewed results for the 85th-percentile speed.*

Support:

14 Advance warning signs and other traffic control devices to attract the motorist's attention to a signalized intersection are usually more effective than a reduced speed limit zone.

Guidance:

15 *An advisory speed plaque (see Section 2C.08) mounted below a warning sign should be used to warn road users of an advisory speed for a roadway condition. A Speed Limit sign should not be used for this situation.*

Option:

16 Other factors that may be considered when establishing or reevaluating speed limits are the following:

A. Road characteristics, shoulder condition, grade, alignment, and sight distance;
B. The pace;
C. Roadside development and environment;
D. Parking practices and pedestrian activity; and
E. Reported crash experience for at least a 12-month period.

17 Two types of Speed Limit signs may be used: one to designate passenger car speeds, including any nighttime information or minimum speed limit that might apply; and the other to show any special speed limits for trucks and other vehicles.

18 A changeable message sign that changes the speed limit for traffic and ambient conditions may be installed provided that the appropriate speed limit is displayed at the proper times.

19 A changeable message sign that displays to approaching drivers the speed at which they are traveling may be installed in conjunction with a Speed Limit sign.

Guidance:

20 *If a changeable message sign displaying approach speeds is installed, the legend YOUR SPEED XX MPH or such similar legend should be displayed. The color of the changeable message legend should be a yellow legend on a black background or the reverse of these colors.*

Support:

21 Advisory Speed signs and plaques are discussed in Sections 2C.08 and 2C.14. Temporary Traffic Control Zone Speed signs are discussed in Part 6. The WORK ZONE (G20-5aP) plaque intended for installation above a Speed Limit sign is discussed in Section 6F.12. School Speed Limit signs are discussed in Section 7B.15.

Section 2B.14 Truck Speed Limit Plaque (R2-2P)

Standard:

01 **Where a special speed limit applies to trucks or other vehicles, the legend TRUCKS XX or such similar legend shall be displayed below the legend Speed Limit XX on the same sign or on a separate R2-2P plaque (see Figure 2B-3) below the standard legend.**

Section 2B.15 Night Speed Limit Plaque (R2-3P)

Standard:

01 **Where different speed limits are prescribed for day and night, both limits shall be posted.**

Appendix D: Speeding Categories

This appendix lists the attributes of the "speeding related" data element in the *Model Minimum Uniform Crash Criteria* (*MMUCC*) *Guideline* and the corresponding attributes of the "speedrel" data element in the Fatality Analysis Reporting System (FARS) database. The *MMUCC Guideline* and FARS definitions for speeding are both based on the determination of officers, with the *MMUCC Guideline* stating that these categories are an "indication of whether the investigating officer suspects that the driver involved in the crash was speeding based on verbal or physical evidence and not on speculation alone," and FARS documentation stating that each category "records whether the driver's speed was related to the crash as indicated by law enforcement" (GHSA and NHTSA 2012; NHTSA 2015a). See table D-1.

Table D-1. Speeding categories in *MMUCC Guideline* and FARS database

Speeding Category	***MMUCC Guideline* "speeding related" Data Element**		**FARS "speedrel" Data Element**
	Attribute	**Definition**	**Attribute**
Not Speeding	No	(none)	No
Exceeding Speed Limit	Exceeded Speed Limit	When a motor vehicle is traveling above the posted/statutory speed limit on certain designated roadways or by certain types of vehicles (for example, for trucks, buses, motorcycles, on bridge, at night, in school zone, and so on)	Yes, Exceeded Speed Limit
Too Fast for Conditions	Too Fast for Conditions	Traveling at a speed that was unsafe for the road, weather, traffic or other environmental conditions at the time	Yes, Too Fast for Conditions
Racing	Racing	When two or more motor vehicles are engaged in a speed-related competition on the trafficway	Yes, Racing
Speeding of Unspecific Type	n/a	n/a	Yes, Specifics Unknown
No Driver Information	n/a	n/a	No Driver Present / Unknown if Driver Present
Unknown if Speeding	Unknown	(none)	Unknown

Appendix E: State Laws Regarding Automated Speed Enforcement

Table E-1 summarizes state laws regarding automated speed enforcement (ASE) and notes whether any ASE programs are active in each state (IIHS 2016a). The District of Columbia allows ASE throughout its jurisdiction and operates an ASE program.

Table E-1. ASE state laws and active programs, April 2017

State	ASE State Law	Active ASE Programs	Notes
Alabama	No state law	Yes	
Alaska	No state law	No	
Arizona	Allowed with restrictions	Yes	Prohibited on state highways; contractors must be licensed as private investigators,
Arkansas	Allowed with restrictions	No	Officer must be present and citation issued at time of violation
California	No state law	No	
Colorado	Allowed with restrictions	Yes	Restricted to construction and school zones, residential areas, and streets that border a municipal park; officer or government employee must be present at time of violation.
Connecticut	No state law	No	
Delaware	No state law	No	
Florida	No state law	No	
Georgia	No state law	No	
Hawaii	No state law	No	
Idaho	No state law	No	
Illinois	Allowed with restrictions	Yes	Restricted to construction zones; allowed in school zones and park districts in municipalities with a population of 1,000,000 or more
Indiana	No state law	No	
Iowa	No state law	Yes	
Kansas	No state law	No	
Kentucky	No state law	No	
Louisiana	Allowed with restrictions	Yes	Restricted to specified jurisdictions and interstate work zones
Maine	Prohibited	No	
Maryland	Allowed with restrictions	Yes	Restricted to school zones, work zones on expressways or controlled access highways, and Montgomery County residential areas
Massachusetts	No state law	No	
Michigan	No state law	No	
Minnesota	No state law	No	
Mississippi	Prohibited	No	
Missouri	No state law	Yes	

State	ASE State Law	Active ASE Programs	Notes
Montana	No state law	No	
Nebraska	No state law	No	
Nevada	Allowed with restrictions	No	Equipment must be hand-held by officer or installed within law enforcement vehicle or facility
New Hampshire	Prohibited	No	
New Jersey	Prohibited	No	
New Mexico	No state law	Yes	
New York	Allowed with restrictions	Yes	Restricted to specified jurisdictions
North Carolina	No state law	No	
North Dakota	No state law	No	
Ohio	Allowed with restrictions	Yes	Officer must be present
Oklahoma	No state law	No	
Oregon	Allowed with restrictions	Yes	Restricted to specified jurisdictions, state highway construction zones, and Portland urban high crash corridors
Pennsylvania	No state law	No	
Rhode Island	Allowed with restrictions	No	Restricted to school zones
South Carolina	Allowed with restrictions	No	Restricted to use during declared states of emergency
South Dakota	No state law	No	
Tennessee	Allowed with restrictions	Yes	Restricted to school zones and s-curves inhibiting driver vision
Texas	Prohibited	No	
Utah	Allowed with restrictions	No	Restricted to school zones with speed limit of 30 mph or lower; officer must be present
Vermont	No state law	No	
Virginia	No state law	No	
Washington	Allowed with restrictions	Yes	Restricted to school zones and a single camera for any city west of the Cascade mountains with a population of more than 195,000 located in a county with a population of fewer than 1,500,000
West Virginia	Prohibited	No	
Wisconsin	Prohibited	No	
Wyoming	No state law	No	

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