Feasibility of Photo-Radar for Traffic Speed Enforcement in Virginia

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Because of increasing difficulties in enforcing speed limits on high-speed, high-volume roads, it was proposed that experiments be conducted with photo-radar to determine whether using it could help reduce average speed and speed variance. It has been widely used in Europe for about 30 years and very recently used in the western United States. A project task force led by researchers from the Virginia Transportation Research Council conducted site visits to cities in Europe and the United States where photo-radar is being used. The task force also invited five manufacturers of photo-radar equipment to demonstrate their equipment during a 2-week series of tests on sections of U.S. Interstate highways with varying volumes of traffic and differing traffic characteristics. The tests were designed to provide the researchers with data on the accuracy, reliability, and efficiency of each unit and help them determine whether photo-radar could be successfully deployed as an enforcement tool on high-speed, high-volume roads. The researchers concluded that four of the five photo-radar units tested in the study met the minimum standards for accuracy, reliability, and efficiency established by the evaluators in conjunction with the project task force and therefore recommended efforts to pass enabling state statutes and test further the efficacy of using photo-radar under actual traffic-enforcement conditions.

Speeding on high-speed, high-volume highways continues to be a serious problem in the United States. The expansion of roadways to up to eight lanes in response to increasing traffic has reduced and sometimes eliminated the shoulder area traditionally used for roadside ticketing of speeders. The size and capacity of these roadways add to the problem. This is especially true on the Capital Beltway (I-495) around Washington, D.C., where more than 60 percent of the drivers exceed the speed limit.

Because of increased speeds and the resulting increase in incidents on the Capital Beltway, the Departments of State Police and Transportation in Maryland and Virginia, in cooperation with the Federal Highway Administration and the National Highway Traffic Safety Administration, instituted a feasibility study of the use of photo-radar for speed enforcement. The study was conducted by the Virginia Transportation Research Council (VTRC) for the Virginia Department of State Police.

Photo-radar equipment combines a camera and electronic controls with a radar unit that detects speeding vehicles. The various configurations in which photo-radar may be operated are shown in Figure 1. It can be operated in a stationary mode mounted on a tripod, in a cabinet, on a pole on the side of the roadway, on an overhead structure, or in the back of a motor vehicle. Some types of photo-radar can be operated in a mobile mode, installed in the dashboard area of a vehicle to take pictures of speeding vehicles as they approach or pass. If deployed to photograph oncoming traffic (see Figure 2), once the unit's radar detects a speeding vehicle, the unit's camera photographs the driver's face and front license plate. If deployed to photograph receding traffic, the camera photographs the rear license plate. At least one manufacturer's unit can photograph in both the oncoming and receding modes through use of an additional camera, which is activated by the flash unit of the primary camera.

The radar used in photo-radar equipment operates on the same principle as the radar used by police in everyday speed enforcement. This principle, called the Doppler effect, is the apparent change in the frequency of a sound wave resulting from the change in the distance between the "listener" and a moving object. The radar unit sends out sound waves of a given frequency that bounce off the moving vehicle and are received by the radar unit. By measuring the change in frequency over a given time period, the distance traveled is measured and the speed of the vehicle is calculated. After the license number of the speeding vehicle is determined from the photograph, a citation is sent to the registered owner of the vehicle. If the owner was not the driver, the owner may avoid liability for the ticket by identifying the driver.

Traffic Monitoring Technologies (TMT), located near Houston, Texas, is the only manufacturer of photo-radar equipment in the United States. TMT equipment is currently being used in Pasadena, California, and Paradise Valley, Arizona. The other five principal manufacturers are located in Western Europe and Scandinavia, where photo-radar equipment has been used for more than 30 years, and Australia.

METHOD

The researchers sought to evaluate the feasibility of photo-radar use on the Capital Beltway through four methods:

1. Outline the history and acceptance of speed enforcement technology and address the constitutional and evidentiary issues presented by photo-radar use (not discussed in this summary document).
2. Make site visits to the two cities in the United States where photo-radar technology has been used in speed enforcement and to four European manufacturers of photo-radar equipment.

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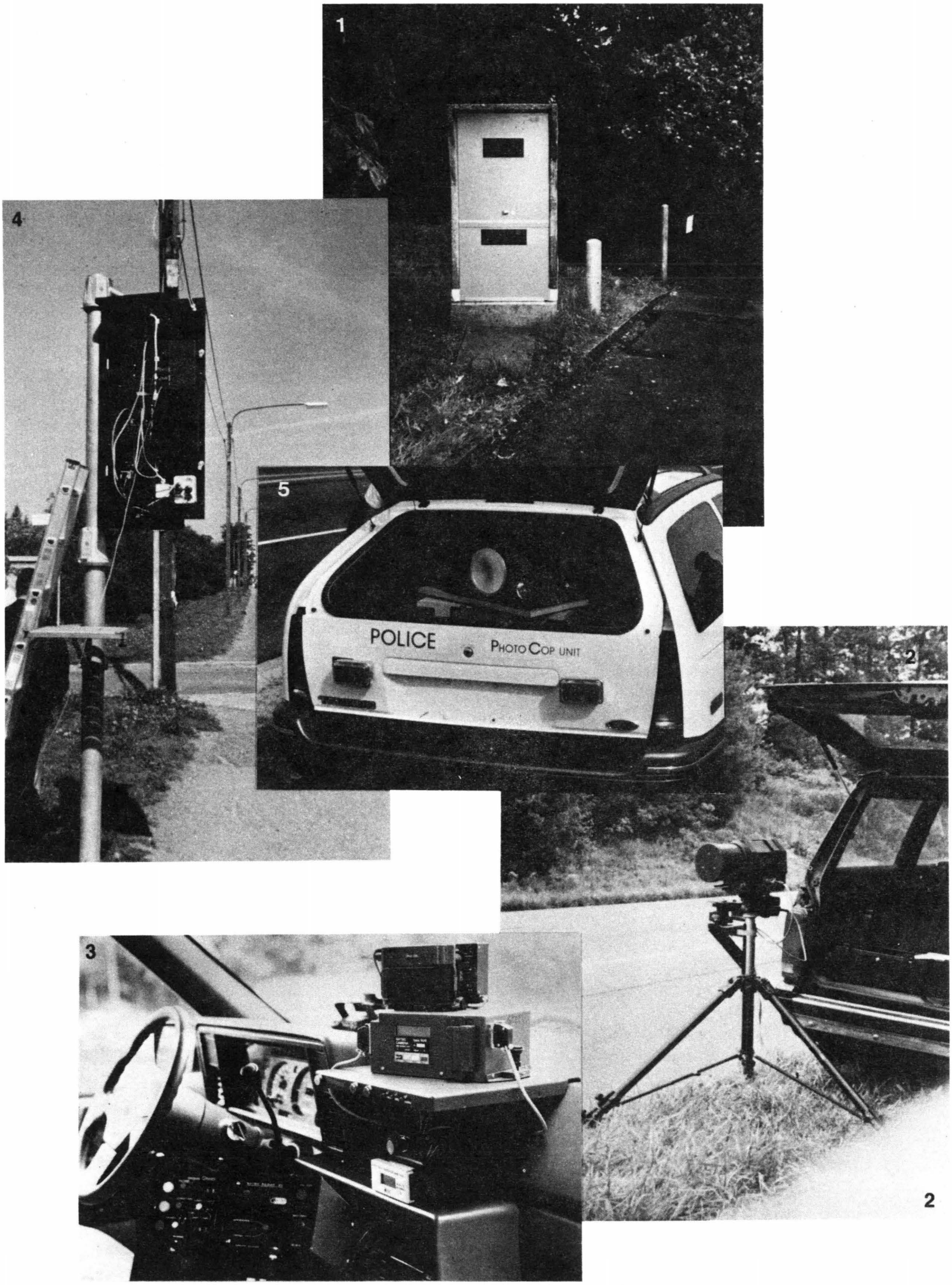

FIGURE 1 Modes of photo-radar operation.

FIGURE 2 Typical photograph produced by a photo-radar unit. License plate number was deleted to ensure the privacy of the vehicle's owner.

3. Test photo-radar equipment on selected highways in Virginia and Maryland.
4. Conduct an opinion survey to measure public sentiment concerning the potential use of photo-radar on the Capital Beltway.

The study culminated in a report entitled *Automated Speed Enforcement Pilot Project for the Capital Beltway: Feasibility of Photo-Radar*, from which this summary is drawn. (A more detailed discussion of the issues presented in this paper is available in that report, available from VTRC.)

RESULTS

Site Visits

From February 26 to March 5, 1990, site visits were made to Pasadena, California, and Paradise Valley, Arizona, where photo-radar leased from TMT is currently used in speed enforcement. Between May 20 and June 2, 1990, the facilities of four European manufacturers of photo-radar were visited: Gatsometer (the Netherlands), Multanova (Switzerland), Traffipax (Germany), and Trafikanalysis (Sweden). The manufacturer in Australia—AWA Defence Industries—was not visited because of budgetary constraints.

The purposes of the site visits were to review and discuss the equipment on site with its users and manufacturers, observe the equipment in use at locations where the manufacturer believed it had been used successfully, compare the equipment with the manufacturer's claims, and evaluate its potential for effectiveness on a congested urban highway such as the Capital Beltway.

Pasadena, California

Confronted with speed-related problems arising from heavy commuter traffic through residential neighborhoods, Pasadena, a city of 130,000, commenced the testing of photo-radar in 1987 in speed zones of up to 50 mph. Photo-radar is currently used on highways with three or fewer lanes. Approximately 45 percent of drivers ticketed by photo-radar pay the fine without attending court, nearly 32 percent of drivers choose traffic school, and about 7 percent of the cases are dismissed.

However, 16 percent of those cited ignore the ticket. Moreover, those who ignore the ticket suffer no consequences because the administrative cost of issuing a summons for a photo-radar violation in Pasadena is too high. Police fear that this may eventually undermine the program. TMT leases the photo-radar equipment to Pasadena for a fee of $20 per conviction. However, the Pasadena program does not pay for itself because of a low fine schedule and the use of attending traffic school as an alternative to fines.

Paradise Valley, Arizona

Paradise Valley, a town of 14,000, has a high volume of speeding commuter traffic. Photo-radar has garnered community, judicial, and media support. Estimates suggest that citation rates for photo-radar are 19 times greater than for mobile patrols. Citations are mailed within 2 weeks of the offense, and if the offender challenges the citation, a photograph is developed for trial. At trial, if the driver photographed is not the owner, the owner is requested to identify the driver under oath. If the owner identifies the driver, a citation is issued to the driver within 30 days of the offense, satisfying due process requirements. If the owner refuses to identify the driver, the owner can be held in contempt. However, to protect the public image of the photo-radar project in Paradise Valley, this option is rarely used.

Paradise Valley, unlike Pasadena, discounts the threat presented by ignored citations. The authorities may issue a summons immediately to those who disregard citations. Moreover, Paradise Valley authorities suspend the vehicle owner's license indefinitely if the summons is ignored. Speeds on most roads have decreased, and local officials believe that photo-radar has freed more police time for enforcement of alcohol-related violations. Furthermore, police officers assert that once they gained experience concerning the locations and times at which photo-radar is most effectively used, the percentage of usable photographs increased. TMT services the program in Paradise Valley at a fee of $20 per conviction. Fines generated from photo-radar convictions exceed the costs of the program itself, providing a source of revenue for the Paradise Valley community.

Western Europe and Scandinavia

Photo-radar has been used in Western Europe for about 30 years and in Scandinavia for about 5 years. Although one brand of photo-radar equipment has been used on a high-speed, high-volume roadway (i.e., the Autobahn in Elzberg, Germany), photo-radar is used in basically the same manner as in the United States—on relatively low-volume, low-speed surface streets. Most manufacturers cite success stories in which photo-radar use resulted in reduced speeds or reduced accidents.

Capabilities of Equipment

Table 1 summarizes the capabilities of the equipment manufactured in the United States and overseas. The equipment made by AWA Defence Industries is included in the table. Although no site visit was made to Australia, AWA participated in the field demonstrations in the United States, thereby providing the researchers with the pertinent information.

All of the equipment can operate in a stationary mode. All of the units can operate at night using a strobe. Three of the six units can monitor traffic while being operated in a moving vehicle. Five of the six units can monitor oncoming and receding traffic at the same time, although this feature is rarely used. Finally, and most important for states like Virginia that have a separate speed limit for trucks, four of the six photo-radar units can enforce one speed limit for passenger vehicles and another for large trucks.

Add-ons and attachments are available for use with photo-radar. All manufacturers offer a computer interface and software that will analyze the speed data collected on site. Video is also available for on-site use. One of the more interesting peripherals available is a photographic processing unit that converts images from negatives into a picture on a television monitor. These TV pictures can be viewed to determine whether they are clear enough to be used in court. They can be manipulated by changing the contrast or by zooming in on the driver or license plate. Also, the passenger or any other image in the picture can be blacked out or excluded from the photograph, and the resulting image can be printed instantaneously.

Feasibility of Use on the Capital Beltway

Since photo-radar use had proven feasible in several American and European cities, the study proceeded to the issue of whether photo-radar use would be technically and operationally feasible in the high-speed, high-volume environment of the Capital Beltway. A major aspect of feasibility was the accuracy of the equipment and the clarity of the photographs produced. Without documented evidence as to its accuracy, photo-radar use would not pass muster with the courts, and without a sufficient number of clear, readable photographs, too few citations would be produced to make the program worthwhile. Another major aspect of feasibility was whether the specific units could perform adequately in varying conditions. Thus, field demonstrations of each of five manufacturers of photo-radar equipment were conducted during the summer of 1990 on Interstates 64, 81, 95, 295, and 495 in Virginia and I-95 in Maryland. The equipment of each of five manufacturers was tested for a 2-week period. The demonstrations yielded the following results:

- Accuracy of recorded speeds: Unless a speed enforcement device is accurate, both the courts and the motoring public will reject it. To test the accuracy of the photo-radar equipment, test vehicles were driven through the path of the photo-radar units. The speed readings generated by the individual photo-radar units were then compared with the speed measurements produced by loop detectors embedded in the pavement. (These loop sensors are permanently installed around the state to collect speed and volume data.) The accuracy of a particular photoradar unit was expressed as the percentage of times the unit measured a vehicle's speed within +2 mph or −3 mph of the speed reading generated by the loop detector. This criterion was derived as follows: (*a*) the accuracy of the police radar currently in use in the United States is +1 mph to −2 mph; (*b*) the accuracy of the loop detector is ±1 mph; (*c*) by combining these two sources of error, the standard against which the photo-radar units were measured (i.e., +2 mph and −3 mph) was developed.

The accuracy of the photo-radar units varied, with one unit's recorded speeds falling within the required range 96 percent of the time and another's falling within the range only 84 percent of the time (see Table 2). Moreover, certain units resolved speed reading errors in favor of the driver, as do ordinary police radar units used in the United States. This fosters confidence in the speed reading since it reflects an underestimation of the driver's actual speed. Clearly, in considering which type of photo-radar equipment to use, the units that most closely resemble police radar in terms of accuracy and direction of the error are most desirable, since police radar use is so widely accepted in the United States.

- Multivehicle traffic and accuracy of equipment: Test vehicles were driven in pairs through the photo-radar beam to determine the effect that simultaneously driving two or more

TABLE 1 Capabilities of Photo-Radar Equipment

	AWA	Gatso	Multanova	TMT	Traffipax	Trafikanalys
Operations						
Stationary mode	Yes	Yes	Yes	Yes	Yes	Yes
Mobile mode	No	Yes	Yes	No	Yes	No
Nighttime	Yes	Yes	Yes	Yes	Yes	Yes
Both directions at once	No	Yes	Yes	Yes	Yes	Yes
Different speeds for cars and trucks	No	Yes	Yes	No	Yes	Yes
Options						
Computer interface	Yes	Yes	Yes	Yes	Yes	Yes
Video	No	Yes	Yes	Yes	Yes	Yes

TABLE 2 Accuracy of Photo-Radar Equipment

	AWA	Gatso	TMT	Traffipax	Trafikanalys
Percentage within +2 and –3 mph	83.7	93.8	87.2	96.3	86.7
Primary direction of error	Too high	Too high	Too low	Too low	Too low

vehicles through the radar beam had on the accuracy of speed readings. The data indicated that neither the lane in which the vehicle was driven nor the pairing of vehicles affected the accuracy of the speeds recorded. Under field conditions, the photo-radar unit could isolate the speeding vehicle and record its speed without a loss of accuracy.

• Number of usable photographs: Photographs produced by a photo-radar unit must be of sufficient clarity for two reasons: (*a*) a registered owner of a vehicle cannot be cited if the license plate of the vehicle is illegible, and (*b*) a court probably will not admit a blurred photograph as the sole evidence of a speeding violation. The numbers in this summary represent the percentage of speeding vehicles passing each unit that the unit could detect and then clearly photograph. The number of clear (i.e., usable) photographs varies with traffic volume, vehicle speed, threshold speed setting, and site selection.

When the photo-radar equipment was deployed to photograph oncoming traffic, the most efficient unit adequately detected and photographed 2.4 percent of those vehicles exceeding the speed limit and the least efficient unit adequately detected and photographed 1.7 percent (see Table 3). In terms of expected number of citations produced per hour, the least efficient unit would produce 9 citations per hour and the most efficient unit would produce 65 citations per hour, both in the oncoming mode.

Although the percentages of speeding vehicles adequately photographed appear quite low, the citation rate for the least efficient equipment still exceeds the number of citations that could be written by a police officer in 1 hr. The most efficient units produce far more citations per hour than an officer could write. Moreover, these figures do not measure the deterrent effect of photo-radar on speeding drivers. Therefore, photo-radar still might prove highly effective at speed enforcement even if it fails to detect and photograph the majority of speeding drivers.

• Effect of misalignment on accuracy: It is possible that photo-radar equipment will be operated under conditions that do not meet the exacting requirements of experimental conditions. To account for this, the researchers deliberately misaligned the photo-radar equipment up to a maximum of 8 degrees. With the exception of the AWA unit, the misalignment resulted in a maximum error of +3 mph. For the AWA equipment, a misalignment of 8 degrees caused a maximum error of +9 mph. All misaligned units overestimated vehicle speed.

• Ease of detection by radar detectors: It is reasonable to surmise that some drivers will attempt to evade photo-radar speed enforcement through the use of a radar detector. With that in mind, the researchers tested the distance at which each manufacturer's equipment was detectable. A test vehicle with the radar detector installed was driven slowly toward the equipment until it actuated the radar detector. The location of detection was marked, and the distance from the equipment measured.

Both the AWA and the Trafikanalys equipment were detected by the radar detector at 2,250 ft, and both the Gatsometer and Traffipax equipment were detected at 1,056 ft. The radar detector did not detect the TMT equipment since the radar detector used could not pick up the Ka band.

• Effect of photo-radar use on speed characteristics: To measure whether photo-radar use will reduce speeds requires full enforcement of photo-radar citations and increased motorist awareness of photo-radar use, both of which were outside the scope of the study. With this in mind, photo-radar use during the test runs produced a statistically insignificant reduction in the mean speed, which varied according to both the site and the equipment used. Further reductions can prob-

TABLE 3 Efficiency of Photo-Radar Equipment in Oncoming Traffic

	AWA	Gatso	TMT	Traffixpax	Trafikanalys
Total number of speeding vehicles passing the equipment	425	720	1,201	—	2,737
% of all speeding vehicles photographed well enough to issue a citation	2.0	1.7	2.0	—	2.4
Expected number of citations per hour	9	12	24	—	65

ably be expected if drivers are made aware of photo-radar use and are actually ticketed because of detection by a photo-radar unit.

Public Support

Even after a speed enforcement technology gains judicial acceptance, it must withstand the attacks of perhaps its most difficult critic: the motoring public. Public opinion polls in Pasadena and Paradise Valley indicate that motorists favor photo-radar use in residential areas on local roadways, but virtually all of the ticketed drivers are nonlocal. Application to an Interstate highway poses a unique set of concerns. To determine public sentiment on the issue of photo-radar implementation on the Capital Beltway, a cross section of Maryland, Virginia, and District of Columbia residents was sampled.

Approximately 60 percent of those sampled either approved or strongly approved of photo-radar use as a speed enforcement tool, and approximately 35 percent of respondents disapproved or strongly disapproved of its use (see Table 4). Roughly 5 percent of respondents had no opinion. Although less than 2 percent of respondents named photo-radar as a speed enforcement tool without its being suggested, once mentioned, 78 percent of respondents claimed to have heard of photo-radar technology.

Nondrivers and non-Beltway drivers felt more positively concerning photo-radar than did drivers or Beltway drivers. Moreover, women were more inclined to favor photo-radar use than men, and District of Columbia residents viewed it more favorably than Virginia or Maryland residents.

Generally, the findings support two assertions. First, despite certain gender-specific and geographic-specific variations in the results, those least affected by potential photo-radar use on the Beltway were the most positive concerning its use. Confirming intuition, Beltway drivers were more likely to oppose photo-radar use than the other drivers sampled. Second, the overall attitude of those sampled toward photo-radar as a speed enforcement device was positive. Even among Beltway drivers, the segment most skeptical of photo-radar use, there was a 53 percent approval rating.

TABLE 4 Public Opinion Concerning Potential Photo-Radar Use on Capital Beltway

Response	Percent of Respondents	
Strongly approve	16.7	
Approve	42.6	(59.3)
Disapprove	19.9	
Strongly disapprove	15.2	(35.1)
No opinion	5.6	

CONCLUSIONS AND RECOMMENDATIONS

It is feasible to use photo-radar technology to detect and cite speed violators on high-speed, high-volume roads. This advance in speed enforcement technology will undoubtedly encounter significant resistance by at least some segments of the motoring public. Moreover, the limits of the study itself should be noted: the study did not determine whether photo-radar use is cost-effective given the staff requirements and administrative costs of its operation. However, if photo-radar meets the requirements of the National Institute of Standards and Technology for accuracy and withstands initial legal challenges, then it should gain acceptance as an effective tool in speed enforcement. Effective photo-radar legislation could safeguard individual rights, meet constitutional requirements, and enhance the litigation of speed violations. (These conclusions are discussed in detail and supporting documentation is presented in the full report.) As part of its continuing commitment to improve safety on the highways, it is recommended that Virginia take steps to test and evaluate further the effectiveness of photo-radar in reducing speeds in traffic situations where traditional techniques for speed enforcement are impractical or unsafe.

The opinions, findings, and conclusions expressed in this paper are those of the authors and not necessarily those of the sponsoring agencies.

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