REPORT OF THE
VIRGINIA DEPARTMENT OF TRANSPORTATION ON

THE SPECIAL TASK FORCE STUDYING SAFE MAXIMUM HIGHWAY SPEED LIMITS

TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA

SENATE DOCUMENT NO. 17

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PREFACE

Secretary of Transportation Robert E. Martínez was asked by the 1996 General Assembly through Senate Joint Resolution 7 (SJR 7) to convene a Special Task Force for the purpose of recommending appropriate maximum highway speed limits for the various classifications of highways and types of vehicles within the Commonwealth. The Special Task Force was asked to assess the standards used to set speed limits and establish sound, rational and objective criteria to facilitate setting maximum safe speed limits.

Members of the Special Task Force included:

Shirley J. Ybarra, Deputy Secretary of Transportation
P. Dale Bennett, Virginia Trucking Association
Philip A. Broadfoot, Waynesboro Chief of Police
Captain Tom A. Clark, Henrico County Division of Police
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Farrar W. Howard, Jr., Virginia Sheriffs' Association
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Staff support to assist the Special Task Force included representatives of the Virginia Department of Transportation's Office of Policy Analysis and Traffic Engineering Division and the Virginia Transportation Research Council.

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EXECUTIVE SUMMARY

Background

In November 1995, Congress repealed the law that required that states adhere to national maximum speed limits (NMSL) as a condition of receiving Federal-aid highway assistance and returned to states the authority to set their own speed limits when it passed the National Highway System Designation Act of 1995. Federally established maximum speed limits had been set at 65 mph on rural Interstate-quality roads and at 55 mph on all other routes. The repeal of the NMSL allows each state to set any speed limit it wants, or no speed limit at all.

Until the 1970s, states were empowered to establish their own speed limits. With the passage of the Emergency Highway Energy Conservation Act in 1974, Congress set the first national speed limit at 55 mph. The speed limit was imposed as a temporary fuel-savings measure in response to the OPEC oil embargo and made permanent by an act of Congress in 1975.

Since the elimination of the Federal mandated speed limit in November 1995, 21 states already have increased their maximum speeds beyond 65 mph. The states in which the speed limits have been raised are predominantly western, but a number of southern and midwestern states have raised their speed limits as well. For example, Florida, Georgia, Mississippi, Missouri, North Carolina, Oklahoma, Texas and Kansas all have raised their speed limits. Seven other states, Delaware, Illinois, Iowa, Massachusetts, New York, Wisconsin and Maryland, did not increase the maximum speed beyond 65 mph, but expanded the system of routes on which vehicles can travel 65 mph.

Senate Joint Resolution 7

Senate Joint Resolution (SJR) 7 was introduced by Senator Waddell and passed by the 1996 General Assembly to determine whether speed limits in Virginia should be changed and to ensure sound, rational and objective criteria are used to set maximum safe speed limits on the various classifications of highways.

A Special Task Force was convened for the purpose of recommending appropriate maximum highway speed limits for the various classifications of highways and types of vehicles within the Commonwealth based on sound, rational, and objective criteria. The Task Force was composed of representatives of the Commonwealth Transportation Board, the Virginia Department of Transportation (VDOT), the Virginia Transportation Safety Board, the Virginia State Police, the Crash Investigation Team of Virginia Commonwealth University, the Virginia Transportation Research Council (VTRC), the Virginia Association of Counties, the Virginia Municipal League, the Virginia Association of Sheriffs, the Virginia Association of Chiefs of Police, and the American Automobile Association.

Study Methods

This report presents a review of the literature dealing with speed limits. There is a large base of data assessing the impacts of the 55 mph speed limit, most of the research for which was conducted between the mid-1970s and the mid-1980s. In addition, there are a number of studies that evaluated the effects of raising speed limits on rural Interstates in the late 1980s. However, because the National Highway System Designation Act passed less than a year ago, there is limited information regarding the effects of changes that have taken place since that time. Where possible, researchers used Virginia data to supplement a review of the literature on a given issue.

Setting Speed Limits

The factors normally taken into consideration by traffic engineers in setting speed limits can be divided into the following four general categories:

1. Prevailing vehicle speeds and 85th percentile speeds.
2. Design speed and other physical features.
3. Crash history.
4. Traffic characteristics.

The 85th percentile speed is the speed at or below which 85% of the drivers travel a specific section of highway. This speed has been selected by traffic engineers as the maximum speed limit for two reasons. It is postulated that most drivers are reasonable and do not want to be involved in a crash and will, therefore, usually select a speed that in their judgment is safe for the prevailing geometric, traffic and environmental conditions.

The suitability of the 85th percentile speed as the maximum safe speed has been supported by studies carried out by several researchers. Cirillo (1968) and Solomon (1964) showed that crash involvement rates are lowest at the 85th percentile speed and that crash risk increases significantly at speeds higher or lower than the 85th percentile value because speed variance is minimized at the 85th percentile speed. The selection of the 85th percentile speed as the maximum speed limit on specific sections of highways seems reasonable both in terms of safety and drivers' desire, and has become a nationally accepted criterion for setting speed limits.

Most research indicates that higher speed variance usually is associated with higher crash rates. One explanation for this is that the crash involvement rate also is correlated with the number of overtaking maneuvers. Since vehicles traveling at the same speed in the same direction do not overtake one another, they cannot collide as long as they maintain the same speed. The more vehicles' speeds differ from the median either way, the more the number of overtakings increases. Additionally, fewer crashes occur on roadways on which all motorists travel at close to the same speed.

Garber and Gadiraju (1989) undertook a study of the effect of speed and speed variance on accident rates in Virginia. Their findings confirmed the studies conducted nationwide. Garber and Gadiraju's data indicated that there is no substantial correlation between average speed and accident rate on any given type of roadway. In contrast, Garber and Gadiraju's regression model showed that 70% of the variation of accident rates on Interstate highways and 82% of such variation on arterial highways is explained by speed variance.

Second, the decision concerning the maximum speed limit also involves the evaluation of the physical features of the section of road. Design speeds generally are set based on highway classification or type as well as the character of the terrain, the extent of existing manmade features, and cost to establish the maximum design curvature and minimum design sight distance necessary for safe operation. The maximum speed usually is selected to ensure that the available sight distance at that section is at least equal to the stopping distance for that speed. That is to say, the total distance traveled by the vehicle from the time the driver first observes an object on the road to the time the vehicle comes to a rest.

The criteria for what is "safe" at a given speed are based upon near-worst case conditions. These criteria include considerable margins of safety and because of these built-in safety factors, exceeding the design speed is not necessarily unsafe. Thus, the design speed of a highway is likely to underestimate the "maximum safe speed" along most of the highway by any reasonable criteria for establishing what is "safe," thus making a road's design speed a reasonable speed at which to set the maximum speed limit.

Third, in setting maximum speed limits, it also is necessary to review the crash experience at the highway section being considered in terms of frequency, severity, type and cause. If crash experience on a specific roadway is higher than normal, speeds limits are changed in light of the accident rate.

Finally, traffic characteristics and control devices are considered when maximum speed limits are being determined. Factors usually considered are peak and off-peak traffic volumes, proportion of commercial vehicles in the traffic streams, whether there is parking on the facility, and the existence of traffic signals and other traffic control devices. The objective is to determine a maximum speed limit that will enhance the efficient flow of traffic.

Current Law

The posting of statutory speed limits on highways is under the jurisdiction of the Commonwealth Transportation Commissioner and the responsibility of VDOT. Statutory speed limits are those that are specified in the *Highway Laws of Virginia*. Currently, the maximum speed limit on all primary routes, except rural Interstates, is 55 mph. The maximum speed limit on secondary routes is 55 mph for cars, and 45 mph for trucks. In residential areas, the maximum speed limit is 25 mph. In cities or towns, the statutory speed limit is 35 mph.

The General Assembly grants VDOT the authority to establish the speed limits on each specific route (not to exceed the statutory maximum) provided such limits are based upon engineering and traffic investigations and placed in effect by a resolution approved by the Commonwealth Transportation Commissioner.

Impact of Increased Speed Limits

The impact of the national decrease of speed limits to 55 mph in 1974 and subsequent increase of rural Interstate speeds in 1987 has been an issue of much controversy. Accidents and fatalities steadily decreased following the NMSL. However, it is difficult to ascertain what proportion of this decline was attributable to decreased speeds. Fatalities consistently declined each year for decades, and continue to do so today. One difficulty in assessing the impact of speed limit changes is caused by the great variability in year to year fatality rates.

The Virginia Transportation Research Council conducted a study in 1993 focusing on the changes in travel speeds, fatal crashes, fatalities and truck crashes on Virginia's rural Interstates after the implementation of the 65 mph speed limit on those highways. Both the average and 85th percentile speeds increased, but by less than the 10 mph increase in the speed limit.

Although earlier VDOT studies had shown that the fatality rate increased immediately following the speed limit increase to 65 mph in 1988 (Jernigan & Lynn, 1992) the fatality and fatal crash rates had stabilized at pre-1988 levels by 1992. The absolute number of fatalities did increase after the speed limit was increased, but vehicle miles of travel increased on these roads as well, resulting in a stable rate of fatalities per hundred million miles of travel. Although increased travel speeds may be associated with increased fatalities other concurrent safety improvements offset this effect.

Nationally, although the total number of fatalities increased somewhat, the fatality rate in 1990 was no higher than that in 1986 (prior to the speed limit increase), because of increases in vehicle miles traveled. The fatality rate on the rural Interstate system in 1990 was 1.3 per 100 million vehicle miles traveled, compared to 1.3 fatalities in 1986. The rural Interstates remain the safest component of our nation's highway system; the fatality rate for our nation's roads as a whole is 2.1 per million vehicle miles traveled. However, it is not accurate necessarily to assume that changes in the speed limit on roadways other than the Interstate system would impact roadway safety in the same manner as it did on the rural Interstates.

Other Issues

Speed limits are effective only if drivers obey them. Although most drivers obeyed the 55 mph speed limit in 1974, this is no longer the case. By 1985, more than half of all vehicles were exceeding the speed limit on roads posted at 55 mph in 44 of the 50 states (Federal Highway Administration, 1985). It repeatedly has been found (Garber and Gadiraju, 1988; Texas Transportation Institute, 1995; American Association of State Highway and Transportation

Officials, 1986) that drivers tend to travel at higher speeds on roadways with higher design speeds, regardless of the posted limits.

Deterrence of speeding appears to depend, in poorly understood ways, upon the level of the fine, the enforcement tolerance, and the intensity of enforcement. All of these influence the public's perception of the risk of violating the law. Research on speed limit compliance has indicated that states with higher penalties on the books tend to have less speeding. Overall, low-penalty states do indeed report more speeding as well as higher fatality rates. Similarly, high-penalty states report the least speeding and the lowest fatality rates. Strict enforcement of speed limits and a public perception that the penalty for speeding will be high, appear to result in more uniform speeds and a lower incidence of accidents.

Some have questioned whether raising speed limits on certain roadways, such as Interstates, would lead to increased fatalities on other types of roadways as well, assuming that drivers would not slow down sufficiently once they exited the major highways. A U.S. DOT report to Congress released in May, 1992 does not support this proposition. In terms of Virginia's experience, this report indicates that fatalities on roads other than rural Interstates remained basically constant in Virginia between 1988 and 1990 -- at 995 and 996 fatalities respectively, and did not increase in response to higher speeds on rural Interstates.

Conclusions

Because the National Highway System Designation Act, and its provision allowing for the increase in speed limits, was enacted only one year ago, data regarding the impact of increased speed limits is rather limited. Collecting information on other state experiences and reviewing the results of FHWA's ongoing national study would provide more information.

Speed limits could be raised in Virginia without violating accepted traffic engineering practices. The design speeds (developed to set appropriate speed limits) and 85th percentile speeds, (a measure to achieve the minimum of speed variation), are both greater than the current speed limit on many of Virginia's roadways. In addition, the maximum speed limit was 70 mph in Virginia in 1973 and is currently at least 70 mph in 21 states. VDOT has established guidelines to establish lower speed limits where roadway, traffic or environmental conditions would not support such an increase.

Increasing the speed limit would be expected to result in a reduction in speed variance on the highways at least in the short run. Such a decrease in speed variance would be expected to result in a decrease in the total number of crashes, at least in the short run. However, travel speeds would be expected to increase. Based on previous experiences in Virginia and other states, and on the fact that crashes at higher speeds are more severe, some increase in the absolute number of fatalities and injuries can be expected on the affected roadways. Conversely, fatality and injury rates per hundred million vehicle miles of travel can be expected to continue to decrease in the long run.

If the General Assembly raises the maximum speed limit for any of the road classifications for any type of vehicle, the Task Force would recommend that the General Assembly set maximum allowable limits and empower the Commissioner to determine which roads could accommodate higher speed limits. The Commissioner would not increase speed limits above the current limits unless design speeds, traffic volume and other roadway characteristics so indicated. For example, speed limits on congested urban routes, such as the Capital Beltway, I-95 in Richmond, and I-64 and I-264 in Tidewater would not be increased above 55 mph. Similarly, a heavily trafficked primary route that does not have limited access, such as a Route 17 or a Route 460, would not be increased either.

INTRODUCTION

Background

National Highway System Designation Act

In November 1995, Congress returned to states the authority to set their own speed limits when it passed the National Highway System Designation Act of 1995. Section 205(d) of the National Highway System Designation Act repealed the law that required that states adhere to national maximum speed limits (NMSL) as a condition of receiving Federal-aid highway assistance. Prior to that time, federally established maximum speed limits had been set at 65 mph on rural Interstate-quality roads and at 55 mph on all other routes. The repeal of the NMSL allows each state to set any speed limit it wants, or no speed limit at all.

History of Federal Speed Limits

Until the 1970s, states were empowered to establish their own speed limits. With the passage of the Emergency Highway Energy Conservation Act in 1974, Congress set the first national speed limit at 55 mph. The speed limit was imposed as a temporary fuel-savings measure in response to the OPEC oil embargo and made permanent by an act of Congress in 1975.

Congress relaxed the 55 mph speed limit with the passage of the Surface Transportation Uniform Relocation Assistance Act (STURAA) in 1987. This legislation allowed states to raise speed limits to 65 mph on Interstate roadways passing through areas with a population of fewer than 50,000 persons, affecting speed limits on two distinct components of the Interstate system -- rural Interstates and small urban Interstates.

Subsequent to the passage of STURAA, 42 states increased their speed limit on eligible portions of Interstate roadways. A total of 38 states did so in 1987, three made this change between 1988 and 1992, and one state, Maryland, increased its speed limit in 1995. As a result of these actions, approximately 90 percent of the 34,062 miles of the nation's Interstate highway system eligible for a higher speed limit in these states were posted at 65 mph by 1995. Only 2,734 miles of rural Interstate roadway were within the jurisdiction of those states that retained the 55 mph speed limit.

State Responses

Since the elimination of the Federal mandated speed limit in November 1995, 21 states already have increased their maximum speeds beyond 65 mph.

The states in which the speed limits have been raised are predominantly western, but a number of southern and midwestern states have raised their speed limits as well. For example, Florida, Georgia, Mississippi, Missouri, North Carolina, Oklahoma, Texas and Kansas all have raised their speed limits. These changes have occurred so rapidly in part because a number of states had laws on the book returning speed limits to the rate that had been set prior to the imposition of the Federally mandated maximum speed limit in 1974.

Seven other states, Delaware, Illinois, Iowa, Massachusetts, New York, Wisconsin and Maryland, did not increase the maximum speed beyond 65 mph, but expanded the system of routes on which vehicles can travel 65 mph. Table 1-1 lists the maximum speed limits in each state on the various classifications of primary highways as of August 1996.

Table 1-1
Maximum Speed Limits by State

State	Rural Interstates	Urban Interstates	Other Limited Access Roads	Other Roads
Alabama	70	70	65	65
Alaska	65	55	55	55
Arizona	75	55	55	55
Arkansas	65	55	55	55
California	70	65	70	55
Colorado	75	65	65	55
Connecticut	55	55	55	55
Delaware	65	55	65	55
D.C.	n/a	55	n/a	25
Florida	70	65	70	65
Georgia	70	65	65	55
Hawaii	55	50	45	45
Idaho	75	65	65	65
Illinois	65	55	65	55
Indiana	65	55	55	55
Iowa	65	55	65	55
Kansas	70	70	70	65
Kentucky	65	55	55	55
Louisiana	65	55	55	55
Maine	65	55	55	55
Maryland	65	60	65	55
Massachusetts	65	65	65	55
Michigan	65	65	65	55
Minnesota	65	55	55	55
Mississippi	70	70	70	65
Missouri	70	60	70	65
Montana	Unlimited	Unlimited	Unlimited	Unlimited

State	Rural Interstates	Urban Interstates	Other Limited Access Roads	Other Roads
Nebraska	75	65	65	60
Nevada	75	65	70	70
New Hampshire	65	55	55	55
New Jersey	55	55	55	55
New Mexico	75	55	55	55
New York	65	65	65	55
North Carolina	70	55	70	55
North Dakota	70	55	65	65
Ohio	65	55	55	55
Oklahoma	75	70	70	70
Oregon	65	55	55	55
Pennsylvania	65	55	55	55
Rhode Island	65	55	55	55
South Carolina	65	55	55	55
South Dakota	75	65	65	65
Tennessee	65	55	55	55
Texas	70	70	70	70
Utah	75	65	55	55
Vermont	65	55	50	50
Virginia	65	55	55	55
Washington	70	60	55	55
West Virginia	65	55	55	55
Wisconsin	65	65	65	55
Wyoming	75	60	65	65

Purpose and Scope of Study

1996 Virginia Legislation

Three pieces of legislation were introduced in the 1996 General Assembly Session related to increased speed limits. Two of these bills failed, one passed.

The first, House Billl (HB) 1242, was introduced by Delegate Jones as part of Governor Allen's legislative package. This bill was introduced with a maximum speed limit of 70 mph on Interstates and other limited access highways, 60 mph on non-limited access highways having four or more lanes, and 55 mph on all other state primary highways. The bill was amended in committee to set a reduced maximum speed limit of 65 mph on Interstates and other limited access highways, but retained the increase to 60 mph on non-limited access primary routes with four or more lanes. This bill failed in the House.

A second bill, Senate Bill (SB) 307, introduced by Senators Hanger, Barry and Quayle also was part of the Governor's legislative package. It was identical to the HB 1242 as introduced. This bill was not amended, and retained the maximum 70 mph speed limit, but failed in committee.

The third bill, SB 2, introduced by Senator Waddell, passed. This bill relates only to the Dulles Greenway. The bill raised the speed limit on the Greenway, which is an urban limited-access highway from 55 mph to 65 mph. This is the first road in Virginia that is not a rural Interstate on which the speed limit has been raised above 55 mph since 1974.

Senate Joint Resolution 7

Senate Joint Resolution (SJR) 7 was introduced by Senator Waddell and passed by the 1996 General Assembly to assess the criteria used to set speed limits and establish sound, rational and objective criteria to facilitate setting maximum safe speed limits on the various classifications of highways.

The language of SJR 7 required the Secretary of Transportation to convene a Special Task Force on safe maximum highway speed limits for the purpose of recommending appropriate maximum highway speed limits for the various classifications of highways and types of vehicles within the Commonwealth based on sound, rational, and objective criteria.

Secretary of Transportation Robert Martínez formed a Task Force composed of representatives of the Commonwealth Transportation Board, the Virginia Department of Transportation (VDOT), the Virginia Transportation Safety Board, the Virginia State Police, the Crash Investigation Team of Virginia Commonwealth University, the Virginia Transportation Research Council (VTRC), the Virginia Association of Counties, the Virginia Municipal League, the Virginia Association of Sheriffs, the Virginia Association of Chiefs of Police, and the American Automobile Association.

In addition, a Secretariat staff group was formed to assist the Task Force in the preparation of this report. Participants included representatives of VDOT's Offices of Policy Analysis and Traffic Engineering Divisions, and the Virginia Transportation Research Council.

A copy of SJR 7 is included in Appendix A.

Methodology

This report presents a review of the literature dealing with speed limits. There is a large base of data assessing the impacts of the 55 mph speed limit, most of the research for which was conducted between the mid-1970s and the mid-1980s. In addition, there are a number of studies that evaluated the effects of raising speed limits on rural Interstates in the late 1980s. However, because the National Highway System Designation Act passed less than a year ago, there is limited information regarding the effects of changes that have taken place since that time.

Where possible, researchers used Virginia data to supplement a review of the literature on a given issue. However, when original data were not available, the literature was reviewed and used to estimate the anticipated impact of a change in speeds in Virginia.

The Federal Highway Administration (FHWA) recently began a study of speed and speed limits. This is the first comprehensive national study in 15 years. A number of states are conducting concurrent efforts similar to Virginia's, as well. Additional data will become available in the next few years.

LITERATURE REVIEW

Setting Speed Limits

The establishment of appropriate maximum speed limits for different sections of highways is generally referred to as speed zoning. The primary objective in speed zoning is to inform motorists of the maximum safe speed at which vehicles can be driven under normal conditions. Speed zoning also can be used to facilitate the flow of traffic and assist motorists by selecting appropriate speeds for specific environmental conditions. There are two basic types of speed controls: (1) advisory maximum speed indications that are not enforceable but which advise or warn motorists of suggested safe speeds for specific conditions at a specific location and (2) legal or regulatory limits that are set by law or regulation and are enforceable.

Advisory Speed Limits

Advisory speed limits provide guidance to motorists of what the maximum safe speed is. These types of limits are less frequently used in Virginia. For example, advisory limits are posted on certain curves along the roadway where a lower than posted speed is indicated. Advisory speed limits usually are not enforceable, but in some jurisdictions, the court may consider a driver to be driving recklessly when he or she is driving above the posted advisory limit.

Regulatory Speed Limits

Regulatory controls specify speed limits that are enforceable. These speed limits can be divided into two subcategories: (1) those established by legislation and applicable nationwide, statewide, countywide or citywide and (2) those established by administrative action. For example, the Virginia General Assembly has established a maximum speed limit of 55 mph for most of Virginia's highways. A maximum speed limit lower than 55 mph for a specific section of a highway in Virginia generally would be the result of an administrative action by the Transportation Commissioner based on an engineering and traffic study.

Maximum speed limits also can be classified into two types: (1) the absolute limit, above which it is illegal for anyone to drive, regardless of traffic, highway or environmental conditions, and (2) the prima facie limit, above which a driver is considered to be speeding. If charged with a violation of the prima facie limit, a driver has the right to produce evidence to show that the speed at which he or she was driving was safe for the conditions that existed at that time. Therefore, enforcing prima facie speed limits is more difficult than enforcing absolute speed limits because guilt is more difficult to prove in a court of law. Approximately two-thirds of U.S. states have absolute-type limits and one-third have prima facie limits or some of each. Absolute speed limits are used in Virginia.

Speed Zone Factors

It is essential that speed limits be based on sound engineering judgment, based on a detailed analysis of the data on a highway's traffic and geometric characteristics. The factors normally taken into consideration by traffic engineers in setting speed limits can be divided into the following four general categories:

1. Prevailing vehicle speeds.
2. Design speed and other physical features.
3. Crash history.
4. Traffic characteristics.

Prevailing Vehicle Speeds

Prevailing vehicle speeds are one of the primary considerations in the establishment of speed limits. The factors examined to determine prevailing vehicle speeds include the 85th percentile speed, the mean speed, the 10 mph pace, and the speed distribution. Each of these terms is defined below.

85th Percentile Speed

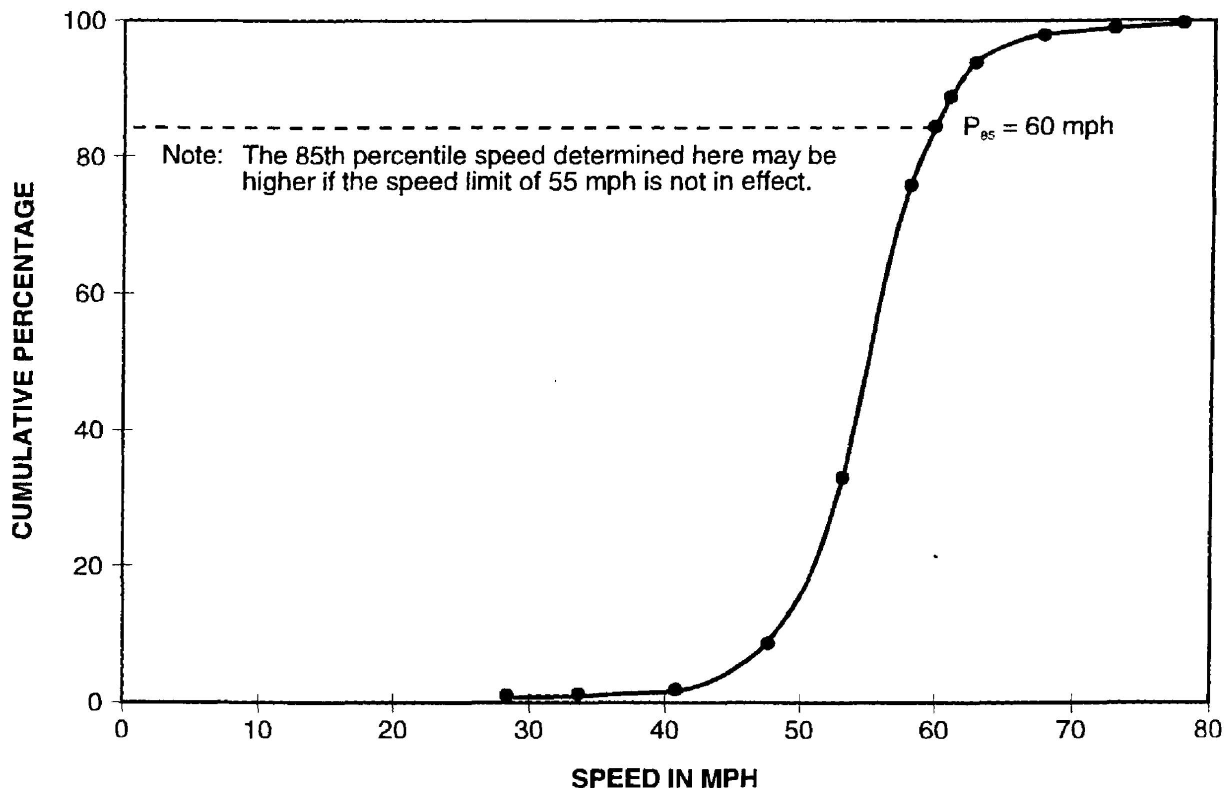
The 85th percentile speed is the speed at or below which 85% of the drivers travel a specific section of highway. This speed has been selected by traffic engineers as the maximum speed limit for two reasons. First, it is postulated that most drivers are reasonable and do not want to be involved in a crash and will, therefore, usually select a speed that in their judgment is safe for the prevailing geometric, traffic and environmental conditions. Selection of the 85th percentile speed as the maximum speed limit will, therefore, cover the usual speed of 85% of the drivers. Thus, enforcement efforts may be targeted at the drivers in the upper 15th percentile. Second, an examination of a typical cumulative speed distribution curve, as shown in Figure 2-1, indicates that above the 85th percentile speed value, speeds usually become more dispersed and the curve flattens out significantly. Setting the speed limit at the 85th percentile speed will, therefore, aid in controlling the dispersion of speeds.

The suitability of the 85th percentile speed as the maximum safe speed has been supported by studies carried out by several researchers, including Cirillo (1968) and Solomon (1964). These researchers showed that crash involvement rates are lowest at the 85th percentile speed and that crash risk increases significantly at speeds higher or lower than the 85th percentile value. The selection of the 85th percentile speed as the maximum speed limit on specific sections of highways seems reasonable both in terms of safety and drivers' desire, and has become a major criterion used for setting speed limits.

Solomon (1964) found that the lowest crash probability was for vehicles traveling close to the 85th percentile speed. Essentially, the 85th percentile rate is the speed at or below which 85%

of traffic on a given roadway is traveling. Crash rates were highest for vehicles traveling substantially above and below this speed. Similarly, Johnson, Klien, Levy and Maxwell (1980) and the Research Triangle Institute (1970) found that the greater the variance from the average speed, the greater the crash risk. Thus, the more uniform the speeds, the safer the driving conditions. Lund and Freedman (1992), criticized the applicability of a number of Solomon's 1960 study to Interstate highways because many of the crashes at slow speeds involve intersections and turning maneuvers. However, other recent studies involving major primary highways verified Solomon's earlier research (Lave, 1985; Garber and Gadiraju, 1988).

Figure 2-1
Speed Distribution Curve



Mean Speed

Mean speed is the arithmetic average of the speeds of vehicles passing a point on a highway during an interval of time. Although the mean speed on a particular section of highway is not normally selected as the maximum speed limit, it can play an important role in determining an appropriate speed limit. Studies conducted by the FHWA have shown that the crash involvement rate is influenced significantly by the variation of speeds from the mean speed. Figure 2-2 shows that the crash involvement rate is lowest at a speed that is about 10 mph higher than the mean speed (Solomon, 1964). Also, data collected on most highways indicate that the

85th percentile speed is usually between 6 and 10 mph above the mean speed. The selection of a speed limit of about 6 mph to 10 mph above the mean speed will, therefore, stipulate a speed limit that is approximately equal to the 85th percentile speed.

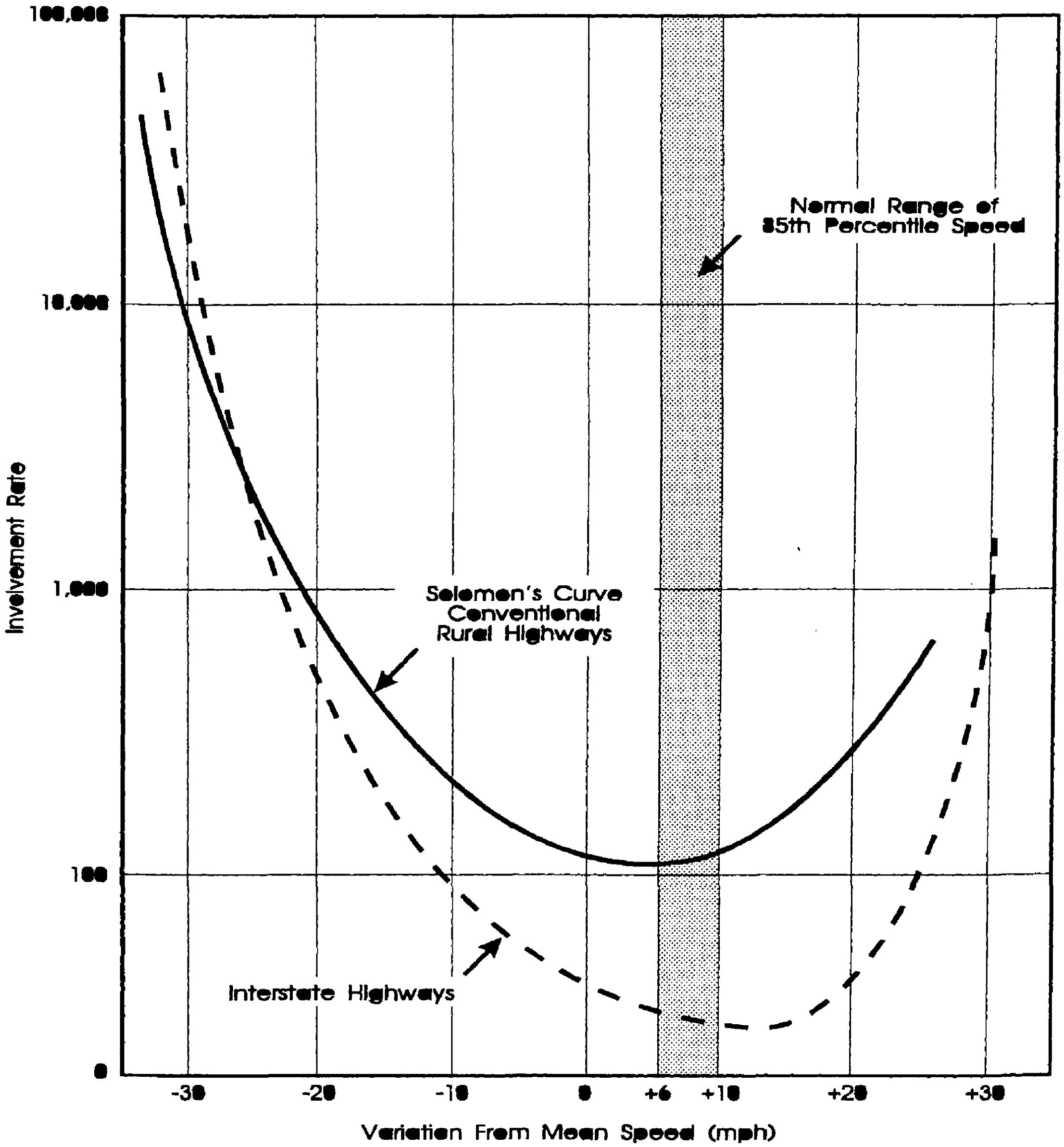


Figure 2-2: Relationship Between Variation From Mean Speed and Crash Involvement Rates

Speed Distribution

The distribution of speeds on a section of highway, especially the variation in speeds and the skew of speeds, also can play a significant role in the selection of maximum safe speeds. These can be depicted most easily by mapping the percentage of motorists traveling at each speed (See Figure 2-3). The variance of the distribution reflects how similar motorists speeds are. For instance, in Graph A, most of the motorists are traveling at approximately the same speed, around 60 mph. This graph depicts low variation, a condition in which crashes are less likely to occur. In Graph B, motorists' speeds are not as consistent and vary considerably, a more dangerous condition.

The skew is the measure of the balance or symmetry of a curve. The symmetry of a speed distribution indicates whether an equal number of drivers are driving faster or slower than the most common speed. Graph C illustrates a balanced distribution in which an equal number of drivers are driving faster than 60 mph and slower than 60 mph. In Graph D, however, more drivers are driving faster than 60 mph than are driving slower, indicating less balance. Generally, the more skewed (unbalanced) a speed distribution, the higher the crash rate (Taylor, 1965). Taylor's other findings include the following:

1. There is a strong relationship between the rate of occurrence of crashes and the speed distribution of rural state highways. The crash rate is significantly higher where the speed distribution is unbalanced, and the crash rate is reduced when most motorists are traveling the same speed.

2. Making the speed distribution less varied results in a crash rate reduction that is about twice that found under any other set of conditions.

The objective in using the speed distribution to determine a maximum speed limit is to obtain a balanced speed distribution and thus a low variance in the speeds of the individual drivers.

There are other reasons why speed variance would affect highway safety as well. A reduction in speed variance means less passing, weaving and lane changing, and reflects a stream of vehicles moving at a more even pace. This flow pattern has long been thought by traffic engineers to be safer than high-variance flow (Godwin and Kulash, 1988).

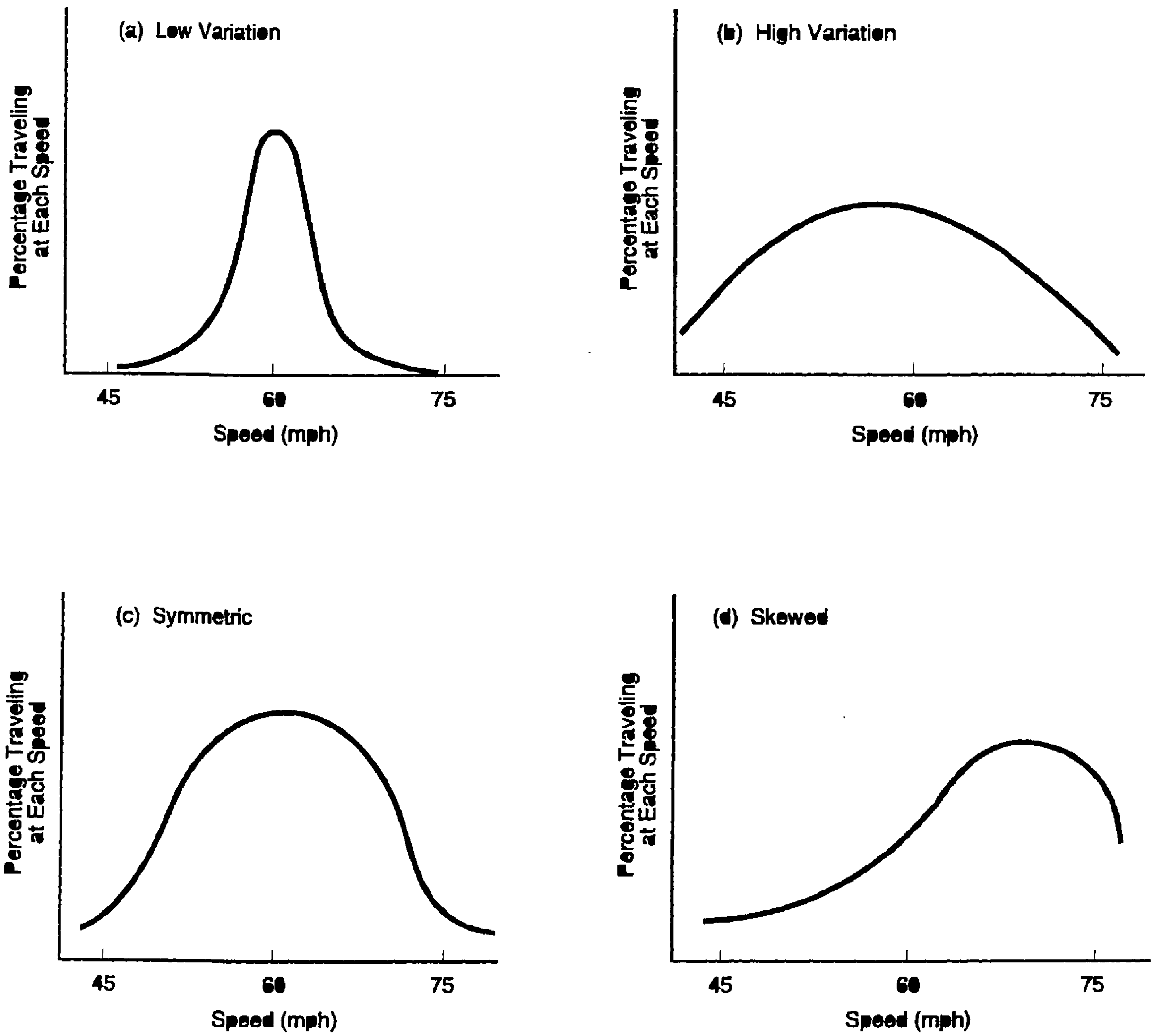


Figure 2-3: Possible Speed Distributions

Speed Variance

Most research indicates that higher speed variance usually is associated with higher crash rates. Pisarski (1986) found a significant statistical relationship between speed variance and crash rate. Cerelli's (1981) research indicated that the rate of crashes is increased as vehicle speed deviated from the prevailing mean speed on the highway.

One explanation for this is that the crash involvement rate also is correlated with the number of overtaking maneuvers (Hauer, 1971). Since vehicles traveling at the same speed in the same direction do not overtake one another, they cannot collide as long as they maintain the same speed. The more vehicles' speeds differ from the median either way, the more the number of overtakings increases. Additionally, fewer crashes occur on roadways on which all motorists travel at close to the same speed.

Lave evaluated the relationship between average highway speed and the fatality rate in a 1985 study. Running independent major regression analyses on a number of different highway types, his empirical results did not support the claimed benefits of the 55 mph speed limit. In addition to average speed data, Lave examined three alternative measures of highway speed: the percentage of drivers exceeding 55 mph, the percentage of drivers exceeding 65 mph and the 85th percentile speed. Substituting any of the three into the regression in place of average speed did not produce any better support for the hypothesis that speed and fatalities are related positively suggesting that absolute speed per se is not the primary determinant of accident rates.

Further analysis raised the possibility that the regressions were confusing the effect of speed, per se, and the effect of speed-variance: having a mixture of car speeds on the same road. The results of his regression analysis strongly supported the importance of speed variance. If everyone is going about the same speed, whether it is fast or slow, he found the fatality rate to be low.

Cerrilli (1975) found that as speed decreased following the imposition of the 55 mph national maximum speed limit in 1974, initially there was a corresponding decrease in speed variance. Speed compliance initially was very high following the passage of the NMSL; however, as drivers became adjusted to the 55 mph speed limit, they became less and less likely to comply. Federal Highway Administration annual studies showed decreasing compliance with the NMSL throughout the late 1970s and the 1980s.

Garber & Gadiraju's 1988 study showed that speed variance decreased, at least in the short run, after speed limits were raised from 55 mph to 65 mph on Virginia's rural Interstates in 1988. Therefore the speed variance that has been attributed to causing an increase in the frequency of crashes is not necessarily associated with higher speed limits.

Garber and Gadiraju (1989) undertook a study of the effect of speed and speed variance on accident rates in Virginia. Their findings confirmed the studies conducted nationwide. Garber and Gadiraju's data indicated that there is no substantial correlation between average speed and accident rate on any given type of roadway. In contrast, Garber and Gadiraju's regression model showed that 70% of the variation of accident rates on Interstate highways and 82% of such variation on arterial highways is caused by speed variance.

Other major findings of Garber and Gadiraju include:

- Minimum speed variance will occur when the speed limit is 5 to 10 mph lower than design speed.
- For average speeds between 25 and 70 mph, speed variance decreases with increasing average speed.
- The difference between the design speed and the posted speed greatly affects speed variance.
- Drivers generally drive at increasing speeds as geometric characteristics improve, despite posted limits.
- Accident rates do not necessarily increase with an increase in average speed, but do increase with an increase in speed variance.

Design Speed and Other Physical Features

The decision concerning the maximum speed limit usually involves the evaluation of the physical features of the section of road. The selection of a design speed is among the most critical early decisions in the highway planning and design process because it is one of the basic controls that defines the highway physical and operational characteristics. The selected design speed establishes the maximum design curvature and minimum design sight distance necessary for safe operation, and is, therefore, the maximum safe speed that can be maintained over a specified section of highway when other conditions are favorable.

Design speeds generally are set based on highway classification or type as well as the character of the terrain, the extent of existing manmade features, and cost. For example, a highway project may justify a particular design speed based on its classification and the volumes of traffic it is expected to handle, but its terrain features (mountains, water, and so forth) may justify a lower design speed because of the high cost of construction.

The main features considered for Interstate-quality highways are the vertical and horizontal alignments. For example, the maximum speed usually is selected to ensure that the available sight distance at that section is at least equal to the stopping distance for that speed. That is to say, the total distance traveled by the vehicle from the time the driver first observes an object on the road to the time the vehicle comes to a rest. This speed usually is referred to as the design speed, and it is defined as "the maximum safe speed that can be maintained over a specified section of highway, when conditions are so favorable that the design features of the highway govern" (American Association of State Highway and Transportation Officials, 1994).

The use of design speed as a primary factor in selecting appropriate speed limits has been standard practice since the 1930s. When the design speed of the highway section is used as the maximum safe speed, geometric features of the roadway, such as minimum radius of horizontal curves and minimum length of vertical curves, will be constructed for the selected speed limit.

It is, therefore, customary for posted speed limits not to be higher than the design speeds. It is, however, impractical to change posted speed limits within distances of less than 1000 feet. The minimum length of a speed zone is, therefore, 0.2 mile, although much longer lengths commonly are used in practice. When a very short section with restrictive geometric characteristics exists on a stretch of highway, an advisory sign indicating the maximum safe speed may be posted instead of a lower speed limit.

Recently, some researchers and transportation engineers have argued that since highways are "overdesigned" and can handle greater speeds than indicated, the posted speed limit could be higher than the design speed. As noted in a 1995 Texas Transportation Institute study,

> "Concerns arise at locations where the posted speed limit based on the 85th percentile speed exceeds the roadway's inferred design speed. This inconsistency is the result of the fact that criteria used in highway design incorporate a significant factor of safety -- i.e., roadways are designed for near worst-case conditions. Consequently, it is not surprising that motorists feel comfortable traveling at speeds in excess of the roadway's design speed during good weather conditions."

As they note, the criteria for what is "safe" at a given speed are based upon near-worst case conditions. These criteria include considerable margins of safety and because of these built-in safety factors, exceeding the design speed is not necessarily unsafe. Furthermore, American Association of State Highway and Transportation Officials (AASHTO) even suggests that "above minimum design values should be used where feasible" (AASHTO, 1995). In fact, many highway features have above-minimum designs, and the design speed may actually apply only to a small number of critical features. As a result, most curves and hill crests are flatter than would be necessary to accommodate a given design speed. Thus, the design speed of a highway is likely to underestimate the "maximum safe speed" along most of the highway by any reasonable criteria for establishing what is "safe."

AASHTO's *A Policy on Geometric Design of Highways and Streets*, contains the following recommendations regarding the selection of design standards:

> In theory, the design speed, operating speeds and posted speeds on a roadway should be similar. That is, we select the design speed of a highway to accommodate the desires of the majority of drivers. Therefore, after the highway is designed and constructed, we would expect to measure operating speeds similar in magnitude to the design speed."

At its annual meeting in 1996, the American Automobile Association approved a policy statement calling for states to rely on engineering and traffic surveys to set appropriate and enforceable speed limits. It also urged states to conduct follow-up studies on the effects of speed increases.

Crash History

In setting maximum speed limits, it is necessary to review the crash experience at the highway section being considered in terms of frequency, severity, type and cause. A comparison is usually made between the crash rate at the site and the critical crash rate in the area for the type of highway being considered. The critical crash rate is that rate above which crash occurrence is higher than expected. Critical crash rates are computed from mathematical formulae that differ from one state to another. When the crash rate is higher than the critical rate, and it can be ascertained that speeding is a contributing factor in a high percentage of crashes, a maximum speed limit is selected that will bring overall speed at the highway location to appropriate levels. In some cases, this may require raising existing restrictive speed limits, which may result in reduced crash frequency and rates.

Traffic Characteristics

Traffic characteristics and control devices usually are considered when maximum speed limits are being determined. Factors usually considered are peak and off-peak traffic volumes, proportion of commercial vehicles in the traffic streams, whether there is parking on the facility, and the existence of traffic signals and other traffic control devices. The objective is to determine a maximum speed limit that will enhance the efficient flow of traffic. Since most of these factors are considered in the determination of the level of service on any section of highway, the consideration of traffic characteristics in the selection of speed limits usually implies the selection of the speed limit that will maintain at least an acceptable level of service. A minimum level of service of C is usually adopted for rural highways. Figure 2-4 on the following page depicts the various levels of service ratings.

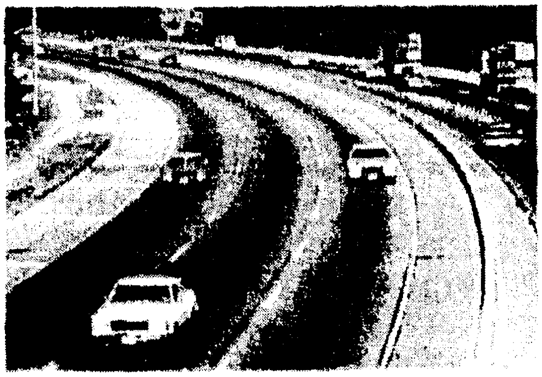


Illustration 3-5. Level-of-service A.

Illustration 3-8. Level-of-service D.

Illustration 3-6. Level-of-service B.

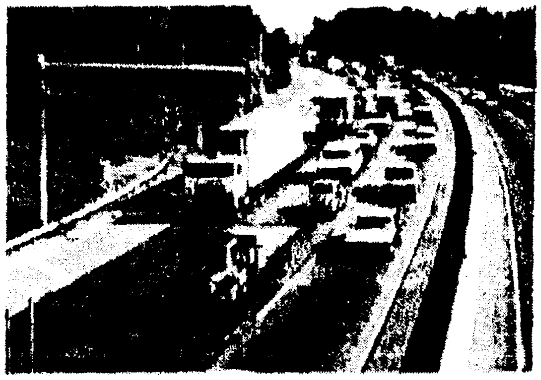


Illustration 3-9. Level-of-service E.

Illustration 3-7. Level-of-service C.

Illustration 3-10. Level-of-service F.

Figure 5-3. Freeway conditions under LOS A through F.
SOURCE: Highway Capacity Manual, 1985, Special Report 209 (Washington, DC: Transportation Research Board), p. 3-9.

Figure 2-4

ITE Recommended Guidelines

The Institute of Transportation Engineers (ITE) developed a nationally recognized check sheet (See Table 2-1) for speed zones based on some of the factors discussed above. This check sheet is frequently used to aid traffic engineers in selecting appropriate maximum speed limits. The ITE also developed the following guidelines for determining where speed limits can be raised beyond 55 mph following the 1987 change in Federal law. They suggest that speed limits should exceed 55 mph only under the following circumstances:

1. Only on freeway segments, with full control of access and complying with freeway design standards.
2. Level of service C or higher with a traffic density less than 30 passenger car equivalents per mile per lane in the peak hour.
3. A minimum segment length of 10 miles.
4. Following an engineering and traffic study that should include:
   - Analysis of compliance with freeway design standards for appropriate design speed.
   - Accident analysis and comparison with statewide average rates.
   - Capacity and level-of-service calculations.
   - Roadway features such as length, interchange locations, terrain considerations.
   - Speed characteristics, traffic volumes, vehicle types, and freeway flow considerations.
   - Special features or considerations relating to roadway segment.
   - Current status and quantity of existing enforcement.
   - Needs to exclude specific vehicles from higher speed zoning.
   - Concurrence of responsible engineering and enforcement authorities.
5. Monitoring study and analysis.

Table 2-1
ITE Check Sheet for Speed Zones

Highway Conditions (Three or More Must Be Satisfied)				
Design Speed (mph)	Minimum Length of Zone Equals or Exceeds (miles)	Average Distance Between Intersections Equals or Exceeds (feet)	Number of Roadside Businesses does not Exceed per mile	Preliminary Estimate of Maximum Speed (mph)
20	0.2	no min.	no max.	20
30	0.2	no min.	no max.	30
40	0.3	125 feet	8	40
50	0.5	500 feet	6	50
60	0.5	500 feet	4	60
70	---	1000 feet	1	70

Speed Characteristics (Two or More Must Be Satisfied)			
85th Percentile Speed Between (mph)	Limits of 10-mph Pace Between (mph)	Average Test Run Speed Equals or Exceeds (mph)	Maximum Proposed Speed Limit (mph)
under 22.5	under 25	17.5	20
22.5 - 27.5	11 - 29	22.5	25
27.5 - 32.5	16 - 34	27.5	30
32.5 - 37.5	21 - 39	32.5	35
37.5 - 42.5	26 - 44	37.5	40
42.5 - 47.5	31 - 49	42.5	45
47.5 - 52.5	36 - 54	47.5	50
52.5 - 57.5	41 - 59	52.5	55
57.5 - 62.5	46 - 64	57.5	60
62.5 - 67.5	51 - 66	62.5	65
67.5 or over	over 55	67.5	70

SPEED ZONING PRACTICE

History of Speed Limits in Virginia

Over the past several decades, Virginia has had several maximum speed limits established by law on its different highway systems.

Statutory Speed Limits

The posting of statutory speed limits on highways is under the jurisdiction of the Commonwealth Transportation Commissioner and the responsibility of VDOT. The State Police and other enforcement officials are responsible for enforcing the posted limits.

Statutory speed limits are those that are specified in the *Highway Laws of Virginia*. Currently, because the federal government imposed a national speed limit from 1974 through 1995, the maximum speed limit on all primary routes, except rural Interstates, is 55 mph. The maximum speed limit on secondary routes is 55 mph for cars, and 45 mph for trucks. In residential areas, the maximum speed limit is 25 mph. In cities or towns, the statutory speed limit is 35 mph.

Currently, the General Assembly grants VDOT the authority to establish the speed limits on each specific route (not to exceed the statutory maximum) provided such limits are based upon engineering and traffic investigations and placed in effect by a resolution approved by the Commonwealth Transportation Commissioner. The Commissioner's signed authorization describing the terminii of the speed zone, its length and the speed limit to be established constitutes such a resolution. The Commissioner is empowered to reduce the speed limit on a certain route below the maximum speed allowable under the Code of Virginia. A statutory limit does not supersede an approved resolution reducing speed limits.

Virginia Speed Limits

The most recent change in the maximum speed limit for a highway system in Virginia was for the Commonwealth's rural Interstate highways. In July 1988, the maximum speed limit for passenger vehicles was raised to 65 mph on these routes. The maximum speed limit for commercial buses was raised to 65 mph in 1989 and that for trucks in 1994.

Prior to the imposition of the national maximum speed limit in 1974 Virginia's speed limits were as follows:

- 70 mph on Interstates and other limited access highways with divided roadways, with reduced truck speeds of 60 mph.

- 60 mph on nonlimited access highways having four or more lanes, with reduced truck speeds of 55 mph.
- 55 mph on all other primary highways not included above.

The Virginia Code sections governing speed limits also required that before speed limits be increased above 55 mph, such routes undergo an engineering and traffic investigation.

The limits established by Code dictated only a maximum speed limit; the Transportation Commissioner was empowered to set minimum speed limits to ensure safe operation of the roadways. Importantly, this section also explicitly stated that the Commissioner has the authority to decrease the speed limits below the maximum set forth in the subsections, and may set daytime and nighttime speeds.

Research indicates that broad codified power is far superior to road specific legislation, because it ensures that all speed limits are set based on engineering standards and traffic examinations. From a safety perspective, it is best to base speed limits on an examination of the prevailing travel speeds, physical features, crash history and traffic characteristics.

Speed Zoning Practice in Virginia

It is the responsibility of VDOT to establish speed zones wherever required to protect citizens, their property, and the motoring public. To do this, it is important that a realistic zone be established, one that the majority of people will obey, and one that can be enforced reasonably by law enforcement personnel.

Each of VDOT's nine construction districts has a traffic engineering office responsible for conducting the traffic and engineering investigations that are required before establishing or adjusting speed zones. The findings of these investigations are submitted to the State Traffic Engineer for his approval before being forwarded to the Commissioner for approval of the resolution.

There are many factors, in addition to strict traffic and engineering standards that affect VDOT's determination of appropriate speed limits. These include:

1. Accident frequency/severity
2. Environmental factors
3. Roadway type and condition
4. Adjacent land use and access
5. Weather conditions
6. Public attitude

Establishment and Adjustment of Speed Zones

The primary source of requests for speed zoning changes comes from private citizens channeled through various groups such as County Boards of Supervisors, legislators, civic associations, and other organizations which make their appeals known to either VDOT Central or Field Office personnel for action. Department officials also initiate studies in order to keep abreast of the ever changing road conditions. Occasionally, hazardous conditions are detected by the State Police which, in their opinion, could be corrected by an adjustment in the speed limit. Their findings and recommendations are submitted to VDOT's local resident engineer in the form of a highway hazard report. The State Police and local law enforcement agencies also review requests for speed zoning changes which emanate from accident or enforcement problems. After a request is received, a traffic and engineering investigation is conducted to determine the proper speed limit for the study area.

Speed zone engineering investigations involve the study of the geometric design of the roadway or street and an evaluation of its adequacy. Elements of a good engineering investigation include a study of the following:

Physical Features

- A. Design speed
- B. Measurable physical characteristics
    1. Lane width
    2. Pavement type and condition
    3. Curvature (and maximum safe speed)
    4. Gradient
    5. Spacing of intersections
    6. Number of commercial or residential entrances
    7. Parking condition and adjacent land uses
    8. Restricted sight distance or view obstructions

Speed zone traffic investigations involve obtaining traffic related data and the analysis of that data. Elements of a good traffic investigation include:

- A. Prevailing vehicle speeds
    1. 85th percentile speeds
    2. Average test run speeds
    3. Speed distribution data
- B. Accident experience
    1. A review of accident experience over a three year time period
    2. Accident rate

- C. Traffic characteristics and volume
    1. Traffic volume (ADT)
    2. Parking and loading vehicles

3. Commercial vehicles and trucks
4. Turning movements
5. Traffic control devices
6. Vehicle and pedestrian conflicts

The 85th percentile speed often is used as a guide in determining the proper speed limit to be posted. In Virginia, every effort is made to set reduced limits as close to the 85th percentile speed as possible.

Usually one speed check is made for every one-half mile of roadway under study. Speed samples are collected when and where representative free-flow speeds will be obtained without the influence of unusual traffic flow. Samples are taken when there is no inclement weather to inhibit speeds. Some of the factors considered when selecting sampling locations are: density and situation of roadside development, variations in terrain, roadway geometric changes, obvious trouble spots, and direction of travel, among others.

Temporary Limits in Areas of Construction or Maintenance

The Department also is empowered to set special speed limits for a number of purposes. In areas of construction and maintenance, the Commissioner has the ability to impose temporary reductions of the speed limit. Such instances are covered in a blanket resolution of the Commissioner, dated April 27, 1994. This resolution gives field engineers the authority to lower the speed limit through areas of construction and maintenance down to 25 mph, or a lesser reduction, if conditions warrant.

School Zones

A school speed zone may be placed within 600 feet of school property with flashing signs to warn motorists when a reduced speed is in effect. The statutory speed limit for a school zone is 25 mph. Any other limit for a school zone must be approved by Commissioner's resolution. Flashing signs may be turned on 30 minutes prior to the beginning of regular school hours and 30 minutes thereafter and during other times where the presence of children reasonably requires a special warning for motorists.

Urban System

All speed studies on highways and streets within cities and incorporated towns with population over 3,500 and the counties of Arlington and Henrico are handled by the city, county or town, and they are responsible for the posting of speed limits on those roadways within their jurisdiction. The VDOT may conduct an engineering investigation for a city or town if requested by the local officials.

SPEED AND SAFETY

National Impact of 65 mph Speed Limit

The impact of the national decrease of speed limits to 55 mph in 1974 and subsequent increase of rural Interstate speeds in 1987 has been an issue of much controversy.

Accidents and fatalities steadily decreased following the national maximum speed limit. However, it is difficult to ascertain what proportion of this decline was attributable to decreased speeds. Fatalities consistently declined each year for decades, and continue to do so today.

One difficulty in assessing the impact of speed limit changes is caused by the great variability in year to year fatality rates. Godwin and Kulash (1988) believe the 15.3% drop in fatalities in 1974 must be caused by the decrease to a 55 mph speed limit. However, as Charles Lave (1988) notes in his study annual drops of equal percentages have occurred in other years. For example, there also was a 12.7% drop of fatalities in 1982. Given the large random year-to-year changes, it is more accurate to use a slightly wider time interval. From 1972-1975 the fatality rate fell 22.1%, while from 1980-1983 the fall was 23.1%. That is, there was a larger decline in the fatality rate in the more recent period, a time characterized by ever-increasing public violation of the 55 mph speed limit.

However, many attribute the decline in fatalities to the decreased speed limit. Although increased speeds do not necessarily increase the likelihood of accidents, they are likely to increase the severity of accidents that do occur. We do know that as the speed at which a crash occurs increases, crash severity does increase as well. (AASHTO, 1974; Kelley, 1973; Solomon, 1964). This has to do with the concept of dissipation of energy. When a fixed object or moving vehicle is struck, the kinetic energy is released and the impact of the crash is absorbed by the struck vehicle or object, the striking vehicle, and the occupant(s). The relationship between kinetic energy and speed is as follows:

$$\text{Kinetic energy} = \tfrac{1}{2}\ \text{Mass x Velocity squared.}$$

Thus, a 20 percent increase in speed results in a 44 percent increase in kinetic energy, which must be absorbed by the struck object or the vehicle, thus increasing the likely severity of the crash. It also has been noted that a driver whose vehicle crashes with a velocity of 50 mph is twice as likely to be killed as a driver of a vehicle that crashes at 40 mph. (O'Day and Flora, 1982).

FHWA conducted a study of the impacts of the increase in rural Interstate speed limits for the years through 1990 and presented this report to Congress in 1992. In 1990, there were 44,529 fatalities on America's roadways, of which slightly more than 5% occurred on rural Interstates with a speed limit of 65 mph. Compared to 1989, nationwide rural Interstate fatalities in 1990 declined about 2%, an amount equal to the change experienced in total motor vehicle crash fatalities. This decline occurred in spite of increases in vehicle miles traveled estimated at 2 percent. Urban Interstate fatalities (where speed limits remained at 55 mph) were about 2% higher than in 1989.

FHWA estimates that the 2,336 fatalities that occurred in 1990 on rural Interstates in those 38 states that had increased their speed limits to 65 in 1987 is 30% greater than might have been expected based on historical trends. This variation from the estimated trend projection is the same that occurred in 1988 and 1989. They believe this suggests the fatality effect of the 65 mph speed limit had stabilized by 1990, just three years after its implementation.

Although the total number of fatalities had increased somewhat, that fatality rate in 1990 was no higher than that in 1986, because of increases in vehicle miles traveled. As FHWA notes, the fatality rate on the rural Interstate system in 1990 was 1.3 per 100 million vehicle miles traveled, compared to 1.3 fatalities in 1986. The rural Interstates remain the safest component of our nation's highway system; the fatality rate for our nation's roads as a whole is 2.1 per million vehicle miles traveled.

Based on speed data for 65 mph roadways, which are only available from 18 of the 40 states with increased limits, the average travel speed on rural Interstates is estimated to have increased from 60.6 mph in 1986 (when the 55 mph speed limit was in effect) to 64.0 mph in 1990. That is, the average speed of drivers exceeded the posted speed limit of 55 mph in 1986 by 5.6 mph, while in 1990 the average speed was one mph below the posted limit.

FHWA produced Table 4-1 below outlining the impact of the 65 mph speed limit on fatalities. The data indicate that the 1990 fatality rate on rural Interstates changed negligibly for the nation as a whole relative to 1986. On the other hand, the fatality rate on roads other than rural Interstates has declined nationally between 1986 and 1990, both in those states that increased their speed limit and those that did not.

Table 4-1

Fatality Rates by Roadway Type

	Fatality Rates per 100 million VMT					Percent Change
National Total	**1986**	**1987**	**1988**	**1989**	**1990**	**1986-1990**
Rural Interstate	1.3	1.5	1.6	1.4	1.3	1.0%
Other Roads	2.6	2.5	2.4	2.2	2.1	-18.0%
All Roads	2.5	2.4	2.3	2.2	2.1	-17.0%

Maryland's Experience with 65 mph Speed Limit

On July 1, 1995 Maryland became the most recent state to raise speed limits on rural Interstate highways to 65 mph. During the first year of increased speeds, Maryland experienced a 42% decline in fatalities (from 29 to 17) on rural Interstates. Maryland officials posit two possible explanations for the decrease in fatalities. First, enforcement of the new speed limit has been tough. State Police have cracked down on speeders and aggressive drivers. Maryland State Police wrote almost 487,500 tickets in 1995 -- a five-year high and a 23% increase over the previous year. Also, troopers are issuing tickets for violations of as little as 5 mph over the speed limit.

Second, the Maryland State Highway Administration reports that the increased speed limit appears to have resulted in more uniform travel speeds. Since the increase one year ago, the 85th percentile speed on Maryland's rural Interstates increased from 69.3 mph to 70.8 mph, a 1.5 mph increase. The average speed increased only 1.0 mph, from 61.8 to 62.8.

Virginia's Experience with 65 mph Speed Limit

The most recent change in the maximum speed limit for a highway system in Virginia was for the Commonwealth's rural Interstate highways. In July 1988, the maximum speed limit for passenger vehicles was raised to 65 mph. The maximum speed limit for commercial buses was raised to 65 mph in 1989 and that for trucks in 1994.

VTRC Study

The Virginia Transportation Research Council conducted a study in 1993 focusing on the changes in travel speeds, fatal crashes, fatalities and truck crashes on Virginia's rural Interstates after the implementation of the 65 mph speed limit. They analyzed annual data from the time period prior to the law change and from 1989-1992. Data for urban Interstates, noninterstates, and all systems were compared with data for rural Interstates in an attempt to determine whether similar patterns emerged.

Speed data were collected at permanent speed monitoring sites established for the Federal speed compliance monitoring program, for which quarterly and annual reports are made to the FHWA. However, the FHWA did not require that speeds be monitored on Interstate highways posted at 65 mph in any of the years studied. Virginia, like many other states, did not routinely collect speed data at rural Interstate speed monitoring stations. Special provisions were made by VDOT to conduct 24-hour rural Interstate speed surveys during each post-65 year. Thus, the reliability of rural Interstate speed data for post-65 years is not as high as for years when data were routinely collected. Speed data for the urban Interstates are as reliable as they were in the past because the data collection methods remained constant in urban areas.

In the analysis of speed and crash data, the pre-65 average was compared to the post-65 average. Further, because crash data were available by month, differences in fatal crash and fatality data pre-65 and post-65 were tested for statistical significance.

Virginia's Rural Interstate Highways

Table 4-2 shows the speeds at which motorists traveled for the three calendar years before and after the change.

Table 4-2

Average and 85th Percentile Speeds on Virginia's Rural Interstates

(1985-1987 vs. 1989-1991)

	55 mph Speed Limit	65 mph Speed Limit	Change
Average	58.6 mph	63.8 mph	+5.2 mph
85th Percentile	64.2 mph	70.5 mph	+6.3 mph

As the table above indicates, both the average and 85th percentile speeds increased, but by less than the 10 mph increase in the speed limit. The increases on rural Interstates are indicative of an upward trend that began in 1989. However, average rural Interstate speeds began to level off by 1991. Data for later years, which have become available since the 1993 study indicate speeds have stabilized.

Table 4-3 depicts the average annual rate of fatalities and fatal crashes on Virginia's rural Interstates for the three calendar years before the 65 mph speed limit was introduced in 1988 and for 1992-94, the most recent years for which data is available. Although earlier VDOT studies had shown that the fatality rate increased immediately following the speed limit increase to 65 mph in 1988 (Jernigan & Lynn, 1992) the fatality and fatal crash rates have since stabilized at pre-1988 levels. Although increased travel speeds appear to be associated with increased fatalities other concurrent safety improvements offset this effect.

Table 4-3

Average Annual Fatality and Rate Crash Rates per Hundred Million Vehicle Miles of Travel on Virginia's Rural Interstates

(1985-1987 vs. 1992-1994)

	55 mph Speed Limit	65 mph Speed Limit	Change
Fatal Crash Rate	0.8	0.8	0.0%
Fatality Rate	0.9	1.0	+11.0%

An earlier change in the speed limit occurred in July 1972, when the speed limit increased from 65 mph to 70 mph on rural Interstates. Table 4-4 compares the three calendar years before the speed limit change with the year 1973, the only full year in which the 70 mph speed limit was in effect. Although fatalities increased 27.8 percent, injuries and fatal and injury crashes increased only slightly.

Table 4-4

Average Annual Fatalities, Injuries, and Fatal and Injury Crashes on Virginia's Rural Interstates

(1969-1971 vs. 1973)

	65 mph Speed Limit	70 mph Speed Limit	Change
Fatal Crashes	74.0	77.0	+4.1%
Fatalities	83.7	107	+27.8%
Injury Crashes	1208.3	1223	+3.4%
Injuries	1953.3	2050	+5.0%

In March 1974, after the establishment of the 55 mph national maximum speed limit, the speed limit was reduced to 55 mph on Virginia's rural Interstates. Table 4-5 compares the average annual injuries, fatalities, fatal and injury crashes in 1973 to those for the three years after the change. Injuries, fatalities, and fatal and injury crashes decreased substantially. However, in 1974, the country was in the middle of an energy crisis. Even though 1974 data are not included in the table, the lingering effects of the energy crisis lessened discretionary travel, which probably accounts at least in part for the decrease.

Table 4-5

Average Annual Fatalities, Injuries, and Fatal and Injury Crashes on Virginia's Rural Interstates (1973 vs. 1975-1977)

	70 mph Speed Limit	55 mph Speed Limit	Change
Fatal Crashes	77.0	46.7	-39.4%
Fatalities	107.0	57.7	-46.1%
Injury Crashes	1223.0	878.0	-28.2%
Injuries	2050.0	1362.7	-33.5%

Virginia's Urban Interstate Highways

The speed limit on Virginia's urban Interstate highways increased from 65 to 70 mph in July 1972 and decreased from 70 to 55 mph in 1974. However, unlike rural Interstate routes, it did not increase to 65 in 1988 because these routes were not eligible for increased speeds under the change in Federal law. However, even though the speed limit did not change, Table 4-6 shows that travel speeds increased. Although urban Interstate average and 85th percentile speeds increased more than 3 mph, the increase was only half as much as on rural Interstates.

Table 4-6

Average and 85th Percentile Speeds on Virginia's Urban Interstates (1985-1987 vs. 1989-1991)

	55 mph Speed Limit	65 mph Speed Limit for Rural Interstates	Change
Average	54.3 mph	57.4 mph	+3.1 mph
85th Percentile	62.0 mph	65.5 mph	+3.5 mph

Table 4-7 compares the three calendar years before the implementation of the 70 mph speed limit with 1973. Fatal crashes and fatalities decreased substantially after the speed limit was increased, but injury crashes and injuries increased.

Table 4-7

Average Annual Fatalities, Injuries, and Fatal and Injury Crashes on Virginia's Urban Interstates (1969-1971 vs 1973)

	65 mph Speed Limit	70 mph Speed Limit	Change
Fatal crashed	27.7	21	-24.2%
Fatalities	33.7	25	-25.8%
Injury crashes	738.3	1018	+37.9%
Injuries	1065.0	1498	+40.7%

Table 4-8 compares fatalities, injuries, and fatal and injury crashes for 1973 with the three years after the establishment of the 55 mph national maximum speed limit. Fatal crashes and fatalities increased substantially and injury crashes and injuries increased moderately.

Table 4-8

Average Annual Fatalities, Injuries, and Fatal and Injury Crashes on Virginia's Urban Interstates (1973 vs. 1975-1977)

	70 mph Speed Limit	55 mph Speed Limit	Change
Fatal crashes	21	33.3	+58.6%
Fatalities	25	39.7	+58.8%
Injury crashes	1018	1177.3	+15.6%
Injuries	1498	1668.3	+11.4%

As these data indicate, the relationship between speed and accident rates is not as simple and direct as many would suppose.

Virginia's Limited Access Highways

Over the past several decades, the maximum speed limit for limited access highways has been the same as that for urban Interstates. Thus, the maximum speed limit established by law changed from 65 to 70 mph in July 1972 and from 70 to 55 mph in March 1974. Table 4-9 compares fatalities, injuries, and fatal and injury crashes for the three years before the 70 mph speed limit with 1973, the only full year in which the 70 mph speed limit was in effect. Fatalities, injuries, and fatal and injury crashes all increased substantially. But as you can see, the number of fatalities and injuries per year is extremely low on these types of routes, making the percentage increase appear large.

Table 4-9

Average Annual Fatalities, Injuries, and Fatal and Injury Crashes on Virginia's Limited Access Highways

(1969-1971 vs. 1973)

	65 mph Speed Limit	70 mph Speed Limit	Change
Fatal crashes	4.7	6	+27.7%
Fatalities	5.3	7	+32.1%
Injury Crashes	114.0	200	+75.4%
Injuries	159.7	284	+77.8%

Table 4-10 compares fatalities, injuries, and fatal and injury crashes for 1973 with the three years after the establishment of the 55 mph national maximum speed limit. Fatalities, injuries, and fatal and injury crashes increased substantially after the speed limit was lowered to 55 mph. Again, the overall accident rate is low, so percentage changes appear very large.

Table 4-10

Average Annual Fatalities, Injuries, and Fatal and Injury Crashes on Virginia's Limited Access Highways

(1973 vs. 1975-1977)

	70 mph Speed Limit	55 mph Speed Limit	Change
Fatal crashes	6	9.3	+55.0%
Fatalities	7	11.0	+57.1%
Injury crashes	200	232.0	+16.0%
Injuries	284	347.3	+22.3%

Virginia's Divided Highways with Four or More Lanes

Before the establishment of the 55 mph national maximum speed limit, these highways had a maximum speed limit of 60 mph. Table 4-11 compares the three years before the establishment of the 55 mph speed limit with the three years after. Fatal crashes and fatalities decreased substantially, and injury crashes and injuries increased slightly.

Table 4-11

Average Annual Fatalities, Injuries, and Fatal and Injury Crashes on Virginia's Divided Highways with 4 or More Lanes

(1971-1973 vs. 1975-1977)

	60 mph Speed Limit	55 mph Speed Limit	Change
Fatal crashes	154.7	126.3	-18.4%
Fatalities	180.3	142.7	-20.9%
Injury crashes	3252.7	3445.0	+5.9%
Injuries	5111.7	5209.7	+1.9%

Table 4-12 compares fatalities, injuries, and fatal and injury crashes on Virginia's undivided highways with four or more lanes for the three years before the establishment of the 55 mph national maximum speed limit with the three years after. Fatalities, injuries, and fatal and injury crashes all decreased modestly when the speed limit was lowered.

Table 4-12

Average Annual Fatalities, Injuries, and Fatal and Injury Crashes on Virginia's Undivided Highways with 4 or More Lanes

(1971-1973 vs. 1975-1977)

	60 mph Speed Limit	55 mph Speed Limit	Change
Fatal crashes	41.3	35.3	-14.5%
Fatalities	48.0	43.3	-9.8%
Injury crashes	1189.7	1129.3	-5.1%
Injuries	1837.3	1698.0	-7.6%

Truck Speeds Since Increase to 65

Virginia had a differential car/truck speed limit on the rural Interstates from 1988 through 1994. The speed limit for trucks was raised on rural Interstates from 55 to 65 mph on July 1, 1994. The Virginia Department of Transportation conducted a study shortly after the implementation of this law assessing the impacts on car and truck speeds. VDOT found that the increased speed limit resulted in an increase in a 1.96 mph increase in the average truck speed, and a negligible increase in the average car speed. Overall, the averaged speed of trucks increased from 61.45 mph to 63.41 mph and the average speed of cars increased from 67.25 mph to 67.43 mph. Table 4-13 below outlines the findings of this examination.

Table 4-13

Car and Trucks Speeds Following the Increased Truck Speed

	Avg. Speed	85th % Speed	% >55	% >60	% >65
Cars	+0.18 mph	-0.17 mph	-1.26%	-2.37%	-2.67%
Trucks	+1.96 mph	+2.61 mph	+3.90%	+17.79%	+16.21%

OTHER FACTORS

Improved Safety Devices

Highway safety is a vital concern of transportation agencies. Over the years, highway safety has been improving continually, reflecting a wide range of long-term improvements in roads, vehicles, and driver behavior. These improvements gradually have reduced the rate of fatalities.

Vehicular improvements in recent decades include increased seatbelt use, airbags, collapsible steering columns, regular vehicle inspections and other increases in automobile crashworthiness. Increased use of energy-absorbing barriers, regulatory and warning signs, improved guardrails, breakaway signs and lighting support, bridge and curve widenings and various construction techniques have increased the safety of the roadways. Increased education efforts, strict licensing requirements and stringent alcohol restrictions have improved driving practices, and thus enhanced highway safety. Finally, improved emergency medical services has played a part in reducing fatalities over the years.

Mandatory Seat Belt Use Law

Safety belts have been estimated to be between 40% and 45% effective in preventing fatalities in crashes that are life-threatening (Evans, 1985; Grey, 1985; and, Insurance Institute for Highway Safety, 1986).

In Virginia, 70% of drivers comply with the safety belt use requirement. However, Virginia's requirement that safety belts be utilized is only a secondary law, meaning that officers may issue a safety belt citation only if the officer has stopped the vehicle for another reason. The National Highway and Transportation Safety Administration (NHTSA)reports that states with primary laws have significantly higher safety belt use rates and greater reductions in fatality and injury rates. Seat belt usage rates in the nine primary law states averaged 12 percentage points higher than in the secondary law states (NHTSA, 1995). NHTSA's data indicate that during the first full year after enforcement of belt laws, fatality rates dropped 21% in five primary law states compared to only 7% in 11 secondary law states.

Logically, it would be expected that faster speeds would be associated with a diminished effectiveness of the safety belt's ability to prevent traffic fatalities. However, a recent study found no significant relationship between vehicle speed and safety belt effectiveness (Evans and Frich, 1986). At high speeds, safety belts remain very effective in some types of crashes, such as rollovers, but are less effective in others, such as head-on crashes. This great amount of variance in safety belt effectiveness prevents determining whether vehicle speed independent of other factors is related to belt-system effectiveness in preventing fatalities.

Additional Legislative Measures

The National Safety Council has lobbied to maintain lower speed limits. However, they state that if states do raise limits, they should adopt the following measures:

- A 0.08 blood alcohol standard for intoxication
- Zero-alcohol tolerance laws for drivers under 21
- Graduated licensing for beginning drivers
- Tougher enforcement of impaired driving laws
- Bans on radar detectors, and
- Primary enforcement of safety-belt laws

Virginia already has laws regarding each of these issues, except the last.

Compliance

Speed limits are effective only if drivers obey them. Although most drivers obeyed the 55 mph speed limit in 1974, this is no longer the case. In the decade following the imposition of the 55 mph speed limit, the percentage of drivers exceeding the speed limit steadily increased. By 1985, more than half of all vehicles were exceeding the speed limit on roads posted at 55 mph in 44 of the 50 states (FHWA, 1985). It repeatedly has been found (Garber and Gadiraju, 1988; TTI, 1995; AASHTO, 1986) that drivers tend to travel at higher speeds on roadways with higher design speeds, regardless of the posted limits.

Even before 55 mph was the national maximum speed limit, motorists had come to expect that marginal violations would be ignored. Enforcement agencies, courts and public opinion have traditionally not been literal in their enforcement of speed limits, but have permitted some tolerance above the state speed limit before issuing citations. Both state enforcement agencies and courts allocate their resources in some proportion to the significance of the problems, and marginal speeding violations are frequently perceived as a secondary concern. Some states have written policies defining the speed tolerance. In Tennessee in 1984, for example, a driver had to be clocked at 6 mph over the limit before a state patrolman could issue a ticket. About one-fourth of states leave the decision about tolerance to the individual patrolman, an equal proportion sets the tolerance at 5 mph or less, 20% of states allow tolerances of 6 to 10 mph; and a very few allow tolerances over 10 mph (Transportation Research Board, 1984).

Studies on drivers' attitudes toward speed limits have shown that drivers will ignore the posted speed limit and will tend to travel at the speed for which the particular roadway is designed or a speed appropriate for existing conditions (Garber and Gadiraju, 1988). Sievers (1976) surveyed New Mexican drivers using self-report methods and found that fewer than 20% traveled at or below the 55 mph speed limit. Also, Garber and Gadiraju (1988) found that drivers tended to ignore the posted speed limit and travel at higher speeds as roadway characteristics improved.

Under the provisions of the Intermodal Surface Transportation Efficiency Act (ISTEA), FHWA was required to make annual reports to Congress on NMSL compliance. FHWA's 1995 report details levels of compliance in Fiscal Year 1993. The report states that over 54 million vehicles were monitored nationwide in Fiscal Year 1993. With adjustments for speedometer variability, statistical error and speed measuring equipment error by state, the nationwide proportion of vehicles found to be exceeding 55 mph was 45.9; 38.4 % of drivers exceeded 55 mph in Virginia. Unadjusted, the percentage was 60.1% nationwide and 53.5% in Virginia.

Nationally, the average speed traveled in 1993 was 56.9 mph and the 85th percentile speed was 64 mph. In Virginia, the average speed was 55.2 mph and the 85th percentile speed was 62.6 mph. Nationwide, the percentage of vehicles exceeding 60 mph was 31.5% and the percentage exceeding 65 mph was 12.5%. In Virginia, 23.2% of drivers exceeded 60 mph on roads posted at 55 mph, and 6.8% exceeded 65 mph.

By functional class of highway, the percent exceeding 55 mph nationwide ranged from a low of 45.2% on nonfreeways within urban areas, to a high of 79.5% on rural Interstates. In Virginia, 72.3% of vehicles monitored exceeded the 55 mph speed limit on urban Interstates, 56.3% on other urban freeways and expressways, and 44.3% on other urban arterials. On rural routes, 61.5% exceeded 55 mph on rural arterials and 22.2% exceeded the limit on major rural collectors. As these data indicate, compliance difficulties appear greatest on Interstate routes, where average speeds are high and where many roads are designed to accommodate speeds well in excess of 55 mph.

Enforcement Issues

Deterrence of speeding appears to depend, in poorly understood ways, upon the level of the fine, the enforcement tolerance, and the intensity of enforcement. All of these influence the public's perception of the risk of violating the law.

On average there is only one highway patrol office on duty for each 190 miles of roadway posted at 55 mph (Transportation Research Board, 1984). Clearly, the enforcement efforts can reach only a small proportion of traffic, and compliance depends upon widespread public support of traffic laws.

Research on speed limit compliance has indicated that states with higher penalties on the books tend to have less speeding. To examine the effects of penalties, Godwin and Kulash (1988) divided states into three groups -- those with high, medium and low penalties. High-penalty states are those that impose maximum fines greater than $25 and also impose points on a convicted speeder's permanent traffic record. The medium-penalty states are those that either impose a fine greater than $25 or impose points. The low-penalty states are those with a maximum fine for speeding of less than $25 and which do not impose points.

Overall, low-penalty states do indeed report more speeding and higher fatality rates. Similarly, high-penalty states report the least speeding and the lowest fatality rates. Strict enforcement of speed limits and a public perception that the penalty for speeding will be high appear to result in more uniform speeds and a lower incidence of accidents.

Stopping Distances

Vehicle stopping distances can be affected by various factors such as driver reaction time, vehicle velocity, gradient of the roadway, and the friction between the vehicle's tires and the pavement. To estimate the effect that speed has on stopping distances, the stopping distances of a vehicle on a dry, level paved surface were estimated by adding the distance traveled by a vehicle from the instant the drivers sights an object to the instant the brakes are applied (i.e., driver perception and reaction time) to the braking distance for a given speed, which is calculated by the following formula:

$$S = \frac{V^2}{30(F)}$$

Where S = the braking distance in feet

V = the vehicle speed in mph

F = the coefficient of friction

In Table 5-1, reprinted from the Institute of Transportation Engineers' Traffic Engineering Handbook, reasonable estimates for the coefficient of friction on dry, level pavement are used to calculate the stopping distances for 50 mph through 70 mph. As this table indicates, the 8.3% increase in travel speed from 60 mph to 65 mph results in a 14.8% increase in total stopping distance. Further, the 18% increase in speed from 55 mph to 65 mph results in a 32% increase in stopping distance.

Stopping distances are one of the guiding factors behind design speeds. Roads with design speeds of 70 mph are designed such that no horizontal or vertical curve obstructs a driver's sight distance to the extent that the stopping distance exceeds his line of vision. Thus, a road with a design speed of 70 mph was engineered to provide enough distance for the majority of drivers traveling at 70 mph to stop safely to avoid collision with an object in the road.

Table 5-1
Speed and Stopping Distances

Speed	Coefficient of Fiction	Braking Distance (ft)	Reaction Time/Distance (ft) 2.5 seconds	Total Stopping Distance (ft)
50 mph	0.62	135	183	318
55 mph	0.60	168	202	370
60 mph	0.58	207	220	427
65 mph	0.56	252	238	490
70 mph	0.54	303	257	560

Headlamp Distances

Some have argued that speed limits should not be increased because if drivers traveled at higher speeds their headlights would not provide sufficient illumination to allow for adequate sight distances. However, headlamp distance has never been considered a design factor in roadway engineering. As noted in AASHTO's Policy on Geometric Design of Highways & Streets (1994) the minimum stopping sight distance values used for design exceed the length of the visible roadway for night driving on highways without lighting. First, vehicle headlights have limitations on projection distance for the light intensity levels that are required for visibility purposes. When headlights are operated on low-beam, the reduced candlepower at the source plus the downward projection angle significantly restrict the length of visible roadway surface. Thus, particularly for high-speed conditions, stopping sight distance values exceed road-surface visibility distances.

It is rationalized that drivers are aware that visibility at night is less than during the day regardless of design features and that vehicle operators are thus more attentive and alert.

In order to not overrun headlamps, maximum vehicle speeds would have to be reduced to 25-30 mph at night, even on Interstates.

Spillover Effects

Some have questioned whether raising speed limits on certain roadways, such as Interstates, would lead to increased fatalities on other types of roadways as well, assuming that drivers would not slow down sufficiently once they exited the major highways. A United States Department of Transportation (USDOT) report to Congress released in May, 1992 refutes this proposition. As USDOT noted, "On all other roads other than rural Interstates ... only one state (Nevada) experienced an increase in fatalities greater than 25%. Only 12 states experienced any increase in 1990 relative to 1986, and 27 states experienced a decrease in fatalities. One state (Arkansas) had the same number of fatalities both years. This general experience is consistent with what might be anticipated on roadways other than rural Interstates given there has been no change in the speed limit on those roadways." In terms of Virginia's experience, this report indicates that fatalities on roads other than rural Interstates remained basically constant in Virginia between 1988 and 1990 -- at 995 and 996 fatalities respectively, and did not increase in response to higher speeds on rural Interstates.

Since Maryland increased the speed limit on some routes to 65 in July, 1995, it has actually seen a decrease in average speeds on roads that retained a 55 mph speed limit. The 85th percentile speed on roads that stayed at 55 dropped from 69.3 to 68.3 mph over the year. The fatality rate on those roads remained unchanged.

Time Consequences

The largest adverse consequence of slower driving is that it takes more time. U.S. motorists spent about one billion extra hours on the road annually because of the 55 mph speed limit (Transportation Research Board, 1984). This means that each road user spends about seven more hours on the road each year due to slower speeds. There are, of course, particular groups of road users whose experience differs substantially from these averages. For example, many truck drivers and traveling sales representatives drive many more miles than the average motorist, and spend far more time traveling because of the 55 mph limit than does the typical motorist.

The time cost is particularly pronounced on the Interstates and freeways because these highways carry a large share of traffic. Further, because these roads formerly had the nation's highest speed limits, the reduction in average speeds is most noticeable. At the same time, these roads were designed to be safe when driven at higher speeds, and the safety benefit of driving slower on these roads generally is proportionately smaller than on other road systems. Goodwin and Kulash estimate that the 55 mph speed limit costs more, in terms of travel time, on the Interstate, and it produces smaller benefits in terms of the number of lives saved. Overall, about 100 years of additional driving is expended for each life saved on the rural Interstate (Goodwin and Kulash, 1988). This time/safety trade-off is much worse than it is for other systems, where only about 25 years of additional driving time are expended for each life saved. Critics of 55 are thus correct in pointing out that the speed limit is least cost-effective on rural Interstate routes.

Lave (1988) also made an assessment of the time-costs of lower speed limits. He believes Godwin and Kulash's calculation understates the cost of the 55 mph limit because it assumes one drives 24 hours per day. Lave recalculated the equation, assuming eight hours of driving per day and found that it takes 233-291 years of extra driving to save one life on rural Interstate highways; 46.5 years of extra driving to save one life on urban Interstates and freeways.

CONCLUSIONS

Background

Posted speed limits generally are established to indicate the safe speed for a given roadway. Factors that are considered in setting speed limits include the type of road (residential, Interstate, etc.), design features (curvature, lane width, etc.), the type of access that motorists have onto the road and accident history.

One major factor considered is the design speeds of the Commonwealth's highway network. Study results indicate that generally, Interstate highway design speeds are sufficient to accommodate safely 70 mph operating speeds and the design speeds of four-lane divided primary highways are sufficient to accommodate safely 60 mph operating speeds. There are, of course, exceptions to this general rule and where these occur, the Commissioner can post a lower speed limit for these particular segments.

A 55 mph speed limit currently applies to several different classes of highways. Interstates and urban freeways are multi-lane roadways that are designed for high-speed driving. These highways, which are among the nation's safest, are the source of much of the current controversy about the speed limit. They make up a small fraction of total highway mileage (less than 5%), but carry 23% of all highway travel. These also are the roads where the 55 mph limit imposes the greatest reduction in driving speeds because they are designed to accommodate much faster travel. Before 1974, most rural potions of the Interstate system were posted at 65 mph or 70 mph.

The physical features of Virginia's Interstate highways and the existing traffic characteristics indicate that the factors discussed above will not be violated if Virginia increases the speed limit. For example, the design speed for most sections of Interstate highways is 70 mph, thus an increase would be consistent with the design speed criteria. Because the Commissioner of the Virginia Department of Transportation has the authority to lower the speed limit on specific sections of highways within the state, sections where design speeds are less than 70 can be identified and posted with appropriate speed limits. In addition, the current 85th percentile speed is 70 mph on Virginia's rural Interstates and 65 mph on its urban Interstate highways. Thus, increasing the speed limit on some of these routes would not violate the 85th percentile concept. The 85th percentile speed (the speed at or below which 85% of the motorists travel on a given roadway) is a critical factor in setting speed zones. Although most drivers adjust their travel speed to one that is comfortable for them, some travel at speeds too fast for the prevailing conditions. When speed limits are set at or near the 85th percentile speed, motorists are advised of what speed is reasonable and safe, and it becomes manageable to enforce the limit for the 15% who exceed it. In any event, a speed limit set too high sends the wrong message to motorists about what speed is reasonable and prudent and a limit set too low provides an excuse for noncompliance.

Nationally, the posted speed is most often set by rounding the 85th percentile speed to the nearest speed value in mph that ends in 5 or 0. Using the 85th percentile speed in selecting posted speeds is based upon the belief that the large majority of drivers are capable of judging appropriate speeds based upon roadway geometrics, roadside development, weather conditions, traffic, etc. and they in fact will do so. Basing posted speeds upon 85th percentile speeds also promotes uniformity of speeds at a given location (i.e., reduces speed variance). The benefit of a uniform speed, as discussed earlier, is that vehicle collisions are less likely to occur if drivers are traveling at about the same speed.

Exceptions to the 85th percentile procedure occur in a number of circumstances. On sections of highway with high accident experience, the speed limit may be as much as 7 mph lower than the 85th percentile speed. There are concerns that, except in cases where safety makes it necessary, posting speed limits below the 85th percentile speed puts the majority of drivers in violation, places unnecessary burdens on law enforcement personnel, leads to a lack of credibility of speed limits and leads to the use of large tolerances by enforcement agencies.

Liability Issue

One final issue to consider is tort liability. With the change in federal law allowing states to set their own speed limits the issue of tort liability emerges as a concern for the Commonwealth. Analysis of the limited case law from other jurisdictions addressing government agency liability for raising speed limits, as well as the wording of the Virginia Tort Claims Act, suggests a probability that decisions to raise a speed limit could form the basis for tort liability. Though the court opinions available differ in outcome, the decisions of jurisdictions weighing the liability of a government agency for its improper speed limit determinations tend to turn on a particular distinction -- that between decisions which are policy-making in nature and decisions which are based on professional judgment. It appears that decisions of the Commissioner, based on engineering judgment, might not qualify for immunity from tort liability suits, whereas decisions based on legislative grants of authority would be exempt from tort liability.

Conclusions

Because the National Highway System Designation Act, and its provision allowing for the increase in speed limits, was enacted only one year ago, data regarding the impact of increased speed limits is rather limited. Collecting information on other state experiences and reviewing the results of FHWA's ongoing national study would provide more information.

Speed limits could be raised in Virginia without violating accepted traffic engineering practices. The design speeds (developed to set appropriate speed limits) and 85th percentile speeds, (a measure to achieve the minimum of speed variation), are both greater than the current speed limit on many of Virginia's roadways. In addition, the maximum speed limit was 70 mph in Virginia in 1973 and is currently at least 70 mph in 21 states. VDOT has established guidelines to establish lower speed limits where roadway, traffic or environmental conditions would not support such an increase.

Increasing the speed limit would be expected to result in a reduction in speed variance on the highways at least in the short run. Such a decrease in speed variance would be expected to result in a decrease in the total number of crashes, at least in the short run. However, travel speeds would be expected to increase. Based on previous experiences in Virginia and other states, and on the fact that crashes at higher speeds are more severe, some increase in the absolute number of fatalities and injuries can be expected on the affected roadways. Conversely, fatality and injury rates per hundred million vehicle miles of travel can be expected to continue to decrease in the long run.

If the General Assembly raises the maximum speed limit for any of the road classifications for any type of vehicle, the Task Force would recommend that the General Assembly set maximum allowable limits and empower the Commissioner to determine which roads could accommodate higher speed limits. The Commissioner would not increase speed limits above the current limits unless design speeds, traffic volume and other roadway characteristics so indicated. For example, speed limits on congested urban routes, such as the Capital Beltway, I-95 in Richmond, and I-64 and I-264 in Tidewater would not be increased above 55 mph. Similarly, a heavily trafficked primary route that does not have limited access, such as a Route 17 or a Route 460, would not be increased either.

APPENDICES

Appendix A

SENATE JOINT RESOLUTION NO. 7

Requesting the Secretary of Transportation to convene a special task force on safe maximum highway speed limits.

Agreed to by the Senate, February 13, 1996
Agreed to by the House of Delegates, February 23, 1996

WHEREAS, the Congress of the United States enacted and the President of the United States signed into law on November 28, 1995, federal legislation abolishing federally mandated maximum highway speed limits; and

WHEREAS, this action returns to the Commonwealth of Virginia the authority to establish appropriate maximum highway speed limits for the various classifications of highways and vehicle types within the Commonwealth; and

WHEREAS, the rapid, safe, efficient, and effective flow of traffic on the Commonwealth's highways should be based on sound, rational, and objective criteria; and

WHEREAS, it is highly desirable that the development and implementation of sound, rational, and objective criteria for setting maximum highway speed limits on the various classifications of highways and for vehicle types within the Commonwealth to promote the rapid, safe, efficient and effective flow of traffic involve the participation not only of those state agencies responsible for highway safety, but also other public and private sector transportation safety-related groups; and

WHEREAS, highways in the Commonwealth built and maintained to federal interstate highway safety and design standards have design speeds in excess of 65 mph and also incorporate a number of other safety features to facilitate the rapid, safe, efficient, and effective movement of traffic; and

WHEREAS, the ultimate responsibility for establishing maximum highway speed limits on the Commonwealth's highways rests with the General Assembly of Virginia; now, therefore, be it

RESOLVED by the Senate, the House of Delegates concurring, That the Secretary of Transportation be hereby requested to convene a special task force on safe maximum highway speed limits to conduct a study for the purpose of recommending appropriate maximum highway speed limits for the various classifications of highways and types of vehicles within the Commonwealth, based on the development of sound, rational, and objective criteria designed to facilitate the rapid, safe, efficient, and effective movement of traffic on the Commonwealth's highways.

The membership of this special task force shall include, but not be limited to, representatives of the Commonwealth Transportation Board, the Virginia Department of Transportation, the Virginia Transportation Safety Board, the Virginia State Police, the Crash Investigation Team of the Department of Motor Vehicles, the Virginia Highway Research Council, the Virginia Association of Counties, the Virginia Municipal League, the Virginia Association of Sheriffs, the Virginia Association of Chiefs of Police, the American Automobile Association, and such other organizations or individuals as may be designated by the Secretary of Transportation.

The Secretary shall report on the findings and recommendations of the special task force to the Governor and the 1997 Session of the General Assembly as provided in the procedures of the Division of Legislative Automated Systems for the processing of legislative documents.

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