Impact of Differential Speed Limits on the Speed of Traffic and the Rate of Accidents

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After the enactment of the Surface Transportation and Uniform Relocation Assistance Act in 1987, several states changed the speed limit on rural Interstate highways from 55 to 65 mph. Some of these states have restricted truck speeds by imposing differential speed limits (DSLs). As a result, the maximum speed limit for trucks is 55 mph and that for passenger cars is 65 mph. The objective was to reduce the impact of the increased speed limit on accidents involving trucks. However, the extent to which this strategy has been successful in achieving the objective has not been documented by field data. The nature and extent of the effects of DSLs on vehicle speeds and accident characteristics were assessed. Speed and accident data at study sites in California, Michigan, Maryland, Virginia, and West Virginia were used. Data from Interstates 64, 77, and 81 that traverse Virginia and West Virginia were used for a direct comparison of the DSL. Statistical analysis of the data indicated that, in states where the DSL was imposed (65 mph for nontrucks and 55 mph for trucks), the mean speeds of passenger cars or vehicles other than trucks increased only from 1 to about 4 mph in response to a 10-mph increase in the speed limit. However, there was no significant increase in the mean speed of trucks. Also, following the increase of the speed limit to 65 mph for vehicles other than trucks, speed fluctuations within the traffic stream decreased. On the other hand, speed variances for all vehicles were still higher on Virginia highways with DSL (65/55 mph) compared with those for similar highways in West Virginia operating under 65/65 mph. There is no evidence that the increase in the maximum speed limit to 65 mph for passenger vehicles on the rural Interstate systems in the states studied has directly resulted in a significant increase in fatal, injury, or overall accident rates.

At the time of the severe oil shortage in the early 1970s, a speed limit of 55 mph was imposed in an effort to reduce fuel consumption. With the easing of the oil crisis in the early 1980s, the benefits of a blanket 55-mph speed limit were questioned. Compliance with the 55-mph speed limit was decaying, leading to a concern that the safety of U.S. highways would be affected (*1*). After the enactment of the Surface Transportation and Uniform Relocation Assistance Act on April 2, 1987, most states changed their speed limits from 55 to 65 mph on rural Interstate highways. However, there was concern among some decision makers that trucks traveling at 65 mph might increase the potential of accidents between trucks and other types of vehicles. The imposition of a lower speed limit for trucks, usually referred to as a differential speed limit (DSL), was identified as one of the ways of reducing the interaction between trucks and other vehicles. The underlying concept of DSL is that for any given speed, a truck takes more time to decelerate to a lower speed and requires more stopping distance than a passenger car. Hence, the speed differential can compensate for the disparity in operating characteristics by making braking distances more compatible. On the basis of this theory, some states adopted the DSL to lessen the effect of raising the speed limit.

Proponents of the higher speed limit for trucks point out the economic benefits of higher limits and contend that enforced speed differentials may generate more accidents and hence increase the propensity for certain categories of accidents such as rear-end collisions, thereby resulting in an increase in fatal crashes involving trucks (*2*).

However, these theories have not been adequately investigated using actual field data. To provide the information required to evaluate and compare the different speed limit strategies, the effects that the 65/65- and 65/55-mph limits have had on the speed of traffic and accident patterns were investigated.

A study in Maryland found that at sites with a posted differential of 10 mph, the actual difference between car and truck speeds was less than 6 mph (*3*). The higher passenger car speed limit associated with a DSL contributed to a higher percentage of compliance (62 percent) than was the case with equal (55/55-mph) limits (40 percent). Elmberg studied the effect of posted speed limits on drivers' speeds (*4*). Elmberg's results indicated that drivers paid little if any attention to the posted speed limits and that drivers chose a speed that they themselves considered appropriate for the prevailing conditions. An important corollary to these results is the finding by Garber and Gadiraju that the difference between the design speed and the posted speed limit has a significant effect on speed variance in that speed variance increases rapidly when this difference is less than 5 mph or greater than 10 mph. That study also showed that accident rates increase with increasing speed variance for all classes of roads (*5*). The Maryland study also noted that although speed variation can be brought about by enforced differential truck speed limits, the existence of a posted DSL was not related to the occurrence of truck accidents. The study also suggested that lower rates of truck accidents could be expected with higher speed limits and hence recommended an increase of truck speed limits from 55 to 60 or 65 mph on highways carrying a sizable fraction of trucks. A simulation study carried out in Virginia also concluded that no safety benefits were observed by imposing a DSL. On the contrary, it was reported that there was a potential for an increase in accident rates, especially on highways with high AADT and a high percentage of trucks (*2*).

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PURPOSE AND SCOPE

The primary purpose of this study was to determine whether the imposition of a DSL on a rural Interstate highway will result in significant changes in the speed of the traffic and the type and number of accidents on the highway. Although the study was limited to the states of California, Maryland, Michigan, Virginia, and West Virginia, the results can be generalized because of the varied locations of these states.

The specific objectives of the study were to

- Determine the effect of increasing the speed limit to 65 mph for passenger cars on the speeds of passenger cars and trucks and on accident patterns;
- Investigate the effect of a DSL on speed dispersion and the difference between mean speeds of trucks and passenger cars, accident rates and the severity of accidents, and different categories of accidents and various types of collisions; and
- Compare the relative benefits of the 65/55- and the 65/65-mph speed limits.

METHODOLOGY

Selection of Study Sites

The selection of sites for this study was based on the premise that data from a few sites from states located in different parts of the country would give more representative results than data from many sites in one or two states in the same area of the country. For comparisons, two sets of sites were chosen. The first set consisted of test sites and control sites. Test sites were segments of the Interstate routes on which the posted speed limit was increased, and control sites were those sections on which the speed limit remained at 55 mph. Typical control sites were Interstate segments near metropolitan areas and other comparable federal routes running parallel to test sites. A total of 11 sites at which extensive data had been collected before and after the speed limit increase were selected. There were three in California (one test and two control), three in Michigan (one test and two control), four in Virginia (two test and two control), and one control site in Maryland. The data from the first set of sites were used to investigate the effect of raising the speed limit to 65 mph for vehicles other than trucks.

The second set consisted of sites on routes I-66, 1-77, and I-81 that traverse both Virginia (with DSL) and West Virginia (without DSL). This facilitated the direct comparison of the effect on accident characteristics of the 65/55-mph speed limit with that of the 65/65-mph speed limit. Unfortunately, it was not possible to obtain "before" speed data at the West Virginia sites. The comparison was therefore made on the "before" and "after" accident rates but only on speed data from the period after the DSL went into effect in Virginia.

Data Collection

Speed Data

The speed data were collected during 24 hr of continuous monitoring. For direct comparison, speeds were recorded before and after the change in speed limit. Tables 1 through 4 give the speed statistics at the test and control sites for the

TABLE 1 "Before" and "After" Speed Data for California Study Sites

PERIOD	VEHICLES	SPEED LIMIT	VOLUME (ADT)	MEAN SPEED (MPH)	STND DEVN	85th % SPEED	% IN PACE	% OVER LIMIT
			Test Section – Interstate 5 Near Williams					
"BEFORE"	CARS	55	3921 SB	66.0	6.4	72	63.3	95.3
	TRUCKS	55	2918 SB	62.7	6.3	68	72.6	89.9
	ALL VEHICLES	55	6839 SB	64.7	6.6	71	65.5	93.0
"AFTER"	CARS	65	5835 SB	67.2	6.3	74	64.5	69.1
	TRUCKS	55	2827 SB	61.2	5.9	67	72.4	21.7
	ALL VEHICLES	65/55	8662 SB	65.2	6.8	72	58.0	53.5
			Control Section A – Interstate 5 in Sacramento					
"BEFORE"	CARS	55	30192 SB	62.7	5.8	69	65.6	93.5
	TRUCKS	55	11022 SB	62.2	5.2	68	69.2	92.8
	ALL VEHICLES	55	41214 SB	62.5	5.7	69	66.4	93.3
"AFTER"	CARS	55	40965 SB	62.7	5.7	69	65.1	92.3
	TRUCKS	55	8521 SB	59.8	5.7	65	70.0	83.9
	ALL VEHICLES	55	49486 SB	62.2	5.8	68	64.3	90.7
			Control Section B – Route 99 at Grant Line Road					
"BEFORE"	CARS	55	9973 SB	62.2	4.9	67	74.7	94.4
	TRUCKS	55	3373 SB	59.9	4.4	64	79.9	89.0
	ALL VEHICLES	55	13346 SB	61.6	4.9	67	74.6	93.0
"AFTER"	CARS	55	11272 SB	62.0	4.7	67	75.2	94.1
	TRUCKS	55	3445 SB	59.2	4.4	64	78.6	85.7
	ALL VEHICLES	55	14717 SB	61.3	4.8	66	74.5	92.1

TABLE 2 "Before" and "After" Speed Data for Michigan Study Sites

PERIOD	VEHICLES	SPEED LIMIT	VOLUME (ADT)	MEAN SPEED (MPH)	STND DEVN	85th % SPEED	% IN PACE	% OVER LIMIT
			Test Section – Interstate 96 Near Fowlerville					
"BEFORE"	CARS	55	29861 EB	65.8	5.9	74	64.2	97.5
	TRUCKS	55	4538 EB	59.2	5.1	66	70.6	81.0
	ALL VEHICLES	55	34399 EB	64.8	6.3	73	61.0	95.2
"AFTER"	CARS	65	32698 EB	67.0	5.4	74	69.4	66.2
	TRUCKS	55	4667 EB	59.1	4.8	65	74.8	8.5
	ALL VEHICLES	55	37365 EB	65.9	5.9	73	63.8	58.5
			Control Section A – Route 52 South of I-96					
"BEFORE"	CARS	55	2646 EB	61.4	7.4	70	59.3	84.1
	TRUCKS	55	411 EB	56.1	8.9	66	53.6	63.1
	ALL VEHICLES	55	3057 EB	60.6	7.9	70	57.6	81.3
"AFTER"	CARS	55	2889 EB	61.0	6.6	70	61.0	84.9
	TRUCKS	55	503 EB	55.7	6.1	63	65.1	58.3
	ALL VEHICLES	55	3392 EB	60.2	6.8	69	58.9	80.8
			Control Section B – Interstate 69 Near Flint					
"BEFORE"	CARS	55	35476 EB	65.6	6.7	75	57.9	95.5
	TRUCKS	55	4237 EB	64.1	6.1	72	63.3	93.4
	ALL VEHICLES	55	39713 EB	65.5	6.7	74	58.1	95.3
"AFTER"	CARS	55	29390 EB	66.1	6.4	74	58.0	95.8
	TRUCKS	55	3891 EB	63.2	6.1	71	59.5	92.7
	ALL VEHICLES	55	33281 EB	65.8	6.4	74	57.6	95.5

TABLE 3 "Before" and "After" Speed Data for Virginia Study Sites

PERIOD	VEHICLES	SPEED LIMIT	VOLUME (ADT)	MEAN SPEED (MPH)	STND DEVN	85th % SPEED	% IN PACE	% OVER LIMIT
			Test Section A – Interstate East of Marshall					
"BEFORE"	CARS	55	7117 WB	62.6	6.2	70	66.2	92.3
	TRUCKS	55	4016 WB	61.5	6.0	69	62.8	88.3
	ALL VEHICLES	55	11133 WB	62.2	6.2	70	64.7	90.8
"AFTER"	CARS	65	9002 WB	65.3	4.9	72	73.8	52.3
	TRUCKS	55	2519 WB	61.8	5.8	70	63.2	28.6
	ALL VEHICLES	65/55	11521 WB	64.5	5.3	71	68.9	47.1
			Test Section B – Interstate 81 South of Lexington					
"BEFORE"	CARS	55	7843 NB	66.5	5.4	74	69.1	99.0
	TRUCKS	55	4249 NB	65.6	5.0	73	70.7	98.7
	ALL VEHICLES	55	12092 NB	66.2	5.3	73	69.7	98.9
"AFTER"	CARS	65	6620 NB	67.4	4.8	74	74.6	70.7
	TRUCKS	55	5577 NB	65.2	5.4	72	65.9	51.0
	ALL VEHICLES	65/55	12197 NB	66.4	5.2	73	70.2	61.5
			Control Section A – Interstate 64 in Chesapeake					
"BEFORE"	CARS	55	19694 WB	61.2	5.8	69	65.6	93.5
	TRUCKS	55	9366 WB	58.4	5.2	68	69.2	92.8
	ALL VEHICLES	55	29060 WB	60.2	5.7	69	66.4	93.3
"AFTER"	CARS	55	20128 WB	62.7	4.0	61	65.1	92.3
	TRUCKS	55	9749 WB	59.8	3.6	63	70.0	83.9
	ALL VEHICLES	55	29887 WB	62.2	4.2	65	64.3	90.7
			Control Section B – Interstate 64 in Newport News					
"BEFORE"	CARS	55	16873 EB	62.2	4.9	67	74.7	94.4
	TRUCKS	55	5009 EB	59.9	4.4	64	79.9	89.0
	ALL VEHICLES	55	21882 EB	61.6	4.9	67	74.6	93.0
"AFTER"	CARS	55	17149 EB	64.2	4.4	70	75.2	94.1
	TRUCKS	55	5830 EB	61.9	3.4	66	78.6	85.7
	ALL VEHICLES	55	22979 EB	63.5	4.2	69	74.5	92.1

TABLE 4 "Before" and "After" Speed Data for Maryland Study Site

PERIOD	VEHICLES	SPEED LIMIT	VOLUME (ADT)	MEAN SPEED (MPH)	STND DEVN	85th % SPEED	% IN PACE	% OVER LIMIT
		CONTROL SECTION – INTERSTATE 70 WEST OF FREDERICK						
"BEFORE"	CARS	55	11399 EW	65.5	5.4	73	68.3	98.3
	TRUCKS	55	3091 EW	64.4	5.8	72	68.5	96.3
	ALL VEHICLES	55	14490 EW	65.3	5.5	72	68.0	97.8
"AFTER"	CARS	55	12801 EW	65.9	5.5	73	68.1	98.5
	TRUCKS	55	2380 EB	65.5	5.5	73	67.5	97.5
	ALL VEHICLES	55	15631 EW	65.8	5.5	73	68.0	98.3

first set of study sites. The parameters of "after" speed data at sites on the routes that traverse Virginia and West Virginia are given in Table 5.

Accident Data

Accident data were collected at each site and designated as either "before" or "after" data. The "before" data covered at least 36 months preceding the effective date of the change in the speed limit, whereas the "after" data covered 12 or more months with the new speed limit. Specific information on accident characteristics was extracted from accident files, including details of vehicles involved, collision type, severity of accident, and several other variables. Volume data in terms of average daily traffic (ADT) were obtained at each site and were used to compute the accident rates that formed the basis of comparison. Three severity classifications were used: fatal (FAT), injury (INJ), and property damage only (PDO). The accidents were also classified in terms of the number of vehicles involved (i.e., one, two, or three or more). The three main categories of two-vehicle accident types were nontruck/nontruck (NT-NT), nontruck/truck (NT-T), and truck/truck (T-T). The three most common types of collisions were sideswipe, rear-end, and those with a fixed object. Tables 6 through 8 summarize the accident rates for the different locations by severity, number of vehicles, and types of vehicles and collisions.

ANALYSIS AND RESULTS

Detailed statistical comparisons were carried out to determine whether significant changes occurred in speed and accident characteristics after the implementation of a given strategy. The *T*-test was used to compare the different sets of speed data, and the chi-square and proportionality tests were used for the accident data. The following null hypotheses formed the basis for comparisons:

1. Hypothesis for "before" and "after" comparison: There is no significant difference in accident or speed characteristics between the "before" and "after" data for the sections of highway under consideration. This hypothesis was tested for changes in accident and speed characteristics at sites where the speed limit was changed from 55 to 65/55 mph and at sites where the speed limit was maintained at 55 mph. The data from a test section during the "before" period were compared with the data from the same test of control section during the "after" period. The results of this analysis also served the secondary objective of creating a background for the interpretation of the results of the accident analysis.

TABLE 5 "After" Speed Data at Virginia and West Virginia Sites

SITE	VEHICLES	SPEED LIMIT	MEAN SPEED (MPH)	SPEED VARIANCE (MPH)
ROUTE 64 (VA)	CARS	65	65.79	23.22
ROUTE 64 (VA)	TRUCKS	55	60.25	17.75
ROUTE 64 (VA)	ALL VEHICLES	65/55	64.31	27.69
ROUTE 64 (WVA)	CARS	65	65.41	11.30
ROUTE 64 (WVA)	TRUCKS	65	61.94	8.74
ROUTE 64 (WVA)	ALL VEHICLES	65	64.36	13.13
ROUTE 81 (VA)	CARS	65	66.02	12.43
ROUTE 81 (VA)	TRUCKS	55	59.78	12.25
ROUTE 81 (VA)	ALL VEHICLES	65/55	63.05	24.60
ROUTE 81 (WVA)	CARS	65	66.18	16.06
ROUTE 81 (WVA)	TRUCKS	65	64.23	19.58
ROUTE 81 (WVA)	ALL VEHICLES	65	65.26	18.54
ROUTE 77 (VA)	CARS	65	66.77	19.11
ROUTE 77 (VA)	TRUCKS	55	58.42	15.56
ROUTE 77 (VA)	ALL VEHICLES	65/55	64.30	32.48
ROUTE 77 (WVA)	CARS	65	63.84	19.54
ROUTE 77 (WVA)	TRUCKS	65	57.78	16.93
ROUTE 77 (WVA)	ALL VEHICLES	65	62.02	26.40

TABLE 6 Accident Rates at First Set of Study Sites (California and Michigan)

Site	Period	Time (yr)	Route	Severity Fat	Severity Injury	Severity PDO	Number of Vehicles 1	Number of Vehicles 2	Number of Vehicles 3+	Two-Vehicle Accidents NT–NT	Two-Vehicle Accidents NT–T	Two-Vehicle Accidents T–T	Types of Collision SDSWP	Types of Collision Rearend
CALIFORNIA SITES														
TEST	"BEFORE"	3.0	5	0.73	16.96	38.61	40.57	15.0	0.73	10.09	3.93	0.98	3.44	6.14
	"AFTER"	1.75	5	0.63	18.02	30.68	32.57	15.81	0.94	12.66	2.84	0.31	6.64	5.06
CONT A	"BEFORE"	3.0	5	0.46	11.15	12.56	8.94	12.36	2.87	10.44	1.53	0.39	5.28	5.81
	"AFTER"	1.75	5	0.55	12.47	16.45	10.04	15.33	4.05	13.45	1.42	0.46	6.72	7.41
CONT B	"BEFORE"	3.0	99	1.31	45.30	60.77	50.52	47.91	8.76	41.58	5.03	1.30	9.51	29.45
	"AFTER"	1.75	99	1.66	50.52	58.30	48.57	49.13	12.77	44.97	3.33	0.83	12.49	32.20
MICHIGAN SITES														
TEST	"BEFORE"	3.0	96	0.42	7.98	28.80	24.46	10.53	2.21	6.96	2.55	1.02	0.34	10.60
	"AFTER"	1.0	96	0.23	11.34	45.12	36.61	17.01	3.07	11.82	4.01	1.18	0.05	12.99
CONT A	"BEFORE"	3.0	52	0.00	23.01	110.49	93.19	32.21	8.05	20.71	9.20	2.30	0.02	4.63
	"AFTER"	1.0	52	3.06	24.53	141.06	119.58	36.79	12.26	18.40	15.33	3.06	0.01	3.07
CONT B	"BEFORE"	3.0	69	0.17	20.66	53.74	39.81	30.35	4.41	22.75	5.63	1.97	0.52	30.23
	"AFTER"	1.0	69	0.21	30.45	69.67	60.70	32.53	7.09	20.02	8.55	3.96	0.42	41.51

*Accidents per 100 million vehicle miles of travel.
NT–NT = non-truck/non-truck, NT–T = non-truck/truck, T–T = truck/truck, and SDSWP = sideswipe.

2. Hypothesis for test and control comparison: There is no significant difference in speeds and accidents between the sites where the 65/55-mph limit is in effect and the sites where the 55-mph limit has been maintained. This hypothesis tested for any spillover effects of speed limit change in the test area. For example, drivers exiting a test section may continue to driver at higher speeds as a result of speed adaptation and affect the accident characteristics at locations with 55-mph speed limit.

3. Hypothesis for 65/65 and 65/55 comparison: There is no significant difference in speed and accident characteristics between sites having 65/65-mph speed limit and those with 65/55-mph speed limit. This hypothesis tested for the differences in the effect of 65/65- and 65/55-mph speed limits on accident characteristics at similar highway sections. The main purpose of the speed comparison was to investigate the effect on vehicle speeds of the imposition of a DSL.

The following categories of vehicle speeds were analyzed: average speed and 85th percentile speed of passenger cars, average speed and 85th percentile speed of large trucks, and average speed and 85th percentile speed of all vehicles.

In addition, the effect of the DSL on speed dispersion and on the difference between mean speeds of cars and trucks was evaluated. Speed dispersion is defined as the measured difference between average speed and 85th percentile speed. This parameter is sensitive to groups of excessive speeders, which are not totally reflected by average speed.

TABLE 7 Accident Rates at First Set of Study Sites (Virginia and Maryland)

Site	Period	Route	Severity Fat	Severity Injury	Severity PDO	Number of Vehicles 1	Number of Vehicles 2	Number of Vehicles 3+	Two-Vehicle Accidents NT–NT	Two-Vehicle Accidents NT–T	Two-Vehicle Accidents T–T	Types of Collision SDSWP	Types of Collision Rearend	Types of Collision FIXOBJ
VIRGINIA SITES														
TEST A	"BEFORE"	66	0.50	12.87	26.25	10.09	23.22	6.31	17.93	3.78	1.51	4.54	5.04	17.16
	"AFTER"	66	1.42	28.55	31.42	19.99	33.55	7.85	26.43	5.71	1.42	5.71	5.71	32.83
TEST B	"BEFORE"	81	0.93	21.82	29.86	19.14	21.82	4.95	11.79	7.22	2.81	7.89	7.22	27.57
	"AFTER"	81	0.76	24.94	38.77	27.24	30.31	6.91	16.12	10.74	3.45	9.97	10.36	39.52
CONT A	"BEFORE"	64	0.00	46.47	35.91	35.91	38.02	8.45	25.35	8.45	4.22	2.11	6.33	14.78
	"AFTER"	64	0.00	31.14	52.95	35.82	37.37	10.90	21.80	10.90	4.67	1.55	6.22	14.01
CONT B	"BEFORE"	64	1.75	45.61	49.12	47.36	29.82	19.29	19.30	8.77	1.75	1.75	3.51	15.78
	"AFTER"	64	0.00	53.04	68.81	24.37	65.94	31.54	53.04	12.90	0.00	4.30	10.03	20.07
MARYLAND SITE														
CONT	"BEFORE"	70	1.21	35.10	28.62	36.52	20.08	8.32	16.63	2.84	0.61	4.54	5.04	
	"AFTER"	70	0.75	21.44	37.62	37.63	20.31	1.88	16.56	3.00	0.75	5.71	5.64	

*Accidents per 100 million vehicle miles of travel.
NT–NT = non-truck/non-truck, NT–T = non-truck/truck, T–T = truck/truck, SDSWP = sideswipe, and FIXOBJ = fixed object.

TABLE 8 Accident Rates in Virginia and West Virginia for the Second Set of Study Sites

ROUTE	DAILY TRAFFIC CATEGORY	SEVERITY FAT	INJ	ALL	NO. OF VEHICLES 1	2	3+	TWO-VEHICLE ACCIDENTS NT–NT	NT–T	T–T	TYPES OF COLLISION SS	RE	FO
					ACCIDENTS IN VIRGINIA DURING "BEFORE" PERIOD								
64	< 50000	1.055	27.81	71.14	42.96	22.61	5.81	13.34	4.60	0.68	12.71	17.46	25.42
	> 50000	0.701	54.48	141.81	35.55	68.90	37.45	57.68	10.41	0.90	24.11	48.23	69.17
77	< 50000	0.897	27.36	60.99	34.98	23.32	3.14	4.93	7.63	3.59	5.12	22.15	30.19
81	< 50000	0.971	23.32	56.84	34.29	20.94	1.75	5.54	10.15	1.26	7.19	19.27	28.18
					ACCIDENTS IN WEST VIRGINIA DURING "BEFORE" PERIOD								
64	< 50000	1.110	39.60	116.32	62.81	47.69	5.82	30.04	14.78	2.86	17.45	24.43	31.41
77	< 50000	0.730	18.31	55.49	29.96	22.75	2.77	14.33	7.05	1.36	8.32	11.65	14.98
81	< 50000	0.330	13.88	38.99	21.05	15.98	1.95	10.07	4.95	0.96	5.85	8.19	10.53
					ACCIDENTS IN VIRGINIA DURING "AFTER" PERIOD								
64	< 50000	0.918	24.94	64.35	39.98	20.55	4.09	10.52	4.37	0.35	15.11	18.31	29.52
	> 50000	0.607	41.57	126.23	28.12	67.03	31.38	49.39	8.66	0.68	21.06	39.41	63.98
77	< 50000	0.675	19.56	57.66	35.74	20.23	1.68	5.06	6.41	1.01	4.36	23.14	29.85
81	< 50000	1.143	20.29	51.35	28.86	19.43	3.18	5.22	7.92	1.22	8.47	17.22	24.81
					ACCIDENTS IN WEST VIRGINIA DURING "AFTER" PERIOD								
64	< 50000	1.480	30.81	78.21	45.36	29.72	3.13	19.32	8.32	2.08	10.95	15.64	21.12
77	< 50000	0.734	35.64	71.82	41.65	27.29	2.87	17.73	7.63	1.91	10.05	14.36	19.39
81	< 50000	1.310	19.62	52.00	30.16	19.76	2.08	12.84	5.53	1.38	7.28	10.40	14.04

NT–NT = non-truck/non-truck, NT–T = non-truck/truck, T–T = truck/truck, SS = sideswipe, RE = rear-end, and FO = fixed object.

Mean Speeds

Table 9 gives the values of the test statistic computed for comparisons of mean speeds. It is clear that mean speeds of passenger cars have increased as a result of the increase in the maximum speed limit for passenger cars; thus, Null Hypothesis 1 for speeds can be rejected. However, this increase is fewer than 3 mph at all sites in response to an increase of 10 mph in the speed limit (see Table 1). Only one control site in Michigan showed significant change; however, the actual difference between the "before" and "after" speeds at this site was only 0.6 mph (see Table 4). These sites therefore seem to be good choices for control areas in the accident analysis. Hence, it can be concluded that the control sections were not significantly affected by spillover effects from the test areas and that Null Hypothesis 1 can be accepted with regard to speeds for the control sites.

At the test sites where a differential speed limit was imposed, the difference between mean speeds of nontrucks and trucks showed a dramatic increase after the imposition of the differential speed limit. This was manifested in more conflicts between these types of vehicles.

Speed Dispersion

The analysis also showed that speed dispersion decreased at all of the test sites at which the DSL was imposed except for the California site. The increase in the average speeds of passenger cars as a result of the institution of a DSL has partially masked the effect of excessive speeding prevalent during the "before" period. The net effect was a reduction in speed dispersion. However, as the proportion of trucks (subject to the 55-mph limit) in the traffic stream increases, a DSL can cause a significant increase in speed dispersion and consequently in interaction among different vehicles.

Accident Data Comparison

As in the speed data analysis, Null Hypotheses 1 and 2 were tested for the accident data comparison. To better understand which characteristic of accidents is considerably affected, various categories of accidents were studied.

"Before" and "After" Comparison at Test Sites

In the "before" and "after" comparison, the accident data from test sections obtained during the "before" period were compared with the corresponding data from the same section during the "after" period. To test for significant changes in different categories of accidents, chi-square tests with two degrees of freedom were conducted and compared with the critical value (i.e., $X^2_{2,\,0.05} = 5.99$). None of the comparisons indicated significant change; therefore, it can be concluded that the increase in speed limit did not significantly affect the accident rates at the test sections and that Null Hypothesis 1

TABLE 9 Results of Mean Speed Data Analysis

Site	T-statistic of Mean Speeds: Passenger Cars	Trucks	All Vehicles
		CALIFORNIA	
Test	9.13*	-9.31	4.62*
Control A	0.00	-30.31	-7.82
Control B	-3.03	-6.56	-5.17
		MICHIGAN	
Test	26.45*	-0.97	24.08*
Control A	-2.11	-0.77	-2.16
Control B	9.69*	-6.64	6.17*
		VIRGINIA	
Test A	30.05*	2.01*	29.96*
Test B	10.61*	-3.79	2.96*
Control A	0.39	-1.61	-1.42
Control B	-4.27	-2.11	0.09
		MARYLAND	
Control	0.57	0.74	0.98

* significant at 5% confidence level

for accidents can be accepted. However, some increases in the rates of most collisions were observed, although these increases were not significant at the 5 percent level (see Tables 6 through 8). Similar results were obtained for the control sites.

Test and Control Comparison

In this comparison, accident data from test sections were compared with data from each control section. A computer program for chi-square analysis (which takes both "before" and "after" accident rates into consideration) was used, but with the critical value being $X^2_{1,\ 0.05} = 3.84$. Table 10 gives the chi-square results of comparison between test and control sites for the different accident characteristics. Almost all of the comparisons were insignificant, indicating that there is no significant change in accident rates at test and control sites. In other words, the increase in speed limits had no significant effect on accident rates at the test and control sites. Therefore, Null Hypothesis 2 for accidents can be accepted.

Comparison of 65/65- and 65/55-mph Speed Limits

Three states adjacent to Virginia have a uniform 65-mph speed limit: Kentucky, West Virginia, and North Carolina. Unfortunately, accident and speed data from only West Virginia could be obtained for this study. The comparison was therefore done only for West Virginia and Virginia. Table 5 gives the mean speed and speed variances observed on the selected routes after the change in speed limits. The data indicate that the average speeds of trucks also increased as a result of the uniform increase to 65 mph in West Virginia. Compared with speed variance in Virginia, where a DSL exists, the overall speed variances were lower in West Virginia, where a uniform maximum speed limit (65/65 mph) exists.

Various types of accident rates on West Virginia rural Interstate routes after the increase in the speed limit were also compared with those in Virginia. For direct comparison, only routes that traverse both Virginia and West Virginia were considered. Also, the influence of traffic volume was isolated by segregating accidents on highway sections carrying different levels of average daily traffic. Table 8 gives the various

TABLE 10 Chi-Square Results of Test/Control Comparisons for the First Set of Study Sites

SITES COMPARED	SEVERITY: FAT	INJ	PDO	NO. OF VEHICLES: 1	2	3+	TWO-VEHICLE ACCIDENTS: NT–NT	NT–T	T–T	TYPES OF COLLISION: SS	RE	FO
T – CA	0.033	0.009	1.265	0.426	0.099	0.073	0.010	0.050	0.238	0.267	0.330	1.726
T – CB	0.035	0.016	0.386	0.340	0.011	0.022	0.103	0.054	0.091	0.287	0.194	2.495
					MICHIGAN							
T – CA	0.082	0.297	0.575	0.274	0.578	0.013	1.295	0.036	0.027	0.027	0.539	0.429
T – CB	0.190	0.013	0.432	0.004	0.790	0.058	1.370	0.004	0.447	0.511	0.067	0.931
					VIRGINIA							
T1 – CA	0.087	8.964*	0.374	2.335	1.183	0.026	1.632	0.041	0.070	0.231	0.036	2.223
T1 – CB	0.162	2.764	0.237	9.087*	1.498	0.213	2.399	0.016	0.971	0.392	1.203	0.852
T2 – CA	1.421	2.057	0.158	0.876	0.917	0.018	0.931	0.064	0.010	0.222	0.274	0.860
T2 – CB	0.268	0.004	0.068	7.013	1.718	0.060	2.283	0.039	1.474	0.470	0.830	0.084

*Denotes significant difference at the 5 percent confidence level.
NT–NT = non-truck/non-truck, NT–T = non-truck/truck, T–T = truck/truck, SS = sideswipe, RE = rear-end, and FO = fixed object.

TABLE 11 Comparison of Accident Rates Between Virginia and West Virginia for the Second Set of Study Sites

SEVERITY			NO. OF VEHICLES			TWO-VEHICLE ACCIDENTS			TYPES OF COLLISION		
FAT	INJ	ALL	1	2	3+	NT–NT	NT–T	T–T	SS	RE	FO
VIRGINIA: BEFORE/AFTER COMPARISON											
0.44	2.07	0.92	0.60	2.85*	0.42	0.31	0.64	1.06	0.25	0.03	0.06
WEST VIRGINIA: BEFORE/AFTER COMPARISON											
1.42	0.51	0.12	0.08	0.32	0.67	0.24	0.57	0.10	0.30	0.25	0.12
BEFORE PERIOD: VIRGINIA/WEST VIRGINIA COMPARISON											
1.09	0.28	0.30	0.04	0.67	0.03	1.54	0.43	0.11	0.52	0.95	1.38
AFTER PERIOD: VIRGINIA/WEST VIRGINIA COMPARISON											
1.00	1.41	1.09	0.75	1.83	0.38	3.66*	0.70	2.76	0.03	2.53	3.68*

*Denotes significant difference at the 5 percent confidence level.
NT–NT = non-truck/non-truck, NT–T = non-truck/truck, T–T = truck/truck, SS = sideswipe, RE = rear-end, and FO = fixed object.

types of accident rates observed during the "before" and "after" periods in both states. The accident rates corresponding to "before" and "after" conditions and between states were statistically compared by category. The *t*-values obtained were compared against the critical value $t_{4,\ 0.05} = 2.77$ to identify significant differences in the effect of the two types of speed limits.

The results indicate that there were no significant differences in the overall accident rates between the "before" and "after" periods in each state. This was also true for fatal and injury accidents. These results are similar to the results presented earlier for Michigan, California, and other sites in Virginia. This reinforces the conclusion that although increasing the speed limit to 65 mph for passenger cars may have resulted in an increase in the number of fatalities, it has not resulted in a significant increase in fatal, injury, or overall accident rates. Therefore, Null Hypothesis 3 can be accepted. However, there was a significant increase in two-vehicle accident rates in Virginia, which supports the premise that a DSL results in increased interaction among vehicles in the traffic stream.

A comparison between the "after" data for Virginia and West Virginia gives an indication of the difference in the effect on accident characteristics of the two speed strategies. Table 11 indicates that there was no significant difference between the two states in fatal, injury, or overall accident rates. This strongly indicates that the DSL does not have any safety benefit over the uniform speed limit. This confirms the results of a previous study by Garber and Gadiraju (*2*) that used simulation techniques to investigate the effect of DSL strategies.

SUMMARY OF FINDINGS

- The increase in the speed limit for passenger cars on rural Interstate highways has resulted in an increase in the mean speeds of passenger cars on these highways.
- The mean speed of passenger cars increased from a range of 61 to 64 mph to a range of 62 to 67 mph, resulting in an increase in mean speed of from 1 to about 3 mph compared with the 10-mph increase in the posted speed limit (because the average speeds for passenger cars were much higher than 55 mph during the period of the 55-mph speed limit).
- Where the speed limit of trucks was maintained at 55 mph, no significant difference in their mean speed was observed.
- Speed variance for passenger cars decreased with the increase in the speed limit to 65 mph.
- Speed dispersion also decreased somewhat because of the increase in speed limit for passenger cars.
- The increase in the posted speed limit to 65 mph on rural Interstate highways has not resulted in a significant increase in accident rates.
- There were no spillover effects of the increase in speed limit; that is, the speed and accident characteristics at control sites were not affected.
- The DSL (65/55 mph) has no significant effect in reducing (*a*) nontruck/truck accident rates or (*b*) two-vehicle accident rates, compared with the uniform speed limit (65/65 mph). There is, however, some indication that the DSL may increase the rates of some types of accidents such as two-vehicle accidents, although this increase is not significant at the 5 percent significance level.

CONCLUSIONS

- The increase in the maximum speed limit to 65 mph for passenger cars at the sites tested did not result in a significant increase in fatal, injury, or overall accident rates.
- The increase in the maximum speed limit to 65 mph for passenger cars at the sites tested did not result in a significant increase in the mean speed of trucks.
- The DSL (65/55 mph) is not more effective than the uniform speed limit (65/65 mph) in reducing the safety of an increased maximum speed limit.
- The differential speed limit increases the interaction among vehicles in a traffic stream as a result of the increase in speed variance.
- The imposition of the differential speed limit on Interstate highways with AADT less than 50,000 may result in higher rates for certain types of accidents such as rear-end and side-

swipe accidents, although the increase is not significant at the 5 percent significance level.

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