# Effect of Enforcement on Vehicle Speeds 

JAMES STANNARD BAKER, Director of Research<br>Traffic Institute, Northwestern University

As a deterrent to people who would otherwise drive faster than the law permits, police activity on the highway is believed to work in three ways: (1) the visible presence of a patrol unit presents the immediate possibility of enforcement against violators at that time and place; (2) the general belief that speed laws are enforced on a highway will deter drivers from exceeding the legal speed limits, even if no patrol unit is known to be in the vicinity; (3) a general belief that traffic laws are enforced in a community or other area will stimulate compliance with the speed laws in that community.

Pilot studies have been made at the Traffic Institute, Northwestern University, in a cooperative project with the Bureau of Public Roads to explore questions raised by the first and third effects of enforcement on speeds mentioned above.

Various methods of measuring the speeds of vehicles were studied, and it was found that two types of recording speed meters were suitable.

Of six different means of describing speed considered, it was decided that the most practical for the purpose of the study is the average excess speed, which is the sum of the amount by which each vehicle exceeds the speed limit divided by the total number of vehicles.

Studies were made of the effects on average excess speed of both a standing patrol unit and a moving patrol unit for traffic within limited distances from the unit. Studies also were made of vehicle speeds in Chicago before and after a substantial increase in the level of law enforcement.

- TRADITIONALLY the legislative branch of government has established maximum speeds for various types of roadways; the executive branch, as represented by police agencies, has the responsibility of arresting drivers who exceed these speeds; and the judicial branch has had the duty of penalizing such violators. In some places the establishment of speed zones has been delegated by the legislative branch of government to traffic engineers in the executive branch.

From the administrative (police) standpoint, we are interested in knowing how much and what kind of activity will be necessary to fulfill the obligations imposed by legal speed limits on the administrative and judicial agencies and what effect such enforcement will have on the accidents which speed laws are intended to prevent.

As a deterrent to people who would otherwise drive faster than the law permits, police activity on the highway is believed to work in three ways:

1. The visible presence of a patrol unit presents the immediate possibility of en-
forcement against violators at that time and place. A question arises as to how far from the patrol unit such influence extends; in other words, what is the "halo" of law observants surrounding a standing or moving patrol unit. A secondary question arises as to the relative effectiveness of patrol units of various degrees of recognized ability.
2. The belief on the part of drivers that speed laws are enforced on a highway will deter some drivers from exceeding the legal speed limits, even if no patrol unit is known or believed to be in the vicinity. How much enforcement is necessary to produce such a belief to the extent necessary to get a given degree of compliance with the law? A second question arises as to how long it will take after enforcement is applied for driver behavior to be affected and how long the law observance will continue after enforcement activity has ceased.
3. A belief that traffic laws are enforced in a community or other area, will stimulate compliance with all laws, including the speed laws, in that community.


Figure 1.

How much change in general traffic law enforcement will secure a given change in speed law observance? What effect will it have on accidents?

To findfactual answers to questions like those raised in discussions of the effect on speed of enforcement is not easy. The
conditions under which measurements or observations must be made are difficult to control, and units of measurement of enforcement, which include not only frequency of apprehension, but severity of penalty, are difficult to devise.

Pilot studies have been made at the


Figure 2.
traffic institute in a cooperative project with the Bureau of Public Roads to explore questions ralsed by the first and third effects of enforcement on speeds mentioned above, namely: (1) the effect of a patrol


Gars 0 to 1025 feet behind


Gars 1025 to 2530 feet behind


Figure 3. Fffect of patrol motorcycle moving at speed limit on vehicles within sight.
unit on speeds of nearby vehicles and (2) effect of increased enforcement on vehicle speeds in Chicago.

## MEASUREMENTS OF SPEED LAW VIOLATIONS

Much of the effort in these studies went into finding suitable means of measuring
the amount of law violation. First there was a problem of economically measuring vehicle speeds with enough accuracy, particularly at the higher speeds which are of primary interest in studies of this kind.


Cars o to 900 feet behind



Figure 4. Effect of patrol motorcycle moving at 5 mph . below speed limit on vehicles within sight.

Hand timing with stop watches was found unsatisfactory, especially where traffic volumes are high. Two types of recording speed meters appeared to be most suitable: (1) the radar meter where traffic volume is low and (2) a specially designed device, not commercially available, operating from road tubes. Automatically

$100=4.5$ arrests per 100 vehicles per year = 77 mph excess speed per vehicle
$=71$ deaths per 10,000 vehicles per year
Figure 5. Indexes of enforcement, speed, and accidents.
recording meters are almost a necessity in such studies as these.

Six different means of describing speeds were considered: (1) mean or arithmetic average, which may be influenced little by enforcement which acts most strongly on the few high-speed drivers; (2) median or 50-percentile, which is subject to the same difficulty as the mean; (3) 85 -percentile; (4) vehicles per hundred exceeding the speed limit; (5) excess speed per vehicle or average excess speed, i. e. , the sum of the amount by which each vehicle exceeds the limit divided by the total number of vehicles; and (6) quadratic mean of the excess speed per vehicle, which gives additional emphasis on the extremely high speeds.

Of all these, the most practical for the purpose is the average excess speed, or excess speed per vehicle. It reflects reductions in high speeds much better than either the 85 -percentile or the percentage of vehicles exceeding the limit. It is easier to compile than the quadratic mean

TABLE 1
CHANGE IN EXCESS SPEED PER VEHICLE FROM NORMAL

| Wath Standing Patrol Unit Speed Limit 35 miles per hour |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Change in Excess Speed |  |  |
| Position | Patrolman Inside | Patrolman Giving Ticket | Normal <br> Excess no Patrol <br> Present |
| 300 feet before over taking 330 feet after over taking | 0.0 <br> 2. 1 decrease | 1. 5 decrease <br> 2. 0 decrease | 2.6 |
| 330 feet before meeting 300 feet after meeting | 4. 1 increase <br> 1.4 increase | 1. 1 increase <br> 0.1 decrease | . 42 |

TABLE 2
CHANGE IN EXCESS SPEED PER VEHICLE FROM NORMAL

| With Moving Patrol Unit Speed Limit 35 miles per hour |  |  |
| :---: | :---: | :---: |
|  | Decrease in Excess Speed With Patrol Vehicle |  |
| Position With Respect To Patrol Unit | $5 \mathrm{~m} . \mathrm{p} . \mathrm{h}$. below speed limit | At speed lamit |
| $\overline{\text { Ahead by }} \overline{0}$ to $\overline{20}$ seconds | 2.4 | 2.1 |
| Behund by 0 to 20 seconds | 1. 7 | 0.5 |
| Behind by 20 to 50 seconds | 1.4 | 0.7 |

Note: The normal excess speed pea vehicle with no patrol in sight amounted to 3.4 miles per hour.
of excess speed per vehicle. The arithmetic mean and the median are neither of much use, because they are affected little when only the highest speeds are reduced which is, of course, the aim of enforcement.

## EFFECT OF STANDING PATROL UNITS ON SPEEDS OF NEARBY VEHICLES

In all cases the observations were made on a long, straight level stretch of road without view obstructions or marginal interference. The changes in the excess speed per vehicle from a normal established when no patrol unit was present are shown. Completely to suppress violations, the excess speed per vehicle would have to be reduced to zero.

The effect of a patrol unit standing by the side of the road on the excess speed per vehicle when vehicles are about 100 yards before overtaking and meeting, and about the same distance after overtaking and meeting, are shown in Table 1. The effect of a highway patrol car not conspicuously marked standing by the roadside with a patrolman waiting at the wheel are shown separately from those of the


Speed Arrests per 100 vehicles per year 1948, 45, 1949, 9 6; 1950, 77, 1951, 66

Figure 6. Night speeds reflect increased enforcement more than day speeds.
same patrol unit in which the officer appears to be giving a ticket to a stopped driver.

These figures suggest some slowing of traffic overtaking the standing patrol unit both before and after overtaking, but little effect on traffic in the opposite direction. We would logically expect that drivers would be more influenced by the likelihood of a patrol car giving pursuit when it was headed the same way than when it was headed in the opposite direction. However, the figures obtained in this pilot study cannot be considered signuficant. Each condition reported represents fewer than 50 vehicles observed and the standard error of the differences is in no case less tinan a third of the difference. Hence larger samples must be studied to get truly significant data. It was estimated that from 150 to 200 cars would have to be observed to get reilable data.

## EFFECT OF MOVING PATROL UNIT ON SPEEDS OF NEARBY VEHICLES

A similar pilot study was made of the effect of a motorcycle patrolman in motion. The location was a long stretch of dual highway. The patrolman passed the check point at a predetermined speed about every 8 minutes in one direction. He couldbe seen by cars as much as half a mile behind him and a quarter of a mile ahead. For each vehicle passing the check point two things were recorded: (1) its speed and (2) the number of seconds by which it preceeded or followed the patrolman. With the patrolman at a constant known speed, his distance ahead of or behind the observed vehicle could be computed.

The observations of vehicles with respect to the patrol vehicle for a number of passes of the patrol vehicle were combined. The observations made when the patrolman was moving at exactly the posted speed limit of 35 miles per hour are shown in Figure 1. Each point represents one vehicle observed. Normally (that is when the patrolman was not in sight), more than half of the cars exceeded the speed limit and of those which did so half exceeded it by more than 5 mph . This is shown by the points at the extreme right and left (more than 20 seconds ahead of or behind the patrolman). Just behind the patrol unit the number of vehicles
exceeding the limit seems to be reduced a little, but for about 1,000 feet ahead few exceed the limit, and of those only one exceeded it by more than 5 mph . The high speed of this one suggests that it may have been an error in observation.

A similar (but larger) number of observations was made with the patrol unit moving 5 mph . lower than the posted limit. These are shown in Figure 2 and even more clearly indicate that the effect of the unit is limited to about 1,000 feet or less ahead and only a few-hundred feet behind. The increased number of cases immediately following the patrolman and the decreased number ahead shows that traffic normally going faster hesitates to overtake and forms a tail or que behind the patrolman.

The same data can be shown by speeddistribution curves for vehicles observed when the patrolman was in sight compared to the normal curve when he was not in sight (Figs. 3 and 4). Note that there's a substantial difference in the speeds of the vehicles in sight ahead: less for those following; for those in sight but about 1, 000 to 2,000 feet behind, almost no difference. Table 2 gives the effect of the moving patrol unit in terms of decrease in average excess speed for intervals before and after patrol.

All of these data are from short pilot studies in which the volume of data were insufficient to be conclusive. Full-scale studies should be made which would show more precisely the effect on speeds of the presence of a patrol vehicle at a greater range of distances from the vehicle and, also, for different degrees of conspicuousness of the vehicle.

## EFFECT OF INCREASED ENFORCEMENT ON VEHICLE SPEEDS IN CHICAGO

To get some idea of what effect overall enforcement has on behavior and accidents, a special study was made.

In connection with a substantial increase ir. the level of law enforcement in Chicago, speed observations were made by day and night, at eight selected typical locations, before enforcement was increased and the first and third year following. Figure 5 shows how the increase in arrests for speed (which remaned a fairly constant percentage of arrests for all hazardous
traffic violations) resulted, either alone or in connection with arrests for other offenses in reductions in excess speed per vehicle, and a similar but smaller reduction in the traffic-accident death rate. Thus, somewhat more than doubling arrests for hazardous traffic law violations results in slightly less than halving the excess speed per vehicle. The death rate also dropped but not quite so much.

Figure 6 shows how the night speeds responded more to the additional enforcement than day speeds did. At the eight points studied the average excess speed at night was, to begin with, consıderably higher than by day, nearly a third, infact. Possibly this may have been because there was little night enforcement. With the increase in enforcement there was a conspicuous, but not specifically recorded, improvement in selectivity of enforce-
ment, which increased the amount of night enforcement more than the day enforcement. How important this effect is, we do not know. The apparent effect on speed seemed to have no comparable effect on accidents by night and day. The percent of total fatal accidents between $8 \mathrm{p} . \mathrm{m}$. and 6 a. m. was 46 in 1948 and 47 , 44, and 42 respectively in the three following years.

No records were avallable to show what changes there were in the severity of penalties. Further studies of this sort should be repeated when suitable opportunity presents itself in communities which are prepared to make substantial and continuing increases in city-wide enforcement. As a result of such studies, it is to be hoped that some kind of formula might be devised which would permit some estimate of the amount of enforcement necessary to secure a given level of accidents.

