Effects of the 88.5-km/h (55-mph) Speed Limit and Its Enforcement on Traffic Speeds and Accidents

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There have been many studies of the effect of the 88.5-km/h (55-mph) speed limit on vehicle speeds and accidents. Although several of these studies mention the need for enforcement to make the speed limit more effective, most do not present any enforcement data. This paper focuses on data from North Carolina, Mississippi, and Louisiana to show the probable role of enforcement. Time-series plots of speed, volume, and accident data for North Carolina are given for the period of 1973 and 1974. Time-series graphs of enforcement data for North Carolina, Mississippi, and Louisiana and Louisiana speed, volume, and accident data have been developed from the published quarterly and annual reports of the state police and highway agencies. The initial decrease in speeds caused by the energy crisis in the three states has been eroded in the past 2 years; except for Interstate highways, speeds have returned to precrisis levels. Of particular importance, however, are that speeds are now more uniform (standard deviations are lower and pace-group percentages have increased) and that very few vehicles are exceeding 105 km/h (65 mph). There are strong indications that the increased enforcement levels of 1974 to 1976 are responsible for maintaining the more uniform and safer speed levels. Louisiana data for 1974 and 1975, as compared with data for 1971 and 1972, show not only significantly fewer fatalities on the rural highways, but also large reductions in the percentages of all rural accidents and of rural fatal accidents for which excessive speed was cited as a contributing factor. A more detailed study of enforcement versus accident rate is said to be warranted.

The advent of the energy crisis in the fall of 1973 convinced U.S. motorists that driving at 88.5 km/h (55 mph) was a good idea. Even before the national 88.5-km/h (55-mph) speed-limit law was passed by Congress and adopted by the states, the average speeds on rural highways started to decrease.

Since that time, many public and private agencies on both national and state levels have made continuing studies to determine the effects of this traffic regulation. Late in 1974, Congress made the 88.5-km/h (55-mph) law permanent and required state-enforcement certification as a continuing prerequisite for the approval of federal-aid highway projects. In September 1975, the Federal Highway Administration (FHWA) issued new guidelines, and by mid-1976 all states were complying. The annual certification package requires quarterly speed surveys and a report of the total number of speeding citations issued.

The current Institute of Transportation Engineers (ITE) policy on the 88.5-km/h (55-mph) speed limit (27, p. 9), adopted August 18, 1975, in Baltimore states,

> It is the policy of the Institute of Transportation Engineers to recommend continuing investigation into the total effects of the 55-mph national speed limit. In the meantime, with the 55-mph speed limit in effect, the institute supports the concept that this limit should be uniformly and equitably enforced in all jurisdictions.

The object of the ITE committee dealing with this matter (27, p. 28) is defined,

> To determine the ramifications of the 55-mph speed limit through the assimilation of available data for review, analysis, and development of a platform of facts on which an institute position may be based.

The charge of the committee, then, was to provide a solid factual background and specific advice with which the ITE board of directors could develop and adopt an official ITE position on the 88.5-km/h (55-mph) speed limit.

LITERATURE REVIEW

Since the beginning of the energy crisis in 1973, there have been many studies of its effects [or of the effects of the 88.5-km/h (55-mph) speed limit] on traffic speeds, volumes, and accidents. Although several of these suggest the need for enforcement to make this speed limit more effective, most do not enumerate any enforcement data. This literature search is not an exhaustive one, but many of the most pertinent reports on the subject have been studied and are briefly reviewed here.

In addition to ITE, several other organizations such as the American Association of State Highway and Transportation Officials (AASHTO), the National Safety Council (NSC), and the Highway Users Federation (HUF) have studied the effects of the energy crisis and of the 88.5-km/h (55-mph) speed limit. The U.S. Department of Transportation through its monitoring programs has also analyzed the situation.

The initial AASHTO study (2) issued after the crisis had peaked, contained these findings and recommendations (somewhat abridged):

1. Speeds have been reduced 8 to 10 mph on rural freeways, 5 to 7 mph on rural conventional roads, and 5 to 7 mph on urban freeways.
2. In both rural and urban areas, speeds are now more uniform. In other words, more people are now driving closer to the average speed than they were before.
3. Even with these reductions in speed, there are still typically 65 percent of the drivers exceeding the 55-mph speed limit on rural freeways and 48 percent on urban freeways. Obviously, many drivers feel it is safe to drive faster than 55 mph.
4. However, there are about 50 percent fewer drivers exceeding 60 or 65 mph than there were in 1973.
5. Future observance of the 55-mph speed limit will be determined by driver attitude, level of enforcement, and fuel availability.
6. Fuel consumption has been reduced by the lower speeds. The fuel savings amount to approximately 3 billion gal annually.
7. In the first 6 months of 1974, approximately 6000 lives were saved. Approximately half of this reduction is the result of the reduced speeds and the more uniform speeds. The remainder of the saving in lives can be attributed primarily to reduced travel and improved driving habits.
8. It is the principal recommendation of this study that at such time that petroleum conservation is no longer a national problem, and when further federal legislation is being considered regarding the setting of maximum speed limits, the authority and responsibility for maximum speed limits be returned to the states with the strong recommendation that maximum speed limits remain at 55 mph. Exceptions should be considered only when engineering and traffic studies have shown that an increase in the speed limit would not result in speed characteristics appreciably different from those recorded during this study and when strong and compelling reasons for the increase in the speed limits exist.

AASHTO later released two follow-up studies. The first (3) showed trends in 1974 and the first 6 months of 1975. There was a steady increase in speeds after the first half of 1974 and also an increase in speed violations of 38 percent in the second half of 1974 and 25 percent in the first half of 1975, as compared to the first 6 months of 1974. The second update (4) gave statistical analyses

of the trend lines for 1967 to 1973. The significant reductions in 1974 and 1975 deaths and injuries to below the trend line are credited to the 88.5-km/h (55-mph) speed limit. The downward trend line from 1967 to 1973 is attributed to safety improvements in vehicles, driver education, and roadways. AASHTO also noted that there has been a steady increase in average speeds since 1974, but that these speeds are still below 1973 levels and that the percentages of vehicles exceeding 97 and 105 km/h (60 and 65 mph) have not increased. The recommendations from this report include the following:

2. AASHTO should go on record as being strongly in favor of retention of the 55-mph speed limit.
3. Maximum efforts should be made by the states to enforce the 55-mph speed limit, and realistic speed monitoring be continued in all states.
4. Every effort should be made to inform and convince the public of the safety benefits of the 55-mph speed limit, with the emphasis on safety rather than on conservation.
5. AASHTO should continue supporting roadway, vehicle, and driver safety programs because these programs contribute a significant cumulative benefit in reducing traffic deaths and injuries.

Rankin (21) has compared speed, travel, accident, and fuel-use characteristics for 1973 and 1974 from data collected across the country. Early 1974 speed checks showed average speed decreases of up to 14.5 km/h (9 mph) on routes previously posted at 113 km/h (70 mph) or greater. However, soon after March 1974, the averages began to increase. The variation in speeds, as shown by the pace group, was also less during the energy crisis—a larger percentage of traffic was traveling in the same pace group, which provides a safer driving environment. Rankin also noted an increase in speeding enforcement in most states that "... must be recognized as a factor in changes in speed characteristics since January 1974." He reported on the decrease in travel and accidents in early 1974 and estimated a 7.5 percent saving in the average daily use of highway fuel in the first half of 1974. In a 1975 paper (22), Rankin added this observation:

In summary, the 55-mph limit has been an effective fuel-conservation measure, and it has contributed to the improvement in traffic safety that began in November 1973. Furthermore, it has focused increased amounts of public and news-media attention on our national traffic-safety problems. But in doing this, it has tended to develop a school of thought that the limit is a magic bullet to solve all traffic safety problems. The 55-mph limit is not a self-enforcing regulation. It apparently will require a large body of federal regulations that will impose additional costs of no small magnitude on state and local highway agencies. As a national regulation encompassed in a number of rules and requirements, it can inhibit the potential for the development of future speed-limit policies that promote fuel-use efficiency and traffic-safety operations, and yet most drivers accept it as reasonable.

The National Safety Council has issued two evaluations of the decrease in traffic deaths in 1974. The first (17) compared the data for the first 4 months of 1974 with those for the corresponding period in 1973. Of the total 24 percent decrease in fatalities, 11 was attributed to speed reduction, 5 was attributed to reduced travel, and the remainder was attributed to such factors as reduced automobile occupancy, less night driving, and greater use of safety belts. The second study (18) compared data for May to August 1973 with those for May to August 1974. It was concluded that most (10 percent) of the total 17 percent reduction in fatalities was attributable to the reduced travel speeds on the highway and that the remainder of the decrease was due to such factors as reduced travel, reduced average vehicle occupancy, and increased use of seat belts. This study also discusses other factors including traffic law enforcement: "Law enforcement in general, and enforcement of the 55-mph speed limit in particular, is important in helping to prevent accidents and deaths, but its contribution to the fatality reduction is difficult to isolate."

Another study on a national level was that of Schechter and Pfeffer (23), which was conducted by the Mitre Corporation for the National Science Foundation. This was a policy-assessment type of study, which is a multidimensional form of benefit-cost analysis applied to a given policy decision, and states that "... the design of future policies should reflect the lessons derived from an assessment of current policy." This study also reviews the historical development of the 88.5-km/h (55-mph) speed limit, presents the results of several other studies, and concludes,

A major cause of the gradual increase in the numbers of those violating the 55-mph speed limit is that there was no extensive ongoing national campaign to conserve motor fuel. Future policy decisions of this order must put strong emphasis on ways to induce citizens to cooperate, in addition to ways that depend on use of police powers.

Two older studies by federal highway analysts are relevant to this paper. In his classic 1964 report, Solomon (25) developed accident-involvement rates by dividing the number of accident-involved drivers by the related vehicle distances of travel. Cirillo (10) added to Solomon's work in 1968 and found that although the average speeds are about 11.3 km/h (7 mph) higher on Interstate highways than on two-lane roads, this system can better accommodate differences in vehicle speeds with much lower accident rates, except at the lowest speeds. This report also showed the results of an attempt to investigate the effect of the level of law enforcement on mean speed and accident involvement. No trend could easily be established between increases in warnings, arrests, or police patrols and the mean speed of travel or the accident-involvement rate on a study section. However, Cirillo mentioned difficulty in finding the exact kind of data needed and that further investigation would be undertaken in the future.

More recent federal studies have included an August 1975 National Highway Traffic Safety Administration (NHTSA) technical report (16), which concluded,

1. The greatest reduction in fatalities occurred on high-speed roads, the least occurred on roads unaffected by the new speed limit, and the relative reduction was twice as great on roads affected by the speed limit and
2. No accurate estimate can be made on the overall safety impact of the 55-mph speed limit, but there should be high confidence that a large portion of the reduction in fatalities is due to the direct or indirect benefits of the new 55-mph speed limit.

A related FHWA report by Page and others (20) states,

Highway fuel consumed in 1975 was 11.4 percent less than would have been expected based on 1962 to 1972 growth rates. Of this, it is estimated that 8.1 percent resulted from reduced travel. Estimates of the reduction due to the introduction of a higher proportion of more fuel-efficient vehicles in the total fleet since 1973 ranged from 0.6 to 2.8 percent depending on the method of calculation. The corresponding range for savings due to speed reduction was 0.8 to 2.9 percent.

Another 1974 U.S. Department of Transportation (U.S. DOT) study, that by Bishop and others (6), is the only one that mentions citations before and after the energy crisis. The numbers of citations issued during the months of July, August, and September in 1973 and in 1974 were obtained from 42 states that responded to the U.S. DOT survey and are compared below.

Year	Number of Citations	Increase (%)
1973	1 053 285	–
1974	1 765 840	67

These are apparently only citations issued for exceeding the 88.5-km/h (55-mph) speed limit (not other speed limits), although it is not clear from the report that this is the case. Citations were lower in only one state in 1974. The percentage increases in the other states varied between 1 and 361.

Burritt and others (8) have analyzed the relationships between accidents in 1974 and 1973 and the 88.5-km/h (55-mph) speed limit and concluded that "... the accident reduction experience on those sections of the Arizona State Highway System that were affected by the 88.5-km/h (55-mph) maximum speed limit almost solely accounted for the entire statewide reduction in fatal accidents." The total reduction for all the highways included was 48 percent. Regarding speed enforcement, they stated that "The total number of speeding citations in 1974 increased about 13 percent over 1973. It was not possible to isolate those speeding citations that were issued on the study area. However, it is reasonable to assume that the increase in citations occurred as a result of enforcing the 55-mph speed limit."

Estep and Smith (13) have reported on California's evaluation of the 88.5-km/h (55-mph) speed limit and its effects. After reviewing some national data, mostly from AASHTO (2), they found that the California data showed similar results, e.g.,

1. By December 1974, average speeds were still down by some 4.5 to 6.5 mph over 1972 levels,
2. Travel was down 2 percent, and
3. Fatalities were down by 18 percent overall, but on freeways where greatest speed changes occurred, reductions were about double that figure.

However, they reported modification of some trends late in 1974:

Since reductions in speeds have been mainly on state highways (most speed zones over 55 mph were previously located on state highways), it can be concluded that the effects of lower speeds have continued. On the other hand, the side effects of the energy crisis, such as improved driver attitudes, appear to have eroded since fatalities on local roads, where speeds changed little, have returned to 1973 levels.

They went on to criticize the need for certification of speed monitoring and enforcement:

Preliminary discussions with U.S. Department of Transportation seem to indicate that substantial state efforts will be required. It has been estimated that the cost of state speed surveys in California will be increased from $10 000 a year to as much as $200 000.

The position taken by California is that these requirements are unduly restrictive. California wholeheartedly supports the national 55-mph speed limit, but believes that a state's certification of compliance should be sufficient to guarantee the existence of necessary laws and their enforcement without the necessity for each state to make detailed certifications of compliance with federal regulations. The intrusion of the federal government into state law enforcement seems unnecessary, redundant, and inappropriate in these circumstances.

Their principal conclusion is,

There is no doubt that fatalities have decreased substantially since the 55-mph maximum speed limit was imposed and that a large part of the reduction is due to the slower and more uniform speeds. California data show that speeds have stabilized. There has been no significant change in average or 85th percentile speeds since August 1974. Fatality rates on California state highways have not increased in 1975 and have remained at the lower 1974 levels. The very substantial decreases in fatalities of 30 to 40 percent on the previously high-speed roads are too large to attribute in any major way to anything but the 55-mph speed limit.

Another California study by Chu and Nunn (9) isolated factors contributing to the decline in fatalities in early 1974. This study considered data for the first 6 months of 1974 and compared them with the previous 10-years experience. Least-square lines were used to establish trends for both the fatality rate (Y) and the vehicle miles of travel (VMT):

$$Y = 4.92 - 0.13X \quad (1)$$

$$VMT = 41.74 \times 2.23X \quad (2)$$

where X = year. (SI units are not given for the variables in this model because its operation requires that it be in U.S. customary units.) This permitted them to estimate that the expected number of fatalities for the first half of 1974 under normal conditions is 2303. The actual number was 1726, a saving of 577 lives (a 25 percent reduction). This decrease was attributed to reduced travel, the permanent daylight saving time, the reduction in driving speed, and other factors.

After showing through regression analysis that fatality levels are related to distances driven, they estimated that the reduction in fatalities due to reduced travel is equal to the 7.3 percent drop in VMT. The effect of daylight saving time was limited to the months of January, February, and March and was deduced from the changes in fatalities between the hours of 6 to 9 a.m. and 4 to 7 p.m. These data dramatically showed the effect that daylight saving was predicted to have, i.e., a sharply higher fatality rate during the morning rush hour and a sharply lower rate in the afternoon hour. It was estimated that a total of 47 lives were saved by this change (a 2 percent reduction).

To derive the effect of the reduced speeds, Chu and Nunn first deduced the effects of other factors by using the values determined by the National Safety Council and discussed above. Allowing for changes in automobile occupancy, travel patterns and routes, and increased seat-belt use, the net saving of lives was estimated to be 6 percent. Thus, 222 lives (a 10 percent reduction in fatalities) were saved by the reduced travel speeds, which is equivalent to 39 percent of the total fatality reduction.

An extensive study in Michigan reported by O'Day and others (19) compared 1974 and 1973 data for the January to May period. They found a 29 percent reduction in fatal accidents that could not be accounted for by the 7 percent reduction in driver exposure. Much was attributed to reduced crash severity because of reduced speeds on all categories of roads [-16 km/h (-10 mph) on Interstates, -8 km/h (-5 mph) on other U.S. and state trunklines, and -5 km/h (-3 mph) on county and local roads]. They observed a continuation of these reduced speeds and fatalities in the last half of 1974 that "... despite a return to normal traffic volumes and patterns, shows that the 88.5-km (55-mph) speed limit is effective in reducing fatalities when enforced." They noted that the 1974 enforcement was greatest on the Interstate highways, where a lower fatality reduction (-20 percent) was combined with the greatest speed reduction. The largest fatality reduction (-41 percent) occurred on non-Interstate-quality highways, where a relatively small decrease in average speeds [-8 km/h (-5 mph)] occurred. This led to two other conclusions:

1. Possibly there would still be a net gain in lives saved if speeds were allowed to rise slightly on Interstate highways, and available police resources were allocated to strict enforcement of the 88.5-km/h (55-mph) speed limit on non-Interstate-quality highways.
2. Speed limits even lower than 88.5 km/h (55 mph) on non-Interstate-quality highways, if strictly enforced, would result in even lower fatalities.

Figure 1. North Carolina automobile-speed trends: 1973 and 1974.

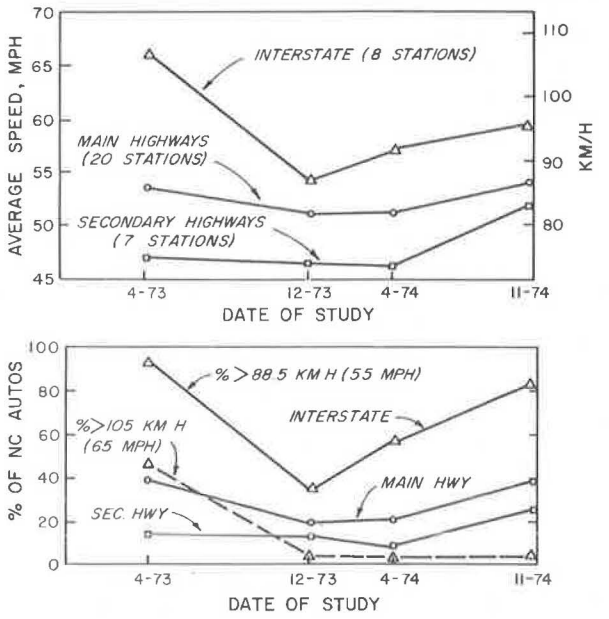


Figure 2. Quarterly North Carolina gasoline use and fatal accidents: 1973 and 1974.

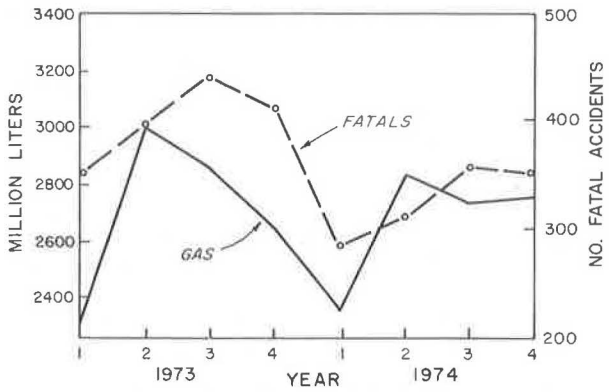
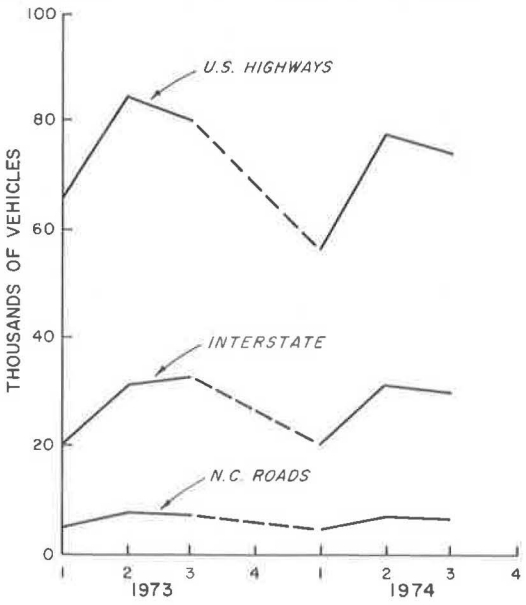


Figure 3. Average North Carolina traffic counts: 1973 and 1974.



Several other state-level studies have shown reductions of fatalities of similar magnitudes. These include those of Borg (7) of Indiana, Heckard and others (14) of Pennsylvania, and Agent (1) of Kentucky. Agent has stated that "Whereas traffic volume and other contributing factors may account for some of the decrease in accident rates since the beginning of the energy crisis, the lower travel speeds certainly stand out as the single most important reason why accident, fatality, and injury rates have decreased." Seila and Reinfurt (24) of North Carolina found a 21 percent fatality reduction, of which they attributed 5 (and possibly 10 to 15) to the 55-mph limit. In a related, but separate study by the Highway Safety Research Center of North Carolina, Council and others (11) found,

1. Following imposition of the lower limit on certain roadways, all sampled roadways experienced initial decreases in various measures of central tendency of speeds (e.g., means). These initial decreases were fully recovered by November 1974, except on Interstate highways.
2. When proportional changes in accidents are compared to proportional changes in counts and to predicted changes based on past research, accidents appear to have decreased significantly more than would be expected on all roadways except rural secondary roads, indicating the presence of causes other than volume decreases.

EVALUATIONS

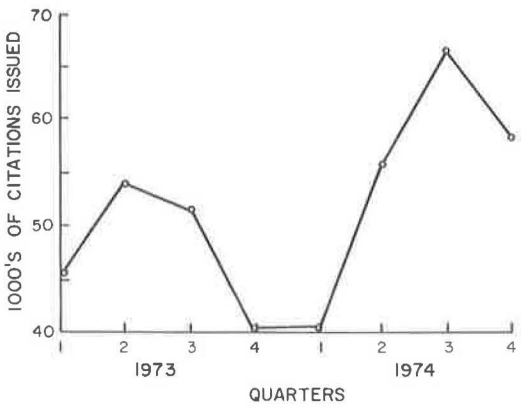
North Carolina

The 1973 and 1974 vehicle speed, traffic count, and fatal-accident patterns developed by Council and others (11) are summarized in Figures 1, 2, and 3. As discussed above, speeds decreased at the height of the energy crisis and then recovered substantially by November 1974. [The speeds of commercial vehicles generally are 1.6 to 5 km/h (1 to 3 mph) less than those of automobiles.] However, although the percentage of speeders increased in late 1974, the percentage of vehicles exceeding a speed of 105 km/h (65 mph) on Interstate highways was virtually zero.

Figure 2 shows the quarterly gasoline consumption (15) for North Carolina in 1973 and 1974. Figure 4 shows the overall state-police enforcement activity in 1973 and 1974. It should be noted that very similar patterns exist for gasoline use, fatal accidents, traffic counts, and total speeding citations. The increase in fatalities throughout 1974 is similar to the recovery in speed on all highways.

Beginning late in the second quarter of 1974, the North Carolina Highway Patrol greatly increased their speed-enforcement activity. At the peak of this crackdown, citations for speeding increased by 31 percent

Figure 4. North Carolina speeding citations: 1973 and 1974.



over the previous year. Although this activity did not prevent overall speed increases in the latter part of 1974, it could be responsible for preventing most drivers from exceeding speeds of 105 km/h (65 mph) and for causing less variance in traffic speeds. These conditions provide a safer highway and contribute to the lower fatality level maintained throughout 1974.

The North Carolina data have also been monitored in 1975 and 1976. All speed characteristics were reduced somewhat in 1975, with the average speeds on all classes of roads down about 3.2 km/h (2 mph). However, 1976 reports show increases in average speeds of up to 5 km/h (3 mph) over 1975 levels. The percentage of North Carolina automobiles exceeding the speed limit now exceeds 90 percent on rural Interstate routes, and the percentage of North Carolina automobiles exceeding 105 km/h (65 mph) has increased to 9.5 percent (21 percent of the tractor trailers observed). In 1975, speeding citations increased 20 percent over 1974; for the first 6 months of 1976, speeding enforcement increased another 12 percent over 1975, but in the summer of 1976, it decreased by 21 percent over 1975, which may have led to increases in speed.

Figure 5. Mississippi average speeds: 1973 to 1976.

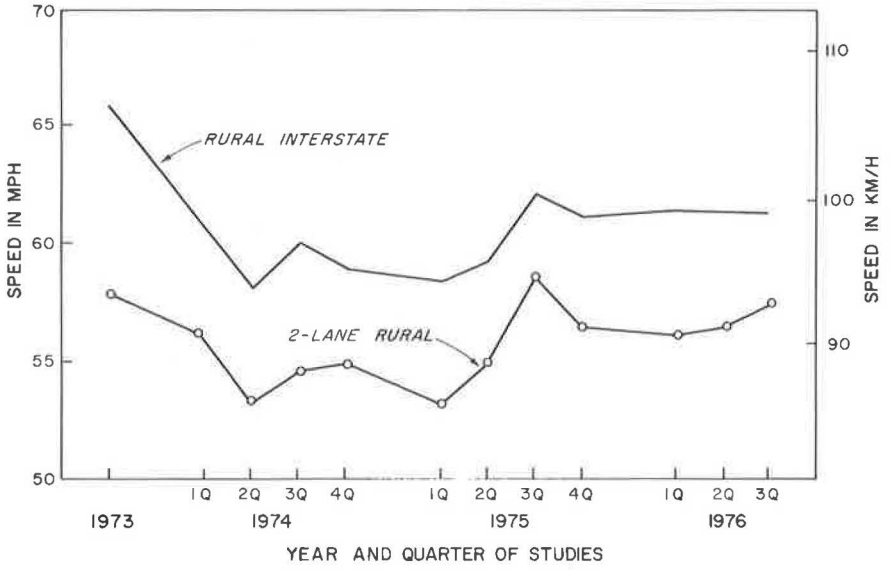
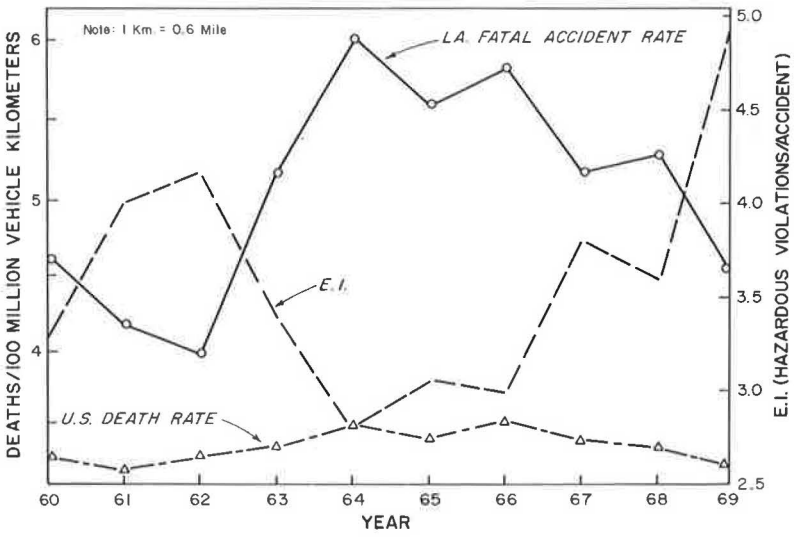


Table 1. Speed characteristics on Mississippi rural Interstate highways: 1973 to 1976.

Speed Characteristic	1973	1974	1975	1976
Avg, km/h	105.4	95.8	98.6	98.5
85th percentile, km/h	112.6	104.6	106.4	105.4
Percentage of vehicles having speeds >88.5 km/h	87.7	66.3	83.0	83.0
Percentage of vehicles having speeds >104.6 km/h	44.5	10.3	19.0	18.0
Standard deviation, km/h	12.6	10.9	8.9	8.5
Speed of pace group, km/h	100.6 to 116.7	84.5 to 100.6	88.5 to 104.6	88.5 to 104.6
Percentage of vehicles in pace group	45.4	57.1	65.0	65.0

Note: 1 km/h = 0.62 mph.

Figure 6. Louisiana death rate versus enforcement index: 1960 to 1969.



Mississippi

The Mississippi Highway Department had been conducting statewide speed studies before the energy crisis so that it was possible to study trends for the past 4 years in that state. Figure 5 shows the quarterly average speed trends for 1974 to 1976 and compares them with the 1973 speeds.

As in most other states, after the initial decrease of speeds in early 1974, speeds increased somewhat, but not to the precrisis levels. Characteristics of interest of speeds measured on rural Interstate highways are shown in Table 1. Traffic fatalities and speed enforcement as reported by the Mississippi Highway Patrol are shown below.

Year	Fatalities	Speeding Citations
1972	922	95 177
1973	883	134 751
1974	643	186 720
1975	612	212 416
1976	677	177 250

Enforcement more than doubled in the postcrisis years as compared to the last precrisis year (1972); however, some slippage occurred in 1976 and, at the same time, fatalities increased. The death rate in Mississippi decreased from 4.3/km (7.0/mile) in 1972 to 2.7/km (4.3/mile) in 1975, and travel increased 8 percent in that period. Surely, the reduced speeds and the increased enforcement have been effective in this state.

Louisiana

Figure 6 shows the apparent interaction of enforcement and the fatal-accident rate in Louisiana during the 1960s. Through the middle of this period, Louisiana was in the unenviable position of leading the nation with its traffic-

Figure 7. Louisiana death rate versus enforcement index: 1971 to 1976.

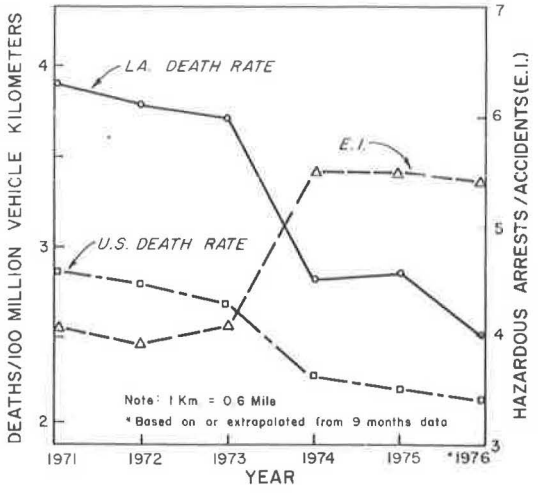


Figure 8. Louisiana enforcement: 1972 to 1976.

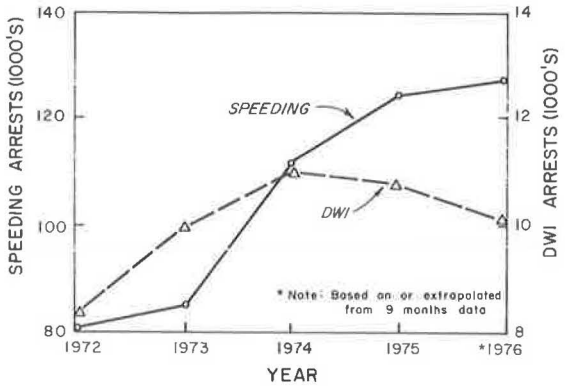


Figure 9. Louisiana rural speed studies: 1974 to 1976.

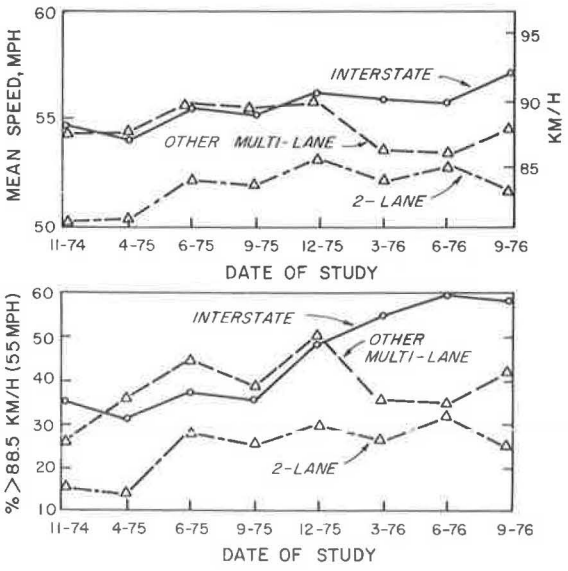
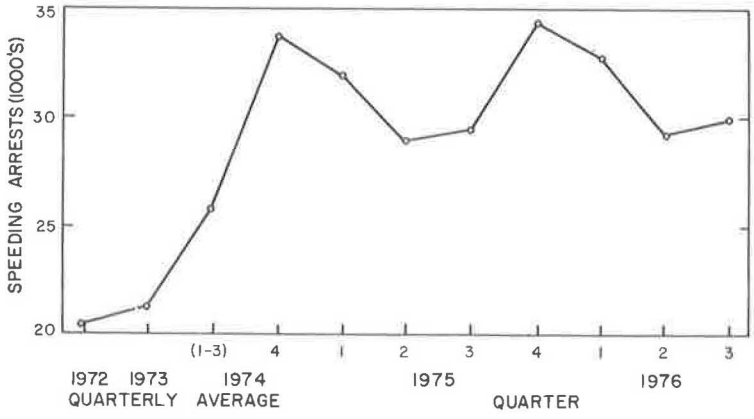


Figure 10. Quarterly Louisiana speed arrests: 1972 to 1976.



death rate approaching 6/100 million vehicle km (10/100 million vehicle miles) driven. Although no regression analysis has been made to incorporate other factors that might contribute to accidents, a very strong relationship appears in Figure 6. The increase in enforcement in 1969 was due to a planned crackdown under a new department head.

In 1970, accident records were in transition as a new uniform reporting form was being introduced. Since 1971, the Louisiana State Police has issued monthly urban and rural breakdowns of accident data, and accident rates are based on the combined total. However, in a separate troop-activity report, accident totals that are only those that occur within the troop jurisdiction are reported. Enforcement indexes consider this total, rather than statewide totals. Trends for the past 5 years are shown in Figures 7 and 8.

Once again, the increased enforcement brought about by the energy crisis and the 88.5-km/h (55-mph) speed limit appears to have had a marked effect. However, without more involved analysis it would be difficult to assess the part played by speeding-restriction enforcement. Figure 8 shows an increased driving-while-intoxicated enforcement. The exact effects of other factors, such as reduced travel and safer vehices, are not known. However, an inspection of motor-fuel consumption trends for Louisiana and typical traffic-volume trends at stations where quarterly speed studies have been conducted showed that reduced travel may have been less of a factor than in many other areas of the country. The total fuel used in 1974 was only about 2 percent less than that used in 1973 and volumes at the monitoring stations did not decrease, in fact some were slightly higher. Fuel consumption in the third quarter of 1976 is increased 13 percent over the same period in 1973.

Neither the Louisiana State Police nor the Louisiana Department of Highways had an established speed-measuring program before the energy crisis. The director of the department of highways issued an order on January 18, 1974, and informed the district attorneys of this action on January 22, 1974. All 88.5-km/h (55-mph) speed-limit signs were in place by March 1974. Late in August 1974, the Louisiana State Police Superintendent requested a small study by the state police in the Baton Rouge region. This study, conducted mostly on Interstate or other four-lane divided highways, showed that 45 to 70 percent of all vehicles were exceeding the 88.5-km/h (55-mph) speed limit with over 30 percent exceeding 97 km/h (60 mph) and up to 10 percent at two sites exceeding 113 km/h (70 mph). A crackdown began shortly thereafter and, as shown in Figure 8, speed enforcement has continued at a high level through 1975 and 1976.

Late in 1974, the Louisiana Department of Highways began regular speed studies at 12 locations around the state in response to directives of the Federal Highway Administration. Speed measurements began 3 months after the state police survey and were made in each quarter of 1975. In 1976, the study was extended to cover 28 locations. Figure 9 summarizes the characteristics derived from these studies, and Figure 10 summarizes the speed-enforcement levels by quarters for comparison with the speed data.

Speeds at rural stations on the Interstate and other divided multilane highways have increased slightly or remained relatively constant through the 2-year study period with an overall mean speed slightly above 88.5 km/h (55 mph) for both groups. The percentage of vehicles exceeding 88.5 km/h (55 mph) has varied considerably, but generally has increased from 30 to 60 percent on Interstate highways, which is still lower than that observed in August 1974. For these same stations, the percentage of vehicles exceeding 97 km/h (60 mph) has been 15 percent or less, and no more than 4 percent have exceeded 105 km/h (65 mph). On the other hand, two-lane highways have experienced a 3.2-km/h (2-mph) increase in mean speed [84 km/h (52 mph)], and the percentage of vehicles exceeding 88.5 km/h (55 mph) has nearly doubled (to 25 percent).

Speed-enforcement levels have reached peaks (in the 4th quarters of both 1974 and 1975) that exceed the pre-energy-crisis (1972 to 1973) efforts by 62 percent. State police officials have indicated that initially much of the increased effort was on the Interstate and other divided highways. This has probably helped to stabilize speed patterns on multilane divided highways, but meanwhile some slippage has occurred on the more dangerous two-lane highways. (Sixty-six percent of all rural accidents in 1973, 1974, and 1975 occurred on two-lane roads: This included 77, 80, and 81 percent of the 1973, 1974, and 1975 rural fatal accidents respectively.) More selective enforcement to combat this trend has now been instituted.

ITE ENFORCEMENT SURVEY

An ITE committee has surveyed state police officials regarding the 88.5-km/h (55-mph) speed limit and obtained data representing a good cross section of the entire country. In general, it was found that no more person power had been assigned to speed enforcement and that the chances of speeders being apprehended were only fair. Most agencies use moving radar as their principal enforcement tool and most unofficially allow tolerances of 10 to 16 km/h (6 to 10 mph). However, most officials emphasize that the individual police officer should use his discretion, but should arrest for any clear-cut violation.

State police managements generally (about 80 percent) favor the 88.5-km/h (55-mph) law and believe that it is enforceable, but only about 60 percent of them feel that most of their officers favor the law. Generally, most think that their data show that the 88.5-km/h (55-mph) speed limit saves lives. Their concern is that the public does not totally accept the need for or the benefit of 88.5-km/h (55-mph) speeds, which makes their job more difficult. However, a Georgia public-opinion survey showed that three-fourths of the 900 people asked favor the 88.5-km/h (55-mph) speed limit because it saves lives. Apparently their public relations effort was getting results, which is what most officials said was most needed.

A footnote to this study is the report of the Louisiana representatives at the December 7 to 9, 1976, meeting in Nashville, sponsored by the National Highway Traffic Safety Administration and International Association of Chiefs of Police. This meeting, at which 17 jurisdictions in the southeastern United States were represented, concluded that the 88.5-km/h (55-mph) speed limit is unenforceable. Police representatives claim that enforcement on the Interstate has diverted traffic to two-lane parallel roads and that this has caused fatalities to increase in 1976. (National Safety Council data for the first 9 months show a 2 percent increase in fatalities.) Incidents of police being harassed were also reported. Public relations representatives say that they cannot cajole the public on this matter any more.

The police in some states are also contending with new state laws that render convictions for violations of the 88.5-km/h (55-mph) speed limit trivial; e.g., only nominal fines, such as $5 or 10, and no points assessed for speeds up to the previous speed limit, i.e., 113 km/h (70 mph). A 1975 appeals court decision in Louisiana

voided a lower court conviction under the state's relatively new multiple-offender law. The violator had had seven speeding tickets in 3 years: All but one had been issued on Interstate highways for driving about 113 km/h (70 mph) in clear weather, no accidents were involved, and the fines had been paid without a court appearance. The court held that this was not a serious disregard of traffic laws.

The police are concerned that the federal government will require more enforcement on the Interstates and divert them from more needed enforcement elsewhere. They believe that some agency other than the police should be used to convince the public to abide by the 88.5-km/h (55-mph) law to conserve energy. The consensus of the group meeting at Nashville was that the speed limit should be increased on the Interstate highways to 97 or 105 km/h (60 to 65 mph) [or possibly 100 km/h (62 mph), which is a nice round number].

DISCUSSION OF FINDINGS

The national 88.5-km/h (55-mph) speed limit was introduced as an energy-conservation measure in late 1973. With the initial decrease in overall highway speeds and travel, modest fuel savings of 5 to 10 percent were obtained. Since the latter part of 1974, these gains have been reduced, and fuel savings today are probably no more than 2 or 3 percent.

However, a generally unanticipated (although not unexplainable) windfall of this energy-conservation policy has been the saving of lives on the highways. In late 1975, 1.5 years past the peak of the crisis, almost all states were still experiencing fewer traffic deaths than in 1973, even though the vehicle kilometers of travel exceeded both 1974 and 1973 levels. In view of this result, federal authorities reaffirmed the 88.5-km/h (55-mph) speed limit as a national policy.

There appears to be adequate evidence to support the role that enforcement plays in maintaining speeds at a safer level. During the height of the energy crisis, people were very conscious of the shortage of gasoline and responded to the perceived real need to conserve it. Once the need to conserve eroded in people's minds, increased enforcement has served to retain much of what had been gained. Unfortunately much of this effort appears to have been concentrated on the safest highways, the Interstate system. The suggestions of O'Day and others (19) make sense. More effort concentrated on the two-lane undivided highways would probably have a greater effect. On the other hand, there may be some spillover in driving habits from the heavily enforced Interstate sections to the relatively unenforced two-lane roads.

However, recent research (12) has shown that speed enforcement has little carry-over effect beyond the point of enforcement activity. The overall speed characteristics on the highway studied agreed with those of other two-lane roads as reported by Council and others (11): On these roads, the 85th percentile speed was generally a little less than 97 km/h (60 mph) away from enforcement influences. This study (12) also showed that unless speed monitoring stations are careful to avoid the appearance of enforcement activity, the speeds observed will be 10 to 13 km/h (6 to 8 mph) below normal levels.

This observation has been confirmed in the past year in driving Interstate and multilane highways in Louisiana. Generally, a vehicle driving I-10 and I-12 out of Baton Rouge at very close to 97 km/h (60 mph), will be passed by almost twice as many vehicles as it passes in an 80-km (50-mile) stretch. This indicates an average speed at least 5 km/h (3 mph) higher than that indicated by state monitoring reports. Some spot speed studies at monitoring stations from a concealed position essentially determined that this was the case, although one study on I-10 produced a mean only 0.8 km/h (0.5 mph) higher than reported in the state quarterly study.

The presence of increasing numbers of citizen's band (CB) radio-equipped vehicles on the highways raises the question of whether or not enforcement of the 88.5-km/h (55-mph) speed limit is being impaired. Limited observations on rural Interstate highways in Louisiana show that about 15 to 20 percent of all vehicles are so equipped, but Louisiana state police officials do not feel that their enforcement effort is being undermined. The Baton Rouge area troop commander told a reporter (5) in June 1976, that "They are slowing people down, and that's what we want to do—not just write tickets. And, despite the 'smoke' warnings on CB radio, troopers in the eight-parish area are still writing 3000 tickets/month." One trooper indicated that the ratio between trucks and automobiles getting speeding tickets is about the same as before and just as many vehicles with CB radios get tickets as do those without them. With so much talk on CB radios today, it is possible for a driver with one to miss a smoke warning.

One of the most discontented with the 88.5-km/h (55-mph) speed limit is the independent trucker with a CB radio. Some are most vocal and abusive to police, but they do not represent the total trucking industry. Both the Louisiana Motor Transport Association and the American Trucking Associations are firmly in support of the 88.5-km/h (55-mph) speed limit. Initially both opposed the law, but in learning to live with it, they found that they were able to reschedule runs satisfactorily and still save money in fuel, maintenance, and insurance costs.

The other problem in enforcement work is the proportion of traffic activity devoted to speed enforcement. Witheford (26) reported in 1970 on a survey of state and city police agencies regarding speed enforcement policies and practices. He noted that about 25 percent of all traffic activity was speed enforcement and, that in many jurisdictions, at least 50 percent of all hazardous citations were for speeding. (Louisiana data for 1972 to 1975 showed 65 to 70 percent of hazardous moving violations to be for the speeding.) Witheford also noted that while there was no unanimity in what the proportion of activity should be, 45 percent of state agencies suggested that it should be increased and none suggested that it be decreased. However, as he points out, there may be merit in reevaluating priorities and possibly redirecting efforts toward other causes of accidents.

In 1974 and 1975, excessive speed was cited on Louisiana State Police accident reports in only 3.8 percent of all rural accidents and 12.5 percent of all rural fatal accidents; in 1971 and 1972, it was cited in 8.0 and 16.85 percent respectively. Obviously the 88.5-km/h (55-mph) speed limit and its enforcement has had an appreciable effect.

CONCLUSIONS

As a result of this study, the following may be concluded:

1. The 88.5-km/h (55-mph) speed limit has definitely altered the average speed and the speed variation on all classes of highways. Average speeds were reduced in early 1974 by as much as 16 km/h (10 mph), but gradual increases have occurred ever since. The percentage of vehicles exceeding 105 km/h (65 mph) is less than 10, and speed variability is significantly less, leading to lower fatality rates.
2. Travel decreased in early 1974, but by late 1974

and ever since, it has been growing at almost precrisis rates.

3. Fuel savings as a result of the 88.5-km/h (55-mph) speed limit are very modest (probably no more than 1 to 3 percent).

4. The saving of 9000 to 9500 lives in 1974, 1975, and 1976 is in large measure due to factors brought about by the energy crisis. In early 1974, the changes in travel habits and the reduced vehicle speeds contributed equally to this reduction. Since then, speed reductions have been the dominant factor with one estimate indicating that 60 percent of the death-rate reduction is due to the 88.5-km/h (55-mph) speed limit.

5. Speed enforcement increased in late 1974 and has been maintained at a high level in most jurisdictions. However, police agencies believe that because a majority of the public does not now favor the law, it is becoming increasingly less enforceable, particularly on Interstate highways.

RECOMMENDATIONS

Basic Policy

The national 88.5-km/h (55-mph) speed limit was passed on the basis of energy conservation needs and was reaffirmed in late 1975 on the bases of a modest fuel savings and a substantial reduction in highway fatalities. The policy question to be resolved is this: Should it be retained more on a safety basis than as an energy conservation tool, should it be retained on equal bases of safety and energy conservation, or should it be repealed?

How can we repeal this law in good conscience? The facts are overwhelming; The reduced speeds have probably been responsible for saving almost 15 000 lives in the past 3 years. The purpose of ITE states that its members should "... contribute toward meeting human needs for mobility and safety..." Are we losing that much mobility for the sake of safety in retaining a blanket 88.5-km/h (55-mph) law? I do not think so!

Public Relations

Police officials are being harassed for enforcing an unpopular law. Yet in Georgia, where there has been a thorough public relations job, three-fourths of 900 people surveyed support the 88.5-km/h (55-mph) speed limit. The police should not be the sole enforcers of an energy policy, but they have an equal concern with transportation engineers in promoting safety on our highways. NHTSA should assist the states in developing a public relations campaign to sell the 88.5-km/h (55-mph) limit on a safety basis as well as on an energy conservation matter. Give the public the real facts and tell them why the limit works. There have been a number of recent papers suggesting that the limit is a safety myth, but a hard look at the data with meaningful analyses will show that substantial benefits exist.

Evaluation of Enforcement's Role

A more detailed study of the interaction of speed enforcement and accidents is warranted. Rather than working from various gross data tabulations, a more integrated study is recommended:

1. Regular speed monitoring on a scientific sampling basis in which conditions of measurement, such as time and weather, are comparable should be conducted throughout the state on all classes of highways.
2. If possible, spot speed stations should be at or near permanent traffic-counting stations and both sets of data should be classified as to type of vehicle. Speed measuring devices should be concealed to provide the most accurate speed data possible.
3. Accident data should be studied along the same routes as speeds and counts are obtained.
4. Speed enforcement records should be collected and should include a careful note of the location, the road type, and the direction, time, weather, and pertinent vehicle and driver descriptions. Data as to prosecution and adjudication of these citations should also be obtained.
5. Regression analyses should be conducted to determine the real contribution of speed enforcement to the control of speed and the reduction of accidents.

Possible National Experiment

To detect the elasticity in the safety benefits, some states might be allowed to raise speed limits to 100 km/h (60 mph) on Interstate and other fully controlled-access facilities. This would be permitted only after each designated state could certify to record keeping that would permit NHTSA and FHWA to monitor the effects on fuel consumption and accidents.

1. Such monitoring should also include two other elements: correlation with enforcement activity and both speed and enforcement monitoring on two-lane roads to identify spillover effects.
2. After one or two years of monitoring, the data should be evaluated and a decision made as to further experiments. If no detrimental effect on highway safety has occurred and no energy crisis has been proclaimed, speeds on the Interstates might be increased to 105 km/h (65 mph) and another period of evaluation follow.
3. If another energy crisis occurs and a stringent conservation policy is launched, these trial speed limits should be one measure. Furthermore, the degree of cutback should be commensurate with the intensity of the crisis; i.e., speeds below 88.5 km/h (55 mph) may be essential and desirable.

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Relationship of the Color of the Highway Centerline Stripe to the Accident Rate in Arizona

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The problem considered in this study was that of the effect of changing the color of the centerline stripe from white to yellow on the accident rate on undivided, two-lane, two-way highways in Arizona. Only sections of roadway that had remained essentially unchanged (except for the color of the centerline stripe) for a period of 1 year before and 1 year after the color change were studied. Accident data on 74 sections of roadway, totaling 4587 km (2867 miles), were analyzed and statistically tested for differences between the accident rate with white centerlines and the accident rate with yellow centerlines under various road surface and light conditions. Of the eight accident-rate categories tested, the following four showed a significant increase: (a) the dawn or dusk accident rate, (b) the dawn or dusk accident rate during periods of wet pavement or poor visibility, (c) the nighttime accident rate during periods of wet pavement or poor visibility, and (d) the overall accident rate during periods of wet pavement or poor visibility. The following other four categories tested showed no significant change: (a) the nighttime accident rate, (b) the daytime accident rate, (c) the daytime accident rate during periods of wet pavement or poor visibility, and (d) the overall accident rate under all conditions combined. These data indicate that the currently used yellow centerline stripes are inferior to the previously employed white centerline stripes.

The most recent edition of the Manual on Uniform Traffic Control Devices, published in 1971, requires that all centerline markings on two-lane, two-way highways be yellow rather than the white previously in use. The expressed intent of this requirement is to further a new concept whereby the color difference between the markings of two-way and divided highways enables the motorist to be immediately aware of the danger of opposing traffic on seeing a yellow line. The lane markings remain white to eliminate any possible confusion.

The new centerline standard has an easily perceived safety objective. There can be no argument with its purpose; however, the questions to be asked are (a) has the desired result been achieved and (b) have any adverse conditions been created?

Some officials of the Arizona Highway Department have voiced an unsubstantiated belief that yellow striping may not be as visible as white striping, particularly in bad weather and at night. The purpose of this study