National Cooperative Highway Research Program

NCHRP Synthesis 219

Photographic Enforcement of Traffic Laws

A Synthesis of Highway Practice

Transportation Research Board
National Research Council

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Synthesis of Highway Practice 219

Photographic Enforcement of Traffic Laws

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Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

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PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation Research Board

This synthesis will be of interest to state and local highway agency administrative and executive officers, enforcement agency personnel, attorneys, traffic engineers, and others concerned with managing and enforcing traffic laws at all levels of government. It will also be of interest to manufacturers and marketers of automated speed enforcement (ASE) technology. The synthesis describes the requirements, applications, effectiveness, and issues related to the use of ASE technology.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

This report of the Transportation Research Board describes the various types of ASE technology as applied in several localities, including descriptions of operational requirements and performance characteristics of these technologies. The synthesis also discusses how citations are processed, and examines the legal and acceptability issues related to

ASE technology and public views on these actions. The various technologies on the market at the time of preparation of this synthesis are also described. It should be noted that, as with any application of public surveillance technology, officials are well advised to exercise proper cautions when employing such enforcement procedures.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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The Principal Investigators responsible for the conduct of this synthesis were Sally D. Liff, Manager, Synthesis Studies, and Stephen F. Maher, Senior Program Officer. This synthesis was edited by Linda S. Mason, assisted by Rebecca B. Heaton.

Scott A. Sabol, Senior Program Officer, National Cooperative Highway Research Program, Transporation Research Board, assisted the NCHRP 20-5 staff and the Topic Panel.

Information on current practice was provided by many highway and transportation agencies. Their cooperation and assistance were most helpful.

PHOTOGRAPHIC ENFORCEMENT OF TRAFFIC LAWS

SUMMARY

There is increasing interest in the use of automated photographic or video equipment to detect traffic violations and enforce traffic laws. This synthesis documents the current state of the art and use of this equipment, and identifies and addresses the issues it raises.

The primary interest areas of traffic law enforcement for this synthesis were those associated with speeding, signal-light (red-light, railroad-grade crossing, and ramp-metering), high-occupancy vehicle (HOV) lane, lane-change, and weight restriction violations. Automated enforcement technology that employs photographic and/or video equipment to record a violation has been used more widely for speed enforcement than for the other enforcement areas. The technology has been used to a lesser extent for detecting red-light, railroad-grade crossing, and HOV violations. Adaptation of the technology to the other enforcement areas investigated for this report is fairly recent and, in some instances, is in the conceptual stage of development.

Eleven automated speed enforcement (ASE) systems were identified through a worldwide search of published and unpublished information and from contacts with known U.S. and foreign manufacturers. These systems were of special interest because of their potential to substantially enhance police efforts in speed enforcement by making the function less labor-intensive and improving safety. The systems have in common some means of automatically identifying, from among the traffic flow, those particular vehicles exceeding a preset limit and then providing evidence. Typically, this evidence is in the form of a photograph, although video evidence is also considered. These systems can, in principle if not in actual practice, be operated automatically without a police officer in attendance. The ASE systems represent the products of 11 firms located in the United States, Europe, Australia, and South Africa.

ASE devices as an enforcement tool have been used widely in Europe since the early 1970s. Units have been used by law enforcement agencies in about 40 countries around the world during the mid 1970s to early 1980s. The origin of the technology goes back to the mid 1950s.

In the early 1980s, ASE equipment was not used in the United States, although field trials of the equipment had taken place in Texas and New Jersey during the 1970s. Now the situation is different. ASE equipment is being used routinely in California, Utah, and Arizona cities to enforce speed limits. Field evaluations of ASE equipment have been held in Washington, Michigan, New Jersey, and Virginia. Also, over 50 city and state law enforcement agencies have expressed varying degrees of interest of using ASE equipment in their jurisdictions.

New manufacturers of ASE equipment emerged in the 1980s along with significant design advances. Improvements were achieved by using more current electronics, together with computers for managing signal detection and camera(s) activation. These

improvements, plus the use of higher radar frequencies, have resulted in more compact and lighter weight systems that are more amenable to mobile operations. Video cameras are also now being used in addition to 35-mm cameras to provide backup evidence of the speed offenses.

A number of technical and legal operational requirements are associated with the use of ASE equipment for photographic enforcement of traffic laws. These requirements vary from state to state and even from one law enforcement jurisdiction to another within a given state. This is because some of the operational requirements, particularly those of a legal nature, are considered to be sensitive and to have political overtones. The literature seems to indicate that the use of ASE systems does not appear to violate any constitutional rights of drivers when implemented in accordance with state and local ordinances.

Operational experience with ASE equipment to photographically enforce traffic laws is presented in this synthesis. Areas of discussion include the range of enforcement strategies used with ASE equipment, the trends in enforcement strategies, some operational constraints associated with the use of ASE and red-light equipment, and several reliability and maintainability issues originating from pilot tests and operational experience with the equipment.

Various issues arise with regard to processing citations emanating from the use of photographic enforcement of traffic laws. Some of these issues include in-house versus contract processing of citations; special issues associated with the identification of vehicle owners; adjudication practices involving drivers and owners; impacts on police, courts, and Department of Motor Vehicle (DMV) resources; and cost and revenue considerations associated with the use of ASE equipment.

There are also legal and acceptability issues that surround the use of photographic enforcement of traffic laws. Limitations imposed by law are obvious. However, the opinions expressed widely by citizens, public interest groups, and governmental authorities such as prosecutors, judges, and police strongly affect the acceptability of ASE programs. These opinions result in policy and strategy requirements that limit the ways in which ASE is carried out. The success of long-running ASE programs in several U.S. cities is due, in large part, to widespread acceptance by the public and various community agencies.

A number of attempts have been made to assess the impact of ASE enforcement on speed limit compliance and traffic safety. The data presented in the literature indicate that the use of ASE devices to enforce speed limits will reduce the incidence of speeding to a certain extent. The speed reduction claims range from a few percent to almost 20 percent, depending on a number of variables. Most of the speed reduction claims are based on enforcement observations and not on scientifically formulated experimental designs.

The effects of ASE programs on speed-related crashes, or crashes in general, are highly publicized but not well supported with scientific evidence. As much as a 50 percent reduction in traffic accidents is claimed as a benefit from the use of ASE equipment. It is evident that some reduction in traffic crashes is possible through the use of ASE systems. However, the expected percent reduction amount is not known with any certainty at this time.

CHAPTER ONE

INTRODUCTION

BACKGROUND

Speed limits and their enforcement are important contributors to maintaining safety on highways. Excessive speed is one of the most prevalent factors contributing to crash occurrences. It is well recognized that accidents occurring at higher speeds are more likely to result in fatal or serious injuries than those at lower speeds. According to a National Highway Traffic Safety Administration (NHTSA) report (*1*), speeding was involved in 12 percent of all police reported crashes.

NHTSA's Fatal Accident Reporting System (FARS) data have been used to estimate the role of speed in contributing to the cause of fatal crashes. For FARS data, speed-related was defined as "driving too fast for conditions or in excess of the posted speed limit" and "high speed police chase." The FARS data clearly indicate that speeding was involved in 39 percent of all fatal crashes in 1979. The percentage of speed-related fatal crashes declined slightly from 1979 to 1982 and then remained basically stable. In 1989, the data indicate that one-third of all fatal crashes were speed-related; it was also estimated that 15,558 fatalities and 80,000 serious injuries occurred in speed-related crashes (*1*). The economic cost of these crashes was more than $10 billion. States and municipalities have continually instructed their police personnel to enforce speed limits in an attempt to curb the incidence of speeding on our nation's highways.

NHTSA has paid considerable attention to speed enforcement and, over the course of its history, the agency has funded and promoted many programs and initiatives to address the issue. NHTSA has prepared a speed enforcement program plan, which relies heavily on programs and projects that have proven to be most effective, to help address the speeding problem (*2*). The plan also stresses a law enforcement commitment to controlling speeds on all public roads by using state-of-the-art equipment and technologies, such as photo radar and laser speed detection, with a strong emphasis on public information and education aimed to increase driver compliance with speed limits.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) encourages the use of technology for traffic enforcement. Specifically, the act states under Title II—Highway Safety: "The Secretary may encourage States to use technologically advanced traffic enforcement devices (including the use of automatic speed detection devices such as photo-radar) by law enforcement officers" (*3*).

Clearly, the problem of achieving better compliance with speed limits in general has been very difficult. Increased compliance requirements by the U.S. federal government have stimulated continued development and application of new ideas, including experimentation with manpower deployment strategies, public information and education, and their coordination. However, education and the increased efforts by personnel alone have not been enough. Cost-effective approaches to improving compliance have been sought through the application of modern technology.

There is increasing interest in the use of automated photo and video equipment to detect violations and enforce traffic laws, particularly those associated with speed limits (*4-7*). There is also a developing interest in the use of this equipment to enforce signal-light (red-light, railroad-grade crossing, and ramp-metering), high-occupancy vehicle (HOV) lane, lane-change, and weight restriction violations. This synthesis documents the state of the art and use of photographic technology for the enforcement of traffic laws. The synthesis also addresses some of the issues raised by use of the technology.

SCOPE OF THIS SYNTHESIS

The scope of this synthesis is limited to existing published and unpublished information on automated enforcement technology that uses photo and video equipment to assist police in enforcing traffic laws. The term "automated" refers to a technology that relieves the police officer of one or more normally manual functions. Technical information on the various photographic technologies was obtained from the manufacturers, both in the United States and abroad, and from published reports and papers. Results of experiments or demonstrations of the devices were obtained from law enforcement and highway safety researchers and other personnel. In addition, results from U.S. and foreign experience with the technology are documented from contacts made with law enforcement personnel and from material received through judicial and legislative channels. The information provided in this synthesis reflects the state of the art of photographic enforcement of traffic laws at the time the report was written. The topic is a rapidly emerging field with continuous changes in equipment, law enforcement approaches, and legal environments.

Following this introductory chapter, Chapter 2 describes the automated enforcement technology identified and discusses experience with the equipment. The operational requirements of photographic enforcement, as well as a discussion of related operational experience, are presented in Chapter 3. The processing of citations resulting from photographic enforcement of speeding violations is discussed in Chapter 4, followed by a description, in Chapter 5, of associated legal and acceptability issues. Chapter 6 notes the effects of automated speed enforcement (ASE) on speed compliance and traffic safety. Finally, conclusions are presented in Chapter 7.

CHAPTER TWO

AUTOMATED ENFORCEMENT TECHNOLOGY

This chapter describes automated enforcement technology that uses photo and video equipment to detect violations and enforce traffic laws. Separate discussions are provided for enforcement areas in which the technology is used, various detection methods employed, and comparisons of and trends in the enforcement technologies. The chapter concludes with a summary of experience, both foreign and domestic, with automated enforcement technology.

ENFORCEMENT AREAS

The primary interest areas of traffic law enforcement for this synthesis were associated with speeding, signal-light (red-light, railroad-grade crossing, and ramp-metering), high-occupancy vehicle (HOV) lane, lane-change, and weight restriction violations. Automated enforcement technology has been used more widely for speed enforcement than for the other enforcement areas. The technology has been used to a lesser extent for detecting red-light, railroad-grade crossing, and HOV violations. Adaptation of the technology to the other enforcement areas investigated for this report is fairly recent and, in some instances, is in the conceptual stage of development.

DETECTION METHODS

Automated enforcement technology currently used in some of the enforcement areas investigated employs a number of detection methods. Detection methods used by technology under consideration for adaptation to other enforcement areas are also briefly discussed. The detection methods are described in terms of four enforcement areas: speed limit, signal-light, HOV lane, and other.

Speed Limit Enforcement

Eleven automated speed enforcement (ASE) systems were identified for this synthesis. These systems were found to be of special interest because of their potential to substantially enhance police efforts in speed enforcement by making the function less labor intensive. The systems have in common some means of automatically identifying, from among the traffic flow, those particular vehicles exceeding a preset limit and then providing evidence, which is typically a photograph, although video evidence is also considered. These systems can, in principle if not in actual practice, be operated automatically without a police officer in attendance. The ASE systems are produced by 11 firms located in the United States, Europe, Australia, and South Africa, respectively.

Of the 11 systems (more than 11 if the various models of each are counted), seven use Doppler radar. However, the physical principle of Doppler radar is applied in a manner quite different than is used in the United States. The way in which five of these systems use the radar principle, sometimes referred to as cross-the-road radar, is presented below. Technical descriptions are given of the seven radar-based systems and the other four systems of particular interest. Specific descriptions of the ASE systems are presented in Appendix A and another report (*6*).

Radar devices commonly used in the United States emit a microwave beam that is directed down the road, usually head-on into oncoming traffic. These radar devices operate in one of three frequency ranges: X-Band (10.5 to 10.55 GHz), K-Band (24.05 to 24.25 GHz), and Ka-Band (33.4 to 36.0 GHz). The reflected Doppler frequency is then converted into a speed measurement. While the radar principle is highly accurate (as are the U.S. devices), the down-the-road concept has some operational limitations. Although the radars often can determine vehicle speeds at long range (0.40 to 1.61 km (0.25 to 1 mi)), they are not able to discriminate between vehicles. An enforcement officer is trained to visually track a suspected speeding vehicle, make a mental estimate of the vehicle's speed, and then make a speed measurement. However, if two or more vehicles are visible to the beam, an officer's training and judgment must be used as to which vehicle is producing a reading; with some radars, it is the vehicle presenting the largest target, which is a function of size, nearness to the transmitter, and flatness of the frontal area, while other units produce the speed of the fastest vehicle in view. These units are usually not recommended for use in heavy traffic. Also, since their use requires the officer to stop the offending vehicle, they may not be appropriate where a high-speed chase is against policy, or where the roadway does not provide safe areas for pulling offenders out of traffic. Finally, the long range of the radars, coupled with their moderately high power, enables them to be detected by drivers with radar detectors.

The cross-the-road radar systems use a very narrow, low-power beam directed at an angle approximately 20° from the direction of traffic, as shown in Figure 1. (The exact angle differs from manufacturer to manufacturer.) Then, signal-processing logic corrects the reflected Doppler frequency for the cosine effect and ascertains whether a stable speed is being observed. For example, consider an angle of 20°. The directly measured speed is then cos20° times the actual speed, or roughly 94 percent of the actual speed. The logic makes a mathematical correction to determine actual speed. A speed reading is displayed after the logic tests designed by the particular manufacturer are passed. The vehicle to which the reading applies is readily apparent to an observer viewing along the beam. If more than one vehicle is in the beam at once, normally no reading will be displayed. Most such systems also incorporate a camera that can be triggered to photograph the vehicle after it leaves the beam. The cross-the-road systems are most frequently used to view receding traffic, as illustrated by Figure 1, but they can also be set up to look at oncoming vehicles,

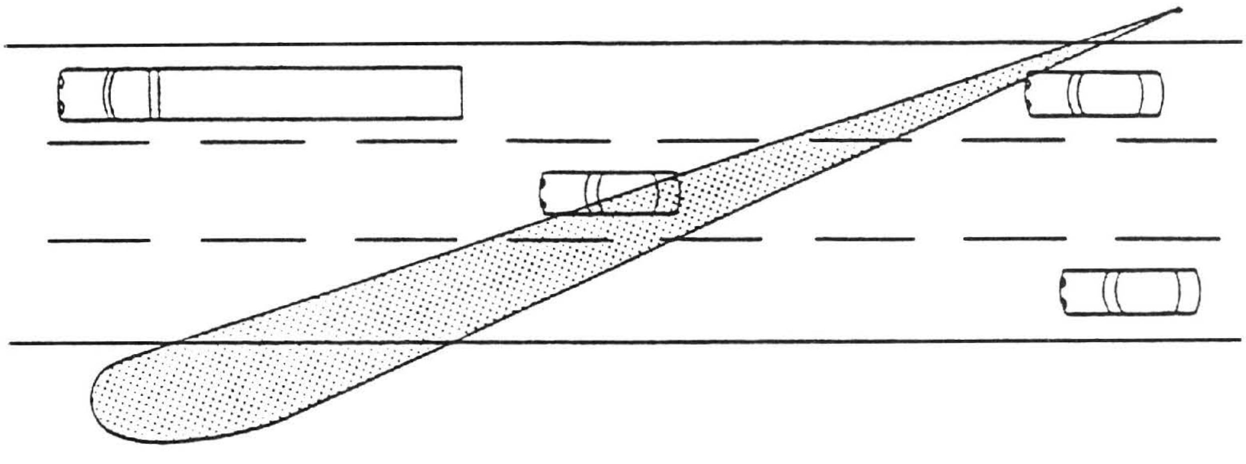

FIGURE 1 Illustration of the cross-the-road concept.

again by aligning the beam at a prescribed angle across the roadway.

Several advantages claimed for cross-the-road radar systems are their ability to make positive identification of speeding vehicles; to detect nearly all speeders, even in dense traffic (time-headway separations of only 0.5 to 1 sec are required); to be relatively free from effects of electrical and other interferences; and to be effective even against vehicles with radar detectors (i.e., the vehicle is in the beam and its speed is noted before a driver could react).

Signal-Light Enforcement

Signal-light violations include red-light, railroad-grade crossing, and ramp-metering violations. The detection methods used or considered for use in the automated enforcement of these violations are presented in this section.

Six manufacturers were identified as producing red-light violation detection equipment. These manufacturers also produce ASE equipment, which is described later. The six red-light violation systems (more than six if the various models of each manufacturer are counted) use roadway sensors (inductive loops, cables, or tubes) for detecting vehicles and 35-mm cameras for recording photographic evidence of the violation.

In traffic monitoring systems, many detectors are widely used to provide the necessary information. Video and image processing is one of the most significant new technologies in this area. Research on automated extraction of traffic parameters through video image processing has been ongoing at the University of Minnesota for some time (*8,9*). A Belgian firm has commercialized a camera and computer-aided traffic sensor after 5 years of field trials. The system uses video signal and image processing, along with high-speed processing hardware, to provide information on traffic flow parameters such as volume, speed, occupancy, and headway measurements. Recently, this firm introduced a new system for video image digitalization, image storage, and image transmission for detecting red-light and speed limit violations. The system's sensor consists of a video camera and a processor box. The sensor hardware digitizes the image, which is either placed on a hard disk for future processing or is transmitted through a telephone line to a central workstation. At the workstation, image processing software and other dedicated software packages are used to automatically produce police warrants for red-light or speeding offenses, to enhance poor optical images, or to record traffic flow data.

One manufacturer makes an automated enforcement system that produces photographic evidence of vehicles crossing railroad tracks illegally. The same manufacturer also produces ASE equipment. Other manufacturers of ASE equipment claim they can package a system to detect and record violations of railroad-grade crossings, even though they are not currently marketing such systems.

The manufacturer's railroad-grade crossing violation detection system uses inductive loops for vehicle detection and a 35-mm camera to record the photographic evidence of the violation (*10*).

No commercially available equipment was found that was used for automatic enforcement of violations of metered freeway ramps or of bypass lanes for metered freeway ramps. Several vendors of ASE equipment indicated that such detection systems could be packaged with existing technology. The systems would use roadway sensors (inductive loops, cables, or tubes) for vehicle detection and either 35-mm or video cameras to record the evidence of the violation.

HOV Lane Enforcement

Research was conducted in the late 1970s into the feasibility of using photographic systems and instrumentation in detecting HOV violators. At that time, the Federal Highway Administration (FHWA) funded a contract with the Naval Surface Weapons Laboratory (NSWL) of Dahlgren, Virginia to research the capabilities and limitations of photographic techniques in determining vehicle occupancy (*11*). Under the research program, NSWL developed a prototype photographic surveillance system, which consisted of a camera, a stroboscopic light source, and a vehicle-activated triggering mechanism. The original program was extended to produce a system specifically for enforcing HOV facilities, which apparently worked satisfactorily in detecting and photographing vehicles in HOV lanes. However, problems were encountered in accurately determining the number of vehicle occupants from the photographic evidence.

Some consideration was given for using the system solely to document the evidence of an HOV lane violation (*12,13*). In this case, an observer positioned next to the detection system would notify a downstream officer to apprehend the driver of the detected vehicle. The photographic evidence would be used only to produce concrete evidence that the violation took place. It is not known if this approach was actually used because of its labor requirement.

In the 1980s, undocumented attempts were made to develop detection systems for HOV lane violations using video cameras in place of photographic cameras. Problems were again noted with accurately determining the number of vehicle occupants. Infants and small children were difficult to detect with the camera systems. Also, some unsubstantiated instances were noted wherein inflatable dummies, stacked boxes, and even dolls were mistaken for or disguised as occupants.

Other Enforcement

Detecting lane-change violations and commercial weight restriction violations are other applications of automated enforcement technology. Currently, the Delaware Department of Transportation (DOT) is looking at the feasibility of using a photographic or video system to identify vehicles that change lanes in a restricted freeway area. Vehicle detection would be accomplished using roadway sensors such as inductive loops. This system is in the conceptual stage.

One vendor has proposed the coupling of a weigh-in-motion detector with a photographic system for use in identifying commercial vehicles that violate weight restrictions. The merging of the two technologies is in the developmental stage.

COMPARISON OF ENFORCEMENT TECHNOLOGIES

This section combines information and data on selected enforcement technologies associated with ASE and red-light violation detection. The systems were identified through a worldwide search of published and unpublished information and from contacts with known U.S. and foreign manufacturers (*4-6*). The technical information on the enforcement equipment was obtained mainly through correspondence with manufacturers and during telephone conversations with manufacturers' representatives in the United States.

System Specifications and Comparisons of ASE Devices

Technical information on the 11 ASE systems identified for this synthesis is presented in this section. A list of the manufacturers of these systems is given below. Detailed descriptions of each system are presented in Appendix A.

- American Traffic Systems (United States)
- AWA Defense Industries Pty. Ltd. (Australia)
- Gatsometer B.V. (Netherlands)
- Plessey South Africa, Ltd. (South Africa)
- Sensys Traffic AB (Sweden)
- Traffipax-Vertrieb (Germany)
- Zellweger Uster AG (Switzerland)
- Eltraff S.r.l. (Italy)
- Proof Digitalsystemer A/S (Denmark)
- Trans-Atlantic Equipment Pty. Ltd. (South Africa)
- Truvelo Manufacturers (Germany).

The major ASE systems of the 11 manufacturers are listed in Table 1, together with their primary components and other information. All of these systems can operate using photographic evidence, although many can be used without that feature.

Of the 11 manufacturers listed, seven use Doppler radar; however, five of the seven systems operate in cross-the-road mode. In addition, three of the cross-the-road radar systems record the speed of the offending vehicle during pacing operations using a digital tachometer. The four systems not using Doppler radar employ various types of sensors including passive optical sensing (Velomatic 103A); roadway sensors; and, in the case of the ProViDa/PDRS (Proof Video Data/Police Data Recording System), stopwatches and distance counters or a tachometer. All but one of the manufacturers produce their own sensing components. Traffipax-Vertrieb's Speedophot device is the one exception; this system uses a radar unit made by Gatsometer and a tachometer made by Robot.

Nine of the manufacturers offer cameras with their systems; some offer a choice of cameras. Most are 35-mm systems, designed for data recording. The PR-100 AutoPatrol system uses a camera that supports three types of sprocketless film including 35, 46, and 70 mm. The ProViDa/PDRS device made by Proof Digitalsystemer uses a color video camera instead of a film camera.

Flash units, either for night use or to enhance daylight photography, are available with seven of the systems; the availability of flash units is uncertain for three of the devices. The ProViDa/PDRS device does not use a flash unit.

All of the systems use sophisticated electronics in conjunction with their signal-processing logic. All make use of integrated circuits and microprocessor technology. Two manufacturers use advanced digital signal processing (DSP) to continually monitor the presence of all vehicles in the measurement zone. This method is a conventional military technique, which has now become commercially attractive because of recent developments and access to compact, low-power consumption DSP processors.

Finally, rough cost figures are given for illustrative purposes. All of the Doppler radar systems, except the Plessey made in South Africa, are offered for sale or lease in the United States by manufacturers' representatives. It is likely, however, that if a substantial U.S. market develops, there will be significant cost reductions from those shown in Table 1.

Each manufacturer listed in Table 1 was requested to provide an estimate of required training in using equipment and the manufacturer's cost for that training. Estimated annual maintenance costs for the equipment were also requested. Responses to these inquiries are presented in Table 2. The period of training offered by manufacturers in the general operation of equipment ranged from 1 to 2 days for all but the Vehicle Speed Radar system. Gatsometer offers a full week of technical training for a skilled technician in maintenance of the equipment. The manufacturer's estimates of training time and requirements are based on European user experience. It is possible the estimates are unrealistic (low) for U.S. needs and would have to be supplemented by department or state training in speed enforcement.

The speed sensor specifications used by the 11 manufacturers are shown in Table 3. Seven manufacturers use Doppler radar units; the cross-the-road concept is used by five of the seven

TABLE 1
SPEED ENFORCEMENT SYSTEMS CAPABLE OF PROVIDING PHOTOGRAPHIC EVIDENCE

Company	Country	Device	Sensor type[a]	Sensor mfg.	Camera	Flash	Electronics technology	Cost[b]
American Traffic Systems	United States	PR-100 AutoPatrol	Doppler radar	American Traffic Systems	TC-1000 TrafficCam	N.S.	Microprocessor and digital signal processing	Leased for unknown fee
AWA Defense Industries Pty. Ltd.	Australia	Vehicle Speed Radar Model 449	Doppler radar	AWA Defense Industries	Canon F1	Bowen Ltd.	Microprocessor	$25,000
Gatsometer B.V.	Holland	Gatso Micro Radar Type 24	Doppler radar and tachometer	Gatsometer B.V.	Robot	Gatsometer B.V.	Microprocessor	$19,000
	Holland	Gatso Micro Radar Type RadCam 24	Doppler radar and tachometer	Gatsometer B.V.	Single lens reflex camera (Canon F1, Pentax SRL)	Gatsometer B.V.	Microprocessor	$23,000
Plessey South Africa Ltd.	South Africa	Plessey Dual-Antenna Speed Monitor	Doppler radar	Plessey South Africa	N.S.	N.S.	Microprocessor	$13,000 SA Rands
Sensys Traffic AB	Sweden	RC 110 ASTRO 110	Doppler radar	Sensys Traffic AB	Robot	N.S.	Microprocessor and digital signal processing	$31,000
Traffipax-Vertrieb	Germany	Speedophot	Doppler radar and tachometer	Doppler radar by Gatsometer Tachometer by Robot	Robot	Bosch	Microprocessor	$40,000
Zellweger Uster AG	Switzerland	Multanova 6F	Doppler radar and tachometer	Zellweger Uster AG	Jacknau Robot	Zellweger Uster AG	Microprocessor	$38,000
Eltraff S.r.l.	Italy	Velomatic 103A	Optoelectronic and Capacitive	Eltraff S.r.l.	Fujica FTIF	N.S.	Microprocessor	$13,000
Proof Digitalsystemer A/S	Denmark	ProViDa/PDRS	Stop watches, trip counters, and tachometer	Proof Digitalsystemer	Color video	–	Microprocessor	N.S.
Trans-Atlantic Equipment Pty. Ltd.	South Africa	Speed Guard De Luxe Model 3000	Roadway rubber tubes	Trans-Atlantic Equipment	N.S.	N.S.	Microprocessor	N.S.
Truvelo Manufacturers	Germany	Truvelo M4[2] and Combi	Piezoelectric and coaxial cables	Truvelo Manufacturers	Robot	Truvelo Manufacturers	Microprocessor	$30,000

[a] All Doppler radars, except the ones used by Plessey and Sensys Traffic, are of the cross-the-road type.
[b] Approximate, for single unit including camera but exclusive of permanent enclosures, installation, customs, taxes, etc. Costs are not firm quotes, but are shown only for rough, comparative purposes.
N.S.—Not stated.

TABLE 2
ESTIMATED TRAINING DURATION, ASSOCIATED TRAINING COSTS, AND ANNUAL MAINTENANCE COST FOR ASE EQUIPMENT IDENTIFIED

Company	Device	Training duration (days)	Cost of training	Annual maintenance cost
American Traffic Systems	PR-100 AutoPatrol	N.S.	Included in cost/lease of equipment	N.S.
AWA Defense Industries Pty. Ltd.	Vehicle Speed Radar Model 449	3-4	$7,800[a]	$600
Gatsometer B.V.	Gatso Micro Radar Type 24	1-5	Included in cost of equipment	$250-500
	Gatso Micro Radar Type RadCam 24	1-5	Included in cost of equipment	$250-500
Plessey South Africa Ltd.	Plessey Dual-Antenna Speed Monitor	1	N.S.	N.S.
Sensys Traffic AB	RC 110 ASTRO 110	N.S.	N.S.	N.S.
Traffipax-Vertrieb	Speedophot	1	N.S.	Included in maintenance contract
Zellweger Uster AG	Multanova 6F	1	Billed on hourly basis plus expenses	N.S.
Eltraff S.r.l.	Velomatic 103A	2	$400[b]	$1,300
Proof Digitalsystemer A/S	ProViDa/PDRS	N.S.	N.S.	N.S.
Trans-Atlantic Equipment Pty. Ltd.	Speed Guard De Luxe Model 3000	N.S.	N.S.	N.S.
Truvelo Manufacturers	Truvelo $M4^2$ and Combi	1	Included in cost of equipment	$500

[a] Training conducted at user's facility.
[b] Training conducted at manufacturer's facility.
N.S.—Not stated.

Doppler radar systems. The radar beam of these five systems is aimed diagonally at between 20° and 25° from the direction of travel. The logic used in these five systems corrects for this angle. The beam alignment for the Sensys Traffic systems and the Plessey system is much smaller: 0° to 10° and 11°, respectively.

The four remaining systems listed in Table 3 use the time/distance concept to determine speed. The Velomatic, Speed Guard DeLuxe, and Truvelo look directly across the road, perpendicular to the direction of travel, and measure the time required by a vehicle to pass between two points. The Velomatic senses this time by means of two passive optical sensors or a set of capacitive sensors; the Speed Guard DeLuxe and Truvelo use a set of roadway tubes or cables. The fourth nonradar system (ProViDa/PDRS) uses manually activated stopwatches and distance counters to compute vehicle speeds.

The radar units use various microwave frequencies, ranging from 10.53 GHz to 34.60 GHz. Many of the radar units operate near to the K-band (24.15 GHz). The higher frequency bands used by all but the Sensys Traffic systems have resulted in smaller and lighter systems than the models of 10 years ago.

With the exception of the down-the-road Sensys Traffic and Plessey systems, all the other radars have very narrow beam widths, in the 4° to 5° range. The beam widths for the Sensys Traffic and Plessey radars are 12° and 10°, respectively. The down-the-road radars emit a radio frequency signal with lower power 2.5 to 3 megawatts (MW) than U.S. radars. The other radars have a beam power of between 0.5 and 25 MW.

The sensing systems have average power consumption during normal operations between 0.06 and 26 watts, and all operate from standard 12-V DC car batteries. The power consumption does not include consumption of camera, flash, or other accessories, which tend to be of short duration and represent peak loads. The

TABLE 3
SENSOR SPECIFICATIONS

Company	Device	Beam alignment[a] (degrees)	Radar frequency (GHz)	Radar beam width[b] (degrees)	Radar beam power (mW)	Power consump. (watts)	Effective lateral range (lanes)	Direction discrimi-nation[c]	Speed meas-urement range (mph)	Accuracy (mph)	Measuring interval (sec)	Temper-ature (°F)
American Traffic Systems	PR-100 AutoPatrol	22.5	34.6	4	1	N.S.	4	Yes	15-126	± 1	N.S.	20 to 125
AWA Defense Industries Pty. Ltd.	Vehicle Speed Radar Model 449	25	24.15	4	10	4.8	4	Yes	12-158	± 1	0.75	32 to 122
Gatsometer B.V.	Gatso Micro Radar Type 24	20	24.125	5	15	10	1-4	Yes	12-160	± 1[d]	0.5	-4 to 140
	Gatso Micro Radar Type RadCam 24	20	24.125	5	25	N.S.	1-4	Yes	12-160	± 1[d]	0.5	-4 to 140
Plessey South Africa Ltd.	Plessey Dual-Antenna Speed Monitor	11	24.225 and 24.175	10	2.5	N.S.	2	No	6-124	± 2%	0.12	32 to 122
Sensys Traffic AB	RC 110	0-10	10.53	12	3	9.5	3	Yes	12-155	± 0.5[e]	0.192	−22 to 140
	ASTRO 110	0-10	10.53	12	3	9.5	3	Yes	12-155	± 0.5[e]	0.192	−22 to 140
Traffipax-Vertrieb	Speedophot	20	24.125	5	20	6	1-4	Yes	12-155	± 1	0.5	14 to 140
Zellweger Uster AG	Multanova 6F	22	34.30	5	0.5	26	3	Yes	15-155	± 2	0.5	32 to 113
Eltraff S.r.l.	Velomatic 103A	90	—	—	—	0.34 Optoelec-tronic sensor 0.06 Capacitive sensor	3	Yes	2-620	± 1%	1.3	14 to 122
Proof Digitalsystemer A/S	ProViDa/PDRS	—	—	—	—	N.S.	2	Yes	0-299	0.05%	Manually depend.	N.S.
Trans-Atlantic Equipment Pty. Ltd.	Speed Guard De Luxe Model 3000	90	—	—	—	0.6	2	Yes	N.S.	N.S.	N.S.	-4 to 167
Truvelo Manufacturers	Truvelo M4^2 and Combi	90	—	—	—	17	Unlimited[g]	Yes[g]	6-186	± 1[h]	0.7	23 to 149

[a] Angle between centerline of beam and direction of travel.
[b] Total width (horizontal) between half-power points (−3 db).
[c] Unit can discriminate direction of vehicle travel.
[d] ± 2% for speeds over 62 mph.
[e] ± 1% for speeds over 62 mph.
[f] ± 3% for speeds over 62 mph.
[g] Dependent on detection cable installation.
[h] ± 2% for speeds over 62 mph.

manufacturers recommend using AC power and converters for permanent (fixed) installation.

All but the Plessey, Proof Digitalsystemer, and Trans-Atlantic Equipment systems claim to be effective across at least three lanes of traffic. The PR-100 AutoPatrol, Vehicle Speed Radar, Gatso Micro Radar, and Speedophot systems claim to detect vehicles across at least four lanes of traffic. The Truvelo systems are not limited in effective lateral range, practically, because the range depends only on the length of cable installed.

All systems, except the Plessey, can detect either approaching or receding traffic. With most systems, the user selects the direction of interest, and the system will ignore signals from vehicles traveling the other way. The Truvelo systems' rejection capability depends on the cable installation configuration.

Most systems are stated to be capable of measuring speeds up to at least 200 km/h (124 mph) with reasonable accuracy, assuming the equipment is set up and aimed properly. With the exception of the Proof Digitalsystemer and Trans-Atlantic Equipment devices, the various logics used by the systems in the automatic mode could identify and record the speeds of vehicles with time headways between them as short as 0.12 to 1.3 sec. These values are generally comparable to the times required to advance the film to a new frame and to recharge the flash unit, if any.

Operations under extreme temperatures are reflected in the last column of Table 3. The values shown are those quoted by the manufacturers, which define the guaranteed range of validity for the stated accuracies. The smallest range of operating temperatures is noted for the Vehicle Speed Radar device, the Plessey system, and the Multanova 6F system. The lower operating temperature for these three systems is 32°F. One temperature problem, which has been partially resolved by a user, concerns the maximum operating temperature (113°F) for the Multanova 6F. (Note that all temperatures are shown in degrees Fahrenheit rather than Celcius for purposes of this report.) This device experienced overheating problems when operated in a vehicle during the summer months in Paradise Valley, Arizona. The problem was partially resolved by ducting chilled air to the unit from the vehicle's air conditioner. This required adding a partition, duct work, and a heavy-duty fan mounted in front of the vehicle's radiator.

The photographic capabilities of each ASE system are displayed in Table 4. The systems use one of seven cameras, listed in the first column. All but two are 35-mm cameras, using a standard format of 24 x 36 mm. The 70-mm TC-1000 TraffiCam can use three types of sprocketless film including 35, 46, and 70 mm. For the 35-mm cameras used in all but the Truvelo systems, the relatively high-speed 400 ASA black and white film is generally recommended. A 200 ASA film is recommended for the Truvelo systems. The standard configuration(s) of each camera system is also given in Table 4.

A wide range of lenses is used with the cameras. The shortest lens, 50 mm, is used by the Velomatic 103A device. This lens size was standard in the mid 1980s. It has since been replaced by either a 75- or 90-mm f3.8 lens. A previous study (*5*) suggested the lens should be 135 mm in length so that state identification and expiration date on the license plate could be read. It appears that three manufacturers have adopted the focal length recommendations. The cameras used with the Multanova 6F can be fitted with either a 135-mm f1.2 or a 150-mm f3.8 lens, depending on the camera used. The American Traffic Systems and Sensys Traffic systems use a 150-mm lens, and the Gatso Micro Radar Type Radcam 24 can use a 60- to 120-mm zoom lens.

The shutter speeds of the cameras range from $\frac{1}{500}$ sec up to $\frac{1}{2000}$ sec, with $\frac{1}{1000}$ sec the most commonly used. All camera systems, excluding the video camera, include a power winder capable of at least one photograph every 1.5 sec, but more commonly, one every 0.5 sec.

All of the devices, except the Gatso Micro Radar Type RadCam 24, come with automatic exposure control as a standard accessory.

Most of the cameras can be fitted with any of several sizes of backs or magazines to handle different lengths of film. The only exceptions to this are the American Traffic Systems and the Trans-Atlantic Equipment system, which accept 100-ft film length and 36-exposure magazines, respectively. For attended operations of relatively short duration, the standard 20- or 36-exposure magazine is recommended. However, for unattended, automatic operation, a larger magazine is used. Four of the systems use an 800-exposure magazine for unattended operations. All of these larger magazines use bulk-loaded film, which may require purchase of loading apparatus and spare cassettes.

One of the biggest differences among the camera systems is in the data chambers because all are specially designed by the speed detection system manufacturer. The purpose of the data chamber is to display (superimpose) pertinent data on the photograph of the speeding vehicle. The data are gathered from various sources into the data chamber, put into a display, illuminated, and reflected through an opening in the back of the camera onto a designated location on the frame of the film. The items normally displayed include the date, time of day, speed of photographed vehicle, direction, sequence number, and a location code. Written information, such as a location description, can be added to the data display area of some models.

The operating temperature range is given in the last column of Table 4. Statements concerning temperature problems with the sensors apply equally to the camera systems.

System Specifications and Comparisons of Selected Red-Light Violation Detection Systems

The major red-light violation detection systems of six manufacturers are listed in Table 5, together with their primary components and other information. All of the systems provide photographic evidence of detected violations. The six manufacturers also produce ASE equipment described in preceding sections. The red-light camera (RLC) systems use various types of roadway sensors, including inductive loops, coaxial cables, piezoelectric cables, and rubber tubes. Gatsometer is the only manufacturer of the six listed to produce more than one RLC system, producing four models of RLC systems that vary in the number of traffic lanes monitored. In addition, two of the four models also record the speeds of vehicles detected. All but one of the RLC system manufacturers make their own roadway sensors. The Traffiphot III is the one exception; its roadway sensors are manufactured by the 3M Company.

The systems use one of three cameras: the Fujica FTIF, the Robot Motor Recorder 36 BET, and the Jacknau. All are 35-mm cameras, using a standard format of 24 x 36 mm. Any 35-mm film may be used, but 400 ASA black and white is generally recommended, especially when rear photographs are taken. Flash units, either for night use or to enhance daylight photography, are available for all the systems. When frontal photographs are taken, the RLC system is usually equipped with red filters in front of the

TABLE 4
PHOTOGRAPHIC SPECIFICATIONS

Company/system	Camera	Film size (mm)	Film (ASA)	Lens (mm)	Largest aperture	Max. shutter speed (sec)	Power winder	Repetition rate (sec)	Automatic exposure control	Magazine size (exp)	Automatic display	Written display	Operating temp. (°F)
American Traffic Systems/ PR-100 AutoPatrol	TC-1000 TraffiCam	70	400	150	N.S.	1/1200	Yes	1.5	Yes	100 ft	Time, date, speed, location info	—	N.S.
AWA Defense Industries Pty. Ltd./Vehicle Speed Radar Model 449	Canon F1	35	400	85	1.4	1/1000	Yes	1.5	Yes	36, ≥ 90	Time, date, speed, location, direction	—	41 to 122
Gatsometer B.V./Gatso Micro Radar Type 24	Robot	35	400	75 or 90	3.8	1/1000	Yes	0.5	Yes	36,800	Time, date, speed, direction, location code	Location descrip-tion	−4 to 140
Gatso Micro Radar Type RadCam 24	Canon F1 or Pentax SRL	35	400	60 to 120	2.8	1/2000	Yes	0.5	No	36, 100	Time, date, speed, direction, location code	—	−4 to 140
Plessey South Africa Ltd./ Plessey Dual-Antenna Speed Monitor						Camera system not available yet							
Sensys Traffic AB/ RC 110 ASTRO 110	Robot	35	400	150	3.8	1/1000	Yes	0.5	Yes	36, 400	Speed, distance to vehicle, direction of traffic, time, date, site code, speed limit	—	14 to 140

TABLE 4
PHOTOGRAPHIC SPECIFICATIONS (*Continued*)

Company/system	Camera	Film size (mm)	Film (ASA)	Lens (mm)	Largest aperture	Max. shutter speed (sec)	Power winder	Repetition rate (sec)	Automatic exposure control	Magazine size (exp)	Automatic display	Written display	Operating temp. (°F)
Traffipax-Vertrieb/ Speedophot	Robot	35	400	75 or 90	3.8	1/1000	Yes	0.5	Yes	36, 800	Speed, range of radar, traffic direction, time, date, code, frame counter, mode of operation	—	14 to 140
Zellweger Uster AG/ Multanova 6F	Jacknau FT/6FJ	35	400	85, 135	1.2	1/500	Yes	0.5	Yes	36, 400	Date, time, speed, direction	Location descrip-tion	14 to 122
Eltraff S.r.l./Velomatic 103A	Fujica FTIF	35	400	50	N.S.	1/1000	Yes	1.3	Yes	20, 36, 72	Date, time, speed	Location descrip-tion	14 to 122
Proof Digital-systemer A/S/ ProViDa/PDRS	Color video camera model ProViDa	—	—	N.S.	N.S.	N.S.	—	Manually depend.	Yes	—	Speed, time, distance, date	—	N.S.
Trans-Atlantic Equipment Pty. Ltd./Speed Guard De Luxe Model 3000	N.S.	35	N.S.	N.S.	N.S.	1/2000	Yes	0.5	Yes	36	Speed, time, date	N.S.	−4 to 167
Truvelo Manufacturers/ Truvelo $M4^2$ and Combi	Robot	35	200	75, 90	3.8	1/1000	Yes	1.0	Yes	36, 300, 800	Date, time, speed, location code	—	23 to 149

N.S.—Not stated.
Note: All temperatures are shown in degrees Fahrenheit rather than Celcius for purposes of this report.

TABLE 5
RED-LIGHT ENFORCEMENT SYSTEMS CAPABLE OF PROVIDING PHOTOGRAPHIC EVIDENCE

Company	Country	Device	Sensor type	Sensor mfg.	Camera	Flash	Electronic technology	Estimated Cost
Eltraff S.r.l.	Italy	Velomatic 103A	Inductive loops or coaxial cables	Eltraff S.r.l.	Fujica FTIF	N.S.	Microprocessor	$13,000
Gatsometer B.V.	Holland	Gatso Traffic Light Camera (RLC 36)	Inductive loops	Gatsometer B.V.	Robot	Gatsometer B.V.	Microprocessor	$21,000
Traffipax-Vertrieb	Germany	Traffiphot III	Inductive loops	3M Company	Robot	Bosch	Microprocessor	$30,000 to $60,000
Trans-Atlantic Equipment Pty. Ltd.	South Africa	Trafficam Red Light Camera (RLC)	Roadway rubber tubes	Trans-Atlantic Equipment	N.S.	N.S.	Microprocessor	N.S.
Truvelo Manufacturers	Germany	Truvelo Combi	Piezoelectric cables	Truvelo	Robot	Truvelo Red Filter System	Microprocessor	$30,000
Zellweger Uster AG	Switzerland	Multafot	Inductive loops	Zellweger Uster AG	Jacknau	Zellweger Uster AG	Microprocessor	$40,000

flash reflector and camera lens. The flash illuminates the inside of the car without blinding the driver. A red-sensitive black and white film has to be used in this case. A variety of lens lengths is available for use with the RLC systems. The lens lengths range from 35 to 105 mm, depending on the camera used. The shutter speeds of the cameras range from $\frac{1}{500}$ sec up to $\frac{1}{2000}$ sec. All cameras have a power winder and come with automatic exposure control.

Three of the camera systems can be fitted with several sizes of magazines to handle different lengths of film. The Velomatic 103A system uses up to 72-exposure magazines, the Traffiphot III system uses up to 1200-exposure magazines, and the Truvelo system uses up to 800-exposure magazines. The Gatso systems, the Trans-Atlantic Equipment system, and the Multafot system use 800-exposure, 36-exposure, and 400-exposure magazines, respectively.

Various data items are displayed on the photographs, including the date, time of day, location code, sequence number, and the red-light elapse time. All of the systems make use of integrated circuits and microprocessor technology.

Finally, rough cost figures are given in Table 5 for comparative purposes. These figures include camera, sensors, and enclosures but exclude costs for factors such as installation, customs, and taxes.

TRENDS IN AUTOMATED ENFORCEMENT TECHNOLOGY

A study was conducted in the early 1980s for NHTSA to identify and examine devices that could be used to enforce speed limit laws (*4*). The study identified a large number of devices, concepts, and systems. Most of these technologies and devices were not of U.S. origin but had been developed and applied rather extensively throughout the rest of the world. The most widespread technology used outside the United States was manned, across-the-road radar. The most promising technology identified was particularly well suited for ASE. That technology used a camera coupled with across-the-road radar to record automatically the license plates of speeding vehicles. The technology was used extensively in Europe and Japan, both in manned and unmanned operations. An update of enforcement technology and speed measuring devices was conducted in the early 1990s for NHTSA (*6*).

Interesting trends in automated enforcement technology, especially in speed enforcement, were noted since the first study. Advances have continued to be made in developing speed detection devices manufactured in the United States. Now, one manufacturer of ASE equipment is located in the United States. Also, representatives of foreign manufacturers of ASE equipment are actively marketing the equipment in the United States.

Advances also have continued to be made in the foreign development of speed detection equipment, with emphasis on automated equipment. These developments are concentrated in European countries, South Africa, and Australia. Japanese manufacturers no longer appear to be involved with the equipment development.

The previously identified major foreign manufacturers of ASE devices are still producing equipment, which appears to be much improved over the models of the early 1980s. The improvements have been achieved by using more current electronics, and in some cases, lower output power levels. These improvements, plus the use of higher radar frequencies, have resulted in more compact and lighter weight systems that are more amenable to mobile operations. These systems use a variety of speed sensors including cross-the-road radar, down-the-road radar, optoelectronic devices, piezoelectric cables, and inductive coils.

New manufacturers of ASE equipment have been identified in

Sweden, Italy, and Australia. The Swedish system is unique because when it detects a moving vehicle, the system's radar unit automatically switches from a standby to an active mode. In the standby mode, a pulse of energy is emitted at a fixed time interval. A continuous beam of power is emitted in the active mode. The system can detect and measure speeds of multiple vehicles simultaneously. The Italian device uses an optoelectronic sensor to measure vehicle speeds over a fixed distance between a pair of sensors. The unit can also be set up to selectively monitor commercial vehicles, as can units produced by three other manufacturers of ASE equipment. The Australian system uses an across-the-road radar.

ASE equipment was not used in the United States in the early 1980s, although field trials of the equipment had taken place in Texas and New Jersey during the 1970s. Now the situation is different as ASE equipment is being used routinely in California, Utah, and Arizona cities to enforce speed limits. Field evaluations of ASE equipment have been held in Washington, Michigan, New Jersey, and Virginia. Also, as of December 1993, more than 50 city and state law enforcement agencies have expressed varying degrees of interest in using ASE equipment in their jurisdictions.

Interest has grown in detecting red-light violations; six manufacturers of red-light violation devices, five in Europe and one in Australia, have been identified. These devices are used throughout Europe and in selected areas of Australia and New Zealand. Field trials of two systems have been conducted in the United States—one in New York City and the other in Pasadena, California. Systems have been in continuous operation in New York City and Jackson, Michigan.

Finally, interest is emerging in the use of automated enforcement technology in the United States for detecting violations associated with railroad-grade crossings, HOV lane usage, lane-change maneuvers, and commercial vehicle weight restrictions. Several systems have been installed in the past few years for detecting railroad-grade crossing violations. The Rail Construction Corporation, a subsidiary of the Los Angeles County Metropolitan Transportation Authority, initiated a demonstration project in 1992 that involved installing automated enforcement systems at two grade crossings in the city of Compton, a grade crossing in the city of Los Angeles, and a grade crossing in Long Beach. Additionally, Metrolink (a commuter rail line), the Union Pacific, and the Southern Pacific Railroads are conducting an automated enforcement system demonstration program in the city of Pomona, California (*10*). Several years ago, the Burlington Northern Railroad installed an automated enforcement system at one grade crossing in Jonesboro, Arkansas. Finally, the cities of Los Angeles and Compton, California have each installed photographic systems connected with inductive loop detectors to photograph vehicles making left turns in front of rail traffic and against a red left arrow indication.

Video and image processing is one of the most significant upcoming technologies for automated enforcement. This technology has been used in the United States for monitoring and analyzing traffic flow parameters, but not for enforcement.

SUMMARY OF EXPERIENCE

Foreign

ASE devices as an enforcement tool have been used widely in Europe since about 1970. Units have been used by law enforcement agencies in about 40 countries around the world during the mid to late 1970s. The origin of the technology goes back to the mid 1950s.

In 1955, a German firm, specializing in the production of cameras for scientific applications, began manufacturing a camera designed for mounting in a police car for purposes of photographing traffic violations. The camera system was used until it became clear that a picture alone was insufficient evidence for a traffic offense conviction. Additional data associated with the violation were required to also be in the picture. This situation created a need for electronic help in the documentation of traffic offenses. A few European companies with experience in the electronic detection and control business began to look for ways of combining their products with cameras.

In the late 1950s and early 1960s, experimental work was underway on combining military speed-measuring radar with a camera. In 1966, cameras were combined with pneumatic rubber tube detectors to produce pictures of both the front and rear of selected vehicles. However, it was not until the late 1960s and early 1970s that commercial units, combining improved speed-measuring radar with a camera, were being produced and used by European and Canadian (Quebec) police agencies in their speed enforcement programs.

The first European units were rather bulky and somewhat difficult to move from place to place. The units were used on tripod mountings, generally near the patrol car, or they were installed in cabinets placed alongside the roadway or on overhead sign bridges. Some of the units were semi-permanently mounted on the dash of a patrol car or in the rear of a van for use in a stationary mode.

New manufacturers of ASE equipment emerged in the 1980s along with significant advances in the design of the units. Improvements were made by using more current electronics, together with computers for managing signal detection and camera(s) activation. These improvements, plus the use of higher radar frequencies, have resulted in more compact and lighter weight systems that are more amenable to mobile operations. Units were also produced that could selectively monitor the speed of commercial vehicles. Video cameras are also now being used in addition to 35-mm cameras to provide backup evidence of the speed offenses.

The designs of the more recent ASE devices are being driven by the needs of law enforcement agencies. The need to create a general deterrence to speeding has resulted in the development of highly mobile and compact equipment. Less emphasis is being placed on the use of fixed, unmanned, fully automatic operations, except for selected portions of expressways. About 5 percent of the ASE devices manufactured by one European firm are used at fixed installations; the remaining 95 percent of the units are used in police vehicles in the stationary or mobile modes ("European Trip Report," Capital Beltway Photo-Radar Demonstration Project, Virginia Transportation Research Council, Charlottesville, unpublished, June 1990).

The development of red-light violation detection equipment in Europe somewhat paralleled the development of ASE devices. Red-light cameras produced by one manufacturer have been used in 33 foreign countries since the 1970s. The two photographic systems complemented each other in their acceptance by the courts. In some countries such as The Netherlands, use of the red-light camera paved the way for acceptance of ASE devices. The Dutch courts were accustomed to seeing photographic evidence from red-light prosecutions. Consequently, the photographs taken by ASE devices were readily accepted into evidence.

TABLE 6
STATUS OF ASE ACTIVITIES IN THREE WESTERN STATES

Location	ASE program period	ASE device used	Reason for discontinuing program
Arizona			
Paradise Valley	Oct 1987-present	Multanova 6F PhotoCop PR-100 AutoPatrol	Ongoing program
Peoria	March 1990-May 1991	PhotoCop	• Public opinion • Passage of proposition to stop program
California			
Campbell	1990-present	Multanova 6F	Ongoing program
Danville	October 1990-April 1993	Multanova 6F	• Cost of ASE program • Lack of judicial support • Too much administrative burden on officers • Dissatisfaction with the ASE vendor • Declining use of the ASE unit by the police department
Folsom	December 1990-January 1993	Gatso	• Cost of ASE program • Too much administrative burden on officers • No way to enforce speeding citations if not voluntarily paid • Police department focus changed from traffic safety to street crime • Adverse publicity concerning adjudication process
National City	May 1991-present	Gatso	Ongoing program
Pasadena	June 1988-June 1992	Multanova 6F PhotoCop	• Cost of ASE program • Erosion of judicial and public support • Reduction in manpower for follow-up • ASE vendor went out of business
Riverside	February 1991-present	Gatso	Ongoing program
Roseville	March 1990-September 1991	Multanova 6F	• New police chief did not support the ASE program • Lack of judicial support • Dissatisfaction with the ASE vendor • Lacked manpower for follow-up on noncompliance with citations
Utah			
Garland	November 1990-present	Multanova 6F	Ongoing program
Huntington	6-month period	Multanova 6F	• No community support • County sheriff's department with jurisdiction over city did not support ASE program operated by mayor
Wellington	Fall 1991-present	Multanova 6F	Ongoing program
West Valley	October 1991-present	PR-100 AutoPatrol	Ongoing program

Domestic

An early form of photographic identification of speeding vehicles, known as Orbis III, was tested in Arlington, Texas in 1976 over a 3-month period (*12,14*). ASE equipment was not used again in the United States for speed enforcement until July 1986 when Precinct 8 of Galveston County, Texas used the equipment for one year. The city police of La Marque, Texas also used ASE equipment for a 90-day period during early 1987. However, because of adverse public opinion, the ASE programs were stopped in both areas.

The use of manned ASE equipment since the Texas experience has been confined to 13 communities in the western states of Arizona, California, and Utah. The status of ASE activities in each of these communities is given in Table 6 along with reasons for the ASE program discontinuation, if any. The reasons for ASE programs being discontinued in 6 of the 13 communities are varied, but predominantly are the result of program costs and/or lack of public/judicial/police support.

Currently, ASE equipment is used in one Arizona city (Paradise Valley), three California communities (Campbell, National City, and Riverside), and three Utah communities (Garland, Wellington, and West Valley). In each of these seven locations, the ASE equipment is installed in a patrol car and operated with an officer present who also makes notes on the speeding offenses photographed. The ASE program in Paradise Valley, Arizona is the longest running program in the United States, beginning in October 1987 and continuing until the present time. The ASE program conducted in Pasadena, California from June 1988 until June 1992 was the second longest running program to the date of this report.

More than 50 state and local law enforcement agencies have an active interest in using ASE equipment. Many of these agencies are waiting for enabling legislation to begin an ASE program. Other agencies are proceeding with a program based on favorable state attorney general opinions and, in some instances, city ordinances. The Washington, Michigan, and New Jersey State Police are currently completing evaluations of ASE programs in their respective states under grant awards from NHTSA.

Additional information on the use of ASE equipment in the United States, as well as experiences with red-light violation equipment and other automated enforcement technology, are presented in Chapter 3.

CHAPTER THREE

OPERATIONAL REQUIREMENTS AND EXPERIENCE

This chapter briefly describes the technical and legal aspects of operational requirements associated with the use of photographic enforcement of traffic laws. Operational experience with photographic enforcement is also presented. Because a majority of the documented experiences and requirements are associated with the use of ASE equipment, discussions are based primarily on the use of photographic evidence for enforcing speeding violations.

OPERATIONAL REQUIREMENTS

The technical and legal requirements for operating ASE equipment vary from state to state and even from one law enforcement jurisdiction to another within a given state. This is because some of the operational requirements, particularly those of a legal nature, are considered to be sensitive and to have political overtones.

Technical Requirements

A number of technical requirements for operating ASE equipment are enumerated below. It is essential that

- Adequate training in operating the equipment under a variety of conditions be provided, both to the enforcement personnel as well as to the support personnel. It is essential that this training include written documentation on the operation, calibration, and troubleshooting aspects of the equipment;
- Some form of certification be available for the equipment that describes its accuracy and other performance specifications;
- The devices be tested frequently for calibration purposes and be taken out of service when operating outside of acceptable ranges;
- Adequate service and repair support be available for the equipment;
- The equipment be designed such that one person can operate it;
- The equipment be compact for portability/mobility considerations;
- The equipment be designed for ease of setup and teardown;
- The equipment be capable of operating under a wide range of temperature (both hot and cold) conditions;
- The operation of the equipment not require the officer or the equipment to be exposed to the elements;
- The detection and camera system be capable of monitoring at least two lanes of traffic;
- The system accommodate two cameras in areas that have vehicles with only rear license plates. This is particularly necessary if photographs of the driver are required by courts for positive operator identification;
- The equipment be able to detect and photograph oncoming as well as receding traffic; and
- The equipment be able to selectively enforce speed limits for both commercial and passenger vehicles simultaneously.

It is desirable that

- The photographic system have an automatic exposure control and be designed to prevent operator error and inadvertent damage; and
- The system be capable of recording information on all vehicles passing through the enforcement zone, not only on those vehicles detected in a speed limit violation. The additional traffic information obtained during the enforcement period can be used to describe the violations in comparison to the general flow conditions.

Legal Issues

A number of legal issues associated with operating ASE equipment are enumerated below. Operating experience indicates that several requirements appear necessary:

- A state statute or city ordinance is needed in most states to be able to cite the registered owner of a vehicle detected of a speeding offense;
- The license plate and state of issue need to be readable from the photograph;
- The vehicle's speed, as well as other enforcement data (e.g., time of day, day of week, year, location, officer's identification) need to be clearly visible on the photograph;
- The driver of the detected vehicle needs to be clearly visible in the photograph in those enforcement jurisdictions wherein the driver is cited for the infraction;
- The speeding vehicle needs to be positively identified in multivehicle photographs; and
- The system's function and operation needs to be accepted by the local prosecutors and courts.

Other Requirements

Some overall requirements for operating ASE equipment also need to be mentioned. Public acceptance for the use of ASE equipment is necessary for an ASE program to be successfully implemented. All the technical and legal requirements can be satisfied, but the ASE program can fail if the public is not in favor of the equipment usage. The public acceptance depends on a good public information and educational campaign. Experience gained from successful ASE programs strongly suggests that enforcement strategies used should be based on traffic safety issues and not on revenue generation considerations. Also, law enforcement personnel are more likely to support the ASE concept if it is accepted by the public.

OPERATIONAL EXPERIENCE

This section contains four parts: 1) a description of the range of enforcement strategies used with ASE equipment; 2) a summary of the trends in enforcement strategies used with ASE equipment; 3) a description of some operational constraints associated with the use of ASE and red-light equipment; and 4) a brief discussion of some reliability and maintainability issues originating from pilot tests and operational experience with the equipment.

Enforcement Strategies

Possibly the most innovative speed enforcement strategy used in the United States and in European countries is that which makes use of ASE equipment (*5,6*). A range of strategies used in European practice by various law enforcement agencies is presented below in order of increasing use of automation, starting with totally manned operations, which are not too dissimilar from U.S. practice, to the use of fully automatic, unmanned equipment:

- Use of stop teams
- Stationary, manned photographic systems
- Moving, manned photographic systems
- Movable, unmanned photographic systems
- Fixed, unmanned, fully automatic operations.

The major European manufacturers of ASE equipment are currently producing systems that are designed for installation in a patrol vehicle and used in either a stationary or a moving operation. These mobile speed enforcement strategies are becoming more prevalent in Europe. Less emphasis is being placed on the fixed, unmanned, fully automatic operations.

The ASE equipment deployed in the United States is predominantly used in a stationary, manned mode. The units are mounted generally in marked police vehicles to comply with either state or local law enforcement codes. The manned mode is used to accommodate legal constraints surrounding use of photographs or other issues. The usual U.S. deployment strategy consists of parking the patrol vehicle in either a right curb lane or on the right shoulder and facing in the direction of the adjacent traffic flow. Sometimes the vehicle is parked in the median or in the median shoulder area. In these situations, the ASE device is mounted in the rear of the vehicle, and frontal photographs are taken of speeding vehicles detected. In some instances, an additional camera is used either manually or automatically to take a rear photograph of the speeding vehicles with no front license plates.

The officer present in the patrol vehicle observes the approaching traffic either through the rear-view mirror or a video monitor and makes notes on the characteristics (e.g., make, model, color) of the vehicle photographed. These notes are sometimes used if court testimony is required for contested cases. The officers generally do not make contact with the violators during the stationary modes of speed enforcement activities.

A fixed, unmanned, fully automatic enforcement strategy was field-tested recently by the Michigan State Police under a grant award from NHTSA. Warning letters, not citations, were sent to detected speeders in the study. More information on this study, plus the enforcement activities of other state and law enforcement agencies, is given in Chapter 5 under Law Enforcement Acceptance.

Trends in Speed Enforcement Strategies

A range of speed enforcement strategies is used in European practice by various law enforcement agencies. The use of ASE equipment in these strategies was identified in the early 1980s and has remained strong over that period. Developments in speed enforcement strategies since then are reviewed here.

Several innovative speed enforcement strategies have been tried in the United States over the last decade to improve compliance with speed limit laws. Possibly the most innovative speed enforcement strategy used in the United States is that which makes use of ASE equipment. Over the last several years, city, county, and state law enforcement agencies have become more interested in using manned ASE technology that has been imported from European manufacturers. The interest at the city and county levels has turned into practical experience. Manned ASE equipment installed in a vehicle and employing across-the-road radar in connection with a camera was used for speed enforcement in Precinct 8 of Galveston County, Texas from about July 1986 to July 1987. The same type of equipment has been used continuously for speed enforcement on nonfreeway facilities from October 1987 in Paradise Valley, Arizona; the equipment was also used from June 1988 until June 1992 in Pasadena, California for the same purpose. City law enforcement agencies in Utah and California have followed the developments in Paradise Valley and Pasadena, and selected communities have begun their own ASE programs with current operations continuing in three California and three Utah communities. The state police of Maryland and Virginia teamed together concerning a pilot study of using ASE equipment on the Capital Beltway. More information about the enforcement activities in these areas and other states is given in Chapter 5.

In the early 1980s, there was some emphasis, particularly in Germany, Switzerland, and Japan, on the use of fixed, unmanned, fully automatic operations for selected portions of expressways. No indication has been found on the use of unmanned, fully automated speed enforcement equipment in areas where it did not exist before. Perhaps one reason for this is the development of highly mobile and compact equipment that did not exist back then.

Also during that time, the use of automatic speed detection equipment by law enforcement agencies in Australia and the United Kingdom was not considered. In March 1986, the Victoria, Australia police began using manned, ASE equipment (*15*). (Automated equipment for detection of red-light violations has been used in Victoria since August 1983.) In the next few years it is believed that automated equipment for the enforcement of traffic violations will be used in the United Kingdom. Such equipment is currently under discussion and, in some cases, trial.

Operational Constraints

The concept of photographic enforcement of traffic laws has a number of potential constraints that pertain to the operational characteristics of the technology used. The operational constraints of importance include

- Camera systems used
- Detection methods employed
- Accuracy of detection
- Ambient conditions
- Roadway type
- Enforcement site geometrics
- Traffic density
- Mix of passenger and commercial vehicles
- Security/system protection
- Interference effects
- Evasive action by drivers
- User-friendly features.

The success of a particular photographic enforcement technology, to some extent, depends on the bounds and limitations on the capabilities of the system in an operational environment. A brief summary is given below of the research conducted to determine some of the important operational constraints associated with the use of ASE and red-light equipment in the United States.

NHTSA has funded six studies that contained activities directed at determining the operational experience with ASE equipment. The first study was conducted between 1980 and 1984 and pertained to pilot tests of ASE devices and procedures (*5*). Nineteen engineering field tests were conducted during the study with four ASE devices to determine constraints relative to the following:

- Effect of ambient lighting on photographic capability
- Effect of range on photographic capability
- Effect of shadowing and glare
- Effects of different camera lenses and projection systems
- Effects of using color film on readability of license plates
- Night photography
- Effect of vehicle speed on photography and accuracy of speed readings
- Effect of rain
- Effect of range on radar detection
- Cosine angle effect
- Effect of traffic density
- Effect of vehicle type
- Detection capability of nonradar devices
- Motorist detectability of across-the-road radar
- Effect of lane change maneuvers
- Effect of braking
- Effect of jammers on radar detection
- Effect of citizen band radio transmission interference
- Effect of high-voltage (161-kV) line interference.

Preliminary law enforcement field tests of the four ASE devices were also conducted by the state police agencies in Washington, Michigan, and New Jersey.

One of the primary findings of the engineering tests indicated the use of a longer camera lens (longer than the 75-mm supplied at that time with the device 35-mm cameras) would greatly enhance readability of the U.S. license plates from the photographic negatives. When a 75-mm lens was used, 67 percent of the license plates on vehicles in lane 1 could be read, while only 31 percent of the license plates on vehicles in lane 2 could be identified. When a 135-mm lens was used, these percentages increased to 93 and 84, respectively. The use of color film (as opposed to the manufacturer-recommended, at that time, black and white film) also enhanced positive identification of the state origin of the license plate and improved the readability of some license plates with poor contrast.

State troopers suggested reasonable engineering improvements for each device that would help overcome the device's operational deficiencies. A typical suggestion was that the units be more compactly designed to enhance their portability/mobility.

Another NHTSA-funded study was reported in 1992 and discussed the feasibility of photo-radar use on high-speed, high-volume roads (*16*). The purpose of this study was to evaluate the feasibility of using ASE technology on high-volume, high-speed roads in terms of the accuracy of the detected speed and to determine the efficiency of the devices in terms of the number of usable photographs that could be taken under different geometric and traffic conditions on interstate highways. Tests of five ASE devices were conducted during the summer of 1990 on interstate highways in Virginia and Maryland. The results of the tests were used to determine the photographic quality and utility, accuracy of recorded speeds, percentage of usable photographs, misalignment flexibility (cosine effect), and ease of detection by radar detectors.

The findings concerning the photographic quality and utility and the percentage of usable photographs are of particular importance when considering operational constraints on high-volume, multilane facilities. The percentage of license plates that were readable (considering both the plate number and state of issue) in receding traffic ranged from 9 to 59 percent; in oncoming traffic, the percent of readable plates ranged from 21 to 56 percent. The utility of the photographs for legal requirements was reduced when the photographic quality was defined to include both the readability of the license plate and the positive identification of the speeding vehicle in multivehicle photographs. The percentage of usable photographs for receding traffic was then between 7 and 52 percent. The utility of photographs for oncoming traffic was between 4 and 13 percent when the photographic quality was expanded to include the readability of the license plate, the positive identification of the speeding vehicle in multivehicle photographs, and the clear identification of the driver's face.

The study results also indicated that, in general, the higher the traffic volume, the lower the percentage of speeding vehicles properly photographed. This observation was an expected result. Vehicle headways decrease and multivehicle photographs are more prevalent as the traffic volume increases. Also, each ASE device has a maximum rate at which photographs can be taken, and the camera systems used by the devices can take one photograph every 1.5 sec but, more commonly, one every 0.5 sec (*6*).

The extremely low percentages of usable photographs generated by the study were affected by a number of important considerations. First, the test sites were chosen on the basis of convenience to a fixed speed monitoring station and safety of the researchers. The orientation of the roadway many times resulted in glare, which reduced the readability of the photograph. Secondly, a large percentage of the photographs wherein the license plate could not be read (37 to 68 percent) or the driver's face could not be identified (41 to 75 percent) was because the camera was too far away from the target. The percentage of usable photographs would have been better defined if the data were presented by lane number away from the camera.

In summary, the study concluded that a higher percentage of usable photographs could be obtained if police officers are trained to select enforcement locations where clear, usable pictures could be taken and where the number of traffic lanes under observation does not exceed the limitations of the ASE equipment. This approach is being taken in another NHTSA-funded study concerning the field testing of ASE programs (*7*). It is estimated that the percentage of usable photographs taken by well-trained officers on two-lane and four-lane facilities should be in the 60 to 75 percent range (personal communications, U.S. Public Technologies, La Jolla, California, April 1992, and (*17*)).

Recently, NHTSA awarded grants to the state police of Michigan, New Jersey, and Washington to field-test various ASE devices. The official reports from these studies were not available at the time of this report. However, some unofficial information has been obtained from the Michigan study (Department of State Police, State of Michigan, East Lansing, unpublished data, May 1992). The Michigan tests were conducted from June through December 1991 on various highway facilities, ranging from a two-lane, two-way highway to an eight-lane divided roadway. The percentage of usable photographs from the eight-lane facility with a 55-mph speed limit was extremely low (3.6 percent), as was expected. The percentage of usable photographs from the two-lane facility (35-mph speed limit) and a six-lane divided roadway (65-mph speed limit) was 57.4 percent.

Several preliminary recommendations from the Michigan study are as follows:

- 35-mm color film should be used.
- The camera, radar antenna, and control unit should be enclosed within the vehicle and not exposed to the weather.
- It must not be necessary to open a window, trunk, or lift a tailgate of the vehicle to operate the ASE device.
- Separate threshold speed limit settings should be available for commercial and passenger vehicles so that enforcement operations can be conducted simultaneously for both types of vehicles.
- The ASE device should be capable of photographing speeding vehicles in at least two lanes of traffic moving in the same direction.
- Multiple camera lenses should be available with the ASE devices to permit the selection of an appropriate lens for a given enforcement location.

The operational experiences in two communities with automated red-light violation equipment are described in another NHTSA-funded study report (*6*). One system was installed for a short time at a busy intersection in downtown Pasadena, California to photograph northbound vehicles that violated the red phase of the traffic signal. About 95 percent of the photographs taken were of nonviolating vehicles. The high percentage of false detections was caused by the poor location at which the vehicle sensors were initially installed and a tendency of many drivers to encroach or creep past the stop bar and into the crosswalk area during the red phase.

Two demonstrations of red-light violation detection equipment took place several years ago in New York City. No particular problems were noted during the first demonstration, which took place from June 1985 through March 1986 at one intersection. During the 44 days of operation, approximately 4,000 red-light offenses (an average of 90 violations per day) were detected and recorded on film. It is not known how many of the photographs were usable for identifying the license plate.

The second demonstration in New York City took place from January 1988 through early 1989 and involved three intersections. The results from two of the three intersections showed that between 40 and 56 percent of the photographs taken recorded a red-light violation in which the license plate number was readable.

The results from both the Pasadena and New York studies strongly indicate that intersection site selection and installation design for red-light violation equipment must be carefully executed to minimize operational constraints.

Reliability and Maintainability

Any sophisticated technology, such as ASE equipment, that is operated in the field by law enforcement officers of varying experience and skills can experience problems with reliability and maintainability. These problems can be aggravated if the vendor of the equipment does not provide adequate training and/or technical support in troubleshooting problems.

In an early study involving pilot tests of ASE devices and procedures (*5*), malfunctions and/or breakdowns were noted for all the ASE devices. Film jamming and breakage, especially in cold weather, was reported for some of the devices when the cameras were mounted on the outside of the patrol car. Most of the operational deficiencies noted in the 1984 study have since been overcome by manufacturers' redesign of the equipment.

The Michigan field test study also noted some problems with the equipment. On one of the ASE units tested, the antenna, which was mounted on the front grill of the enforcement vehicle, malfunctioned when the vehicle was exposed to soap and high water pressure from a car wash. The other ASE device tested used two cameras (70-mm and 35-mm) to photograph the same speeding vehicle. (A VHS video camera was also available in the enforcement vehicle but was not used during the testing.) The 70-mm camera with a flash unit was mounted in the rear of the enforcement vehicle to take frontal photographs of approaching vehicles. The 35-mm camera was mounted on top of the enforcement vehicle to take a rear photograph of the speeding vehicles (Department of State Police, State of Michigan, East Lansing, unpublished data, May 1992).

A number of operational problems were noted with the two-camera system. Synchronization problems existed between the two cameras, and it was difficult to keep the 35-mm camera aligned. These situations made it difficult to match the frontal 70-mm photograph with the rear 35-mm photograph to obtain the rear license plate number for those vehicles having only a rear plate. Problems with improper exposure were also noted.

Computer problems consisting of blown chips, blown fuses, and improper output signals for camera activation were repeatedly noted during the testing. The reliability and maintainability problems noted with the two-camera system indicate the potential difficulties that law enforcement personnel can experience in working with extremely sophisticated ASE equipment.

CHAPTER FOUR

PROCESSING OF CITATIONS

Various issues associated with processing citations emanating from the use of photographic enforcement of traffic laws are presented in this chapter. Because of the more extensive experience gained with ASE equipment than with other imaging technology for the enforcement of other traffic offenses, discussions are based solely on the use of photographic evidence for enforcing speeding violations. The experiences with manned ASE equipment in Paradise Valley, Arizona and Pasadena, California are used extensively in the following discussions. The ASE program in Paradise Valley, Arizona is the longest running program in the United States, beginning in October 1987 and continuing until the present time. The ASE program conducted in Pasadena, California, from June 1988 until June 1992, was the second longest running ASE program in the United States to the date of this report.

This chapter describes in-house versus contract processing of citations. It also summarizes special issues associated with the identification of vehicle owners, as well as briefly describes some of the adjudication practices involving drivers and owners. This chapter also discusses the impacts on police, courts, and Department of Motor Vehicle (DMV) resources and presents some of the cost and revenue considerations associated with the use of ASE equipment.

IN-HOUSE VERSUS CONTRACT PROCESSING

At the time of the research for this synthesis, ASE equipment is used in seven communities in the United States to enforce speed limit laws: Paradise Valley, Arizona; Campbell, National City, and Riverside, California; and Garland, Wellington, and West Valley, Utah. As early as 1991, six additional U.S. communities were using ASE equipment. Also, the state police of Michigan, New Jersey, and Washington have just completed field testing of various ASE devices. In late 1990, the Ministry of Solicitor General and the Vancouver, British Columbia Police Department conducted a study, with the support of the Insurance Corporation of British Columbia (ICBC), on the effectiveness of ASE equipment on traffic speed (*18*). ASE equipment is currently being used in Calgary and Edmonton, Alberta, Canada.

Speeding citations have been sent through the mail in the seven U.S. communities with active ASE programs and in five of the six U.S. communities with former ASE programs. Notices of speeding violation, not actual citations, were mailed in Pasadena. These citations and notices of speeding violation were sent to the registered owners of the detected and identified speeding vehicles. Notices of speeding violation were sent through the mail to registered owners in the British Columbia study and are being sent in the two ongoing ASE programs in Alberta. State police in the three states sent warning letters, not citations, to the registered owners of the detected and identified speeding vehicles.

The law enforcement agencies in 12 of the 13 U.S. communities have contracted the processing of citations/notices. The Campbell Police Department is the only one of the 13 agencies to handle all the processing of citations/notices. In the other 12 communities, a vendor has provided a convenient service package that generally includes the ASE equipment; the enforcement vehicle; maintenance for the equipment and the vehicle; training of the police officers; film; film processing; film review for identification of the license plate number and for clarity of the driver's face; researching the DMV records; printing of the citations/notices (including second mailings as a follow-up); mailing of the citations/notices; assemblage of special photographic evidence for trials; and expert testimony in court, if necessary. In Paradise Valley and Pasadena, many of these services have been handled in the local office of the vendor. In return for these contractual services, the city has paid the firm a fee for each paid ticket or owner attending a defensive driving course.

The law enforcement agencies in the states of Washington, Michigan, and New Jersey and in Vancouver either bought or leased the ASE equipment and the enforcement vehicle. They also contracted out maintenance of the equipment and training of the officers. Beyond that point, the agencies assumed responsibility for balancing administrative duties, including processing warning letters. The only exception to this was in British Columbia where the ICBC performed the film processing, film review, DMV search, and printing and mailing of the notices. This processing work was accomplished through a provincial agreement because ICBC is a government-controlled agency. The law enforcement agency in Calgary owns the ASE equipment and enforcement vehicles, while the law enforcement agency in Edmonton leases the ASE equipment. Both agencies process all of the speeding notices.

Most of the smaller local law enforcement agencies with an active interest in using ASE equipment are strongly considering contracting the processing of citations through the payment of a fee to a vendor for each case going to final disposition. These agencies cannot afford the high start-up costs associated with ASE. Also, they do not have the staff to perform various administrative duties associated with processing citations. Larger local law enforcement agencies and most state police interested in ASE favor purchasing the equipment and controlling the processing of citations.

SPECIAL ISSUES ASSOCIATED WITH IDENTIFICATION OF VEHICLE OWNERS

There are special issues associated with the identification of vehicle owners. Most of the issues involve nonresidents. About 98 percent of the vehicle owners charged in Paradise Valley have lived outside of the city. About 75 percent of the registered owners charged with ASE violations in Pasadena were nonresidents (*17*). Most of the nonresidents charged in both cities lived within the state. Consequently, it was relatively easy to handle these citations, even if follow-up notices were required. Owners of out-of-state commercial vehicles and out-of-state private vehicles were difficult to track and punish. Many times these owners were not sent follow-up notices when responses to the first notice were not received.

Progress has been made in citing local businesses for speeding infractions involving their vehicles. If the citation was sent to a business, the fleet manager was asked to identify the driver. If the citation was sent to a rental car or truck company, the company was asked to research its rental agreements to identify the driver. Good compliance was obtained to these requests in both Paradise Valley and Pasadena.

One final issue related to identifying vehicle owners involves cases of joint ownership. In some cases, both husband and wife are listed in DMV records as joint owners of a given vehicle. If such a vehicle is detected as speeding, the frontal photograph is reviewed to determine the driver's gender. For example, if a male is driving the vehicle, the citation is issued in the husband's name. In some jurisdictions, no citation is issued if the gender of the driver in the frontal photograph does not match the gender of the registered owner.

ADJUDICATION PRACTICES INVOLVING DRIVERS AND OWNERS

The legal environment for use of an ASE device in Paradise Valley is somewhat unique. In 1987, the state changed its statutes regarding speeding penalties. Prior to this, a speeding offense was a misdemeanor, regardless of the speed level. Now, drivers caught speeding more than 20 mph over the posted speed limit are charged with a misdemeanor (a criminal traffic offense). Drivers caught speeding 20 mph or less over the posted speed limit are charged with a civil infraction. In August 1987, the City Council passed an ordinance stating that registered owners of vehicles are presumed responsible for certain violations involving the vehicle, including speeding. The owner of the vehicle cited with a speeding violation has four options: if not the driver at the time of the violation, identify the driver (or the new owner if the vehicle had changed ownership); pay the fine; attend the defensive driving class; or contest the violation by appearing in court. If the owner fails to respond to a civil infraction citation, a second notice will be sent and the owner's driver's license will be suspended until the fine is paid. If the owner fails to respond to a criminal traffic offense, the owner's driver's license will be suspended and a warrant will be issued for his/her arrest.

About 60 percent of those persons cited in Paradise Valley pay their fines without going to court or looking at the photographic evidence of the speeding offense. In cases where the defendants do go to trial, an 8-by-10-in. photograph of the violation is prepared for use by the prosecution. This photograph may be viewed only by the person cited for the offense. If, in fact, the owner was not the driver, he or she is asked to fill out the release of liability by identifying the individual who was driving. In many cases the owner will identify the individual. In some cases when the owner is asked under oath for the identification, the individual will not (or cannot) identify the driver. In these cases the court may proceed against the owner by holding the individual in contempt. However, this action has been avoided for the sake of public relations and continued smooth program operation. Another problem in identification is that in cases of joint ownership, only the first owner's name appears in the DMV files. Thus, the joint owner could be the driver and not be cited. Most businesses and rental car agencies will identify the driver as requested by the citation.

During 1988 and 1989, a total of 17,773 citations were issued in Paradise Valley under the ASE program (*17*). The disposition of these cases is as follows:

Cases dismissed	23%
Cases opting for defensive driving school	37%
Cases involving fines paid	31%
Cases of ignored citations	9%
	100%

The cases dismissed by the court were mainly situations where the owner of the cited vehicle was not the driver or where the pictures were not good enough for identification. The Paradise Valley Police Department claims about 75 percent of all the photographs taken are of sufficient quality to identify both the vehicle license plate and the driver. A problem with glare appears to be why the other 25 percent of the photographs are not useful pictures for issuing citations.

An official court summons is issued to the owner cited if he or she does not appear for court or pay the fine by mail. If the summons is ignored, a warrant is issued. When the warrant and the summons are ignored, the person's driver's license is suspended indefinitely. The percentage of ASE tickets ignored is slightly over 9 percent or about the same as for regular patrols using conventional radar for speed detection.

Of the cases emanating from citations issued during the 1988 and 1989 time frame, less than 1 percent went to trial. For these cases, the city prosecutor's office had an 82 percent conviction rate.

As of March 1990, about 12 court case convictions have been appealed to the county superior court. In each case the owner and driver were the same person. The appeals have been based on arguments involving reasonable and prudent prima facie speed limit considerations, due process of law, chain of custody, and the use of new technology. None of these arguments was successful.

A special case was brought before the Arizona Supreme Court directly from the hearings officer level. This case was nominally backed by the American Civil Liberties Union and was intended to enable appealed ASE cases to be brought directly to that high court rather than going through the lower appellate courts. The Arizona Supreme Court refused to accept jurisdiction over the appellate courts in the ASE cases.

The legal environment for use of an ASE device in Pasadena was different from that in Paradise Valley. There was no city ordinance in Pasadena that specifically dealt with the issuance of citations to the registered owners of detected speeding vehicles. Consequently, the ASE system had to operate within existing city and state ordinances.

No actual speeding citations were mailed in Pasadena; only notice of violation letters were sent to inform the registered owners of the speeding offense, which was put on file at the city court. These letters were developed to look like an official speeding citation. In essence, the notices were not enforceable and did not carry point assessments, only a monetary fine. Also, unknown to the public, the response to the notice of violation was voluntary.

Once the speeding notice was sent to the registered owner, the individual could pay the fine by mail. If the registered owner wished to contest, that person could come to the court and view the photograph in the prosecutor's office. Only the individual cited could see the photograph. The case against the owner was dismissed on the spot if the gender of the driver did not match the gender of the owner cited. In this situation, the owner was asked to identify the driver by signing a release of liability form. The case was also dismissed if the gender was the same, but there was reasonable doubt that the owner was the driver or the owner had sold the vehicle, and the vehicle had not been retitled. If the notice was sent to a business, the fleet manager was asked to identify the driver; if the notice was sent to a rental car company, the company was asked to search its rental agreements and to identify the driver.

If the registered owner (who was also the driver) wished to contest the case, an 8-by-10-in. version of the photo was made and the police sergeant in charge of the program prepared the court packet containing all pertinent information including the photographs, the summons, the DMV readout, speed survey information from the ASE device and from the traffic and transportation engineer (if available), the declaration of the custodian records, and the enforcement site-specific information. In the cases that went to court, the officer manning the equipment testified that the equipment was calibrated and set up properly. The equipment used in Pasadena was self-calibrating. However, the police also ran a calibration check at the beginning and end of each enforcement session. This was accomplished by driving a patrol car through the radar beam and checking that the calibrated speedometer and the ASE equipment produce the same speed. The officer also testified that the equipment was not tampered with during the enforcement period.

During the first 7 months of operation in Pasadena, 4,082 speeding notices were issued out of 9,728 violations detected from 160,354 vehicle passages (*6*). Notices were issued in only those cases where the photograph was clear enough to see the violator's face and the license number could be identified.

Seventeen months after the operation began, a total of 14,733 speeding notices had been issued. About 84 percent of the owners who were sent speeding notices during that period either paid the fine or identified who was driving at the time of the offense. Also during this time, 283 cases (2 percent) were heard in Pasadena's Municipal Court and resulted in a 90 percent conviction rate for the city prosecutor's office. While no actual appeals were heard by higher courts, some appeal motions were attempted and included due process and timeliness issues as their rationale.

The statistics concerning the court activities changed somewhat as the ASE program matured. In a typical month the disposition of cases was as follows:

Cases dismissed	7%
Cases opting for traffic school	32%
Cases involving fines paid	45%
Cases of ignored citations	16%
	100%

The number of cases opting for traffic (driving) school increased over the 4 years of the ASE program. This provision was available to drivers in lieu of the first speeding violation offense in any given year.

In the early stages of the program, about 16 percent of all persons issued ASE notices ignored them and thus suffered few consequences. For these situations, a warrant could not be issued immediately, since under existing ordinances the violator had to sign a citation on file for a warrant to be sent later. The police could investigate these ignored cases only by sending for a facsimile of the person's driver's license picture from the DMV for comparison with the ASE photograph. If there was a match, then a warrant could be issued. However, this procedure was costly in terms of the license search (which was often unsuccessful, since it was a name search only), the reproduction of the license photo, and the police time to make the investigation. At the end of the ASE program in Pasadena in June 1992, the rate of noncompliance with the speeding notice had grown to almost 40 percent as more and more people discovered that compliance was voluntary. Also, the conviction rate declined to between 70 and 80 percent. The increase in noncompliance and decrease in conviction rate were two important adjudication issues facing the city at the end of the program. The erosion of judicial and public support and reduction in the police department's manpower for follow-up were important reasons why the ASE program ended in Pasadena.

IMPACTS ON COURTS, POLICE, AND DMV RESOURCES

The impacts of an ASE program on the court system, police department, and DMV resources vary somewhat from community to community and are not well documented. However, some information is available from the experiences in both Paradise Valley and Pasadena (*17*). In Paradise Valley, the court added two full-time court clerks, one court day per week (which involved one additional court reporter day), and one ASE hearings officer to handle the civil cases only. Originally, the prosecutor's office in Pasadena felt that there would be significant increases in its work as a result of the use of ASE equipment. Consequently, extra court days were added at the beginning of the ASE program. The extra court days were canceled after a period when it was found that a very low percentage of cases went to trial. The prosecutor's office was able to absorb the increased burden of ASE cases. The number of prosecutions increased 25 percent each year over the 4-year program. At the end of the program, the prosecutor's office wanted additional staff (1.5 full-time equivalent) to fulfill the court responsibilities. The extra staff was needed when the office was called on to assist in investigating the 16 percent ignored citations.

The ASE program's impact on the police department in the two communities was also varied. The City of Pasadena added additional motor patrolmen, an additional sergeant, and a lieutenant to oversee the program. In Paradise Valley, a sergeant already on the force was assigned to head up the ASE program within the traffic unit. The fine revenue provided back to Pasadena from its ASE program was less than the cost of the associated enforcement. Consequently, the cost of the ASE program was another reason for its termination in Pasadena. On the other hand, the fines collected from the ASE program in Paradise Valley have been sufficient to pay overtime hours for the police officers manning the equipment.

The impact of the ASE program on the DMV resources in the two states is not well documented. The Pasadena police sometimes requested a facsimile of a suspected person's driver's license picture to compare to the ASE photograph, a costly procedure in terms of searching for the driver's license and reproducing the license photo. The search was often unsuccessful since it had to be made using the driver's name instead of the driver's license number. Similar driver's license searches in Arizona have also been expensive.

In Arizona, the DMV cooperates with the City of Paradise Valley to help collect citation fines that drivers have ignored. In cases where the driver's license number is known, an ignored citation is appended to the driving record. When the cited individuals try to take any licensing action, such as renewal, the individuals have to respond to the citations to clear their license status.

COSTS AND REVENUES

Most U.S. cities with an ASE program contract with a vendor to provide the ASE and support equipment and associated services. These items include the ASE device and the vehicle housing the device, maintenance for the device and the vehicle, the training of police officers, processing of the photographs, researching DMV records, preparing citations, providing special photographic evidence for trials, and providing expert testimony during trials. In return for these contractual items, the vendor receives up to $20 per case going to final disposition.

During Pasadena's 4-year ASE program, a large portion of the fine amounts collected by the court went to the equipment vendor. This was especially true during the last 1.5 years of the program when new California legislation was in effect that severely limited the amount of revenues that California cities could receive from traffic fines. Revenues above certain limits set by the state legislation had to be paid to the state to assist in resolution of the state's budget crisis. Thus, at the end of the ASE program in Pasadena, most of the fine amounts collected from the program went to the state and the vendor. The cost of the ASE programs in Pasadena, Danville, Folsom, and Roseville, California was a contributing factor in the discontinuation of ASE programs in these communities.

The ASE program in Paradise Valley has been self-supporting because it has a higher fine structure for speeding offenses than Pasadena. Also, the city receives more if the defendant attends a defensive driving course than if a typical $60 speeding fine is paid. This is contrary to the situation in Pasadena and other California cities.

In 1988 and 1989, the ASE program in Paradise Valley generated about $325,000 for the town, which paid for the extra court clerks, extra court day, a hearings officer, and overtime hours for the police officers manning the equipment. The program netted $25,000 for Paradise Valley in 1989, or about $0.58 per citation (*17*).

The Campbell Police Department operates an ASE program without contracting with a vendor for services. Instead, the agency purchased the ASE device and related equipment and has performed all the film and citation processing in-house. This independent approach requires a considerable initial cost investment and has certain annual operating costs.

The one-time initial costs consist of the ASE device, the enforcement vehicle, supporting equipment to view the film, and supporting computer and printer equipment. The cost of various ASE devices was provided in a 1989 NHTSA report (*6*). These costs have since increased and range from about $40,000 to more than $100,000, depending on the device selected, extra equipment (e.g., 35-mm/video camera, speed display board), and software packages purchased. The other one-time costs can run up to $48,000. Thus the total initial investment can easily range from about $88,000 to almost $150,000.

The annual operating costs for an agency-owned ASE system are mainly associated with the film and citation processing. One U.S. law enforcement agency estimates it will cost about $4.17 to process each citation based on an assumed enforcement level of 40,000 cases per year (personal communications, Kansas City Police Department, Missouri, July 1992). In 1990, the ICBC estimated a cost of $1.26 per citation to process a total of 32,760 citations per year based on 43,680 photographs taken (75 percent useful photographs) (personal communications, Insurance Corporation of British Columbia, North Vancouver, 1990). Thus the annual operating costs per citation can vary considerably, depending on the facilities and supporting personnel used.

CHAPTER FIVE

LEGAL AND ACCEPTABILITY ISSUES

This chapter describes the legal and acceptability issues that surround the use of photographic enforcement of traffic laws. The discussions are based primarily on the use of photographic evidence for enforcing speeding violations. Similar discussions could apply to the use of other imaging technology for enforcing traffic laws.

ASE technology and its use are constrained by the legal and acceptability environments. Limitations imposed by law are the more obvious. However, opinions expressed widely by citizens, public interest groups, and governmental authorities such as prosecutors, judges, and police also impact strongly, and result in policy and strategy requirements that limit the ways in which enforcement is carried out.

This chapter describes some of the ways that foreign laws enable the use of certain speed enforcement practices, as well as ways that the laws limit some practices. It also notes how policies of some foreign law enforcement agencies are affected by public sentiments. Several constitutional issues related to the use of ASE are addressed. Also, trends in the legal issues associated with ASE are described, as well as the legal outcome of affixing accountability on registered owners for moving violations. A summary of various state attorney general opinions regarding the use of ASE is presented, followed by a brief description of law enforcement acceptance of ASE and other photographic enforcement equipment. Finally, the chapter summarizes findings of various researchers concerning U.S. public acceptance issues and their impacts.

FOREIGN EXPERIENCE

Because laws vary appreciably from country to country in Europe, more so than they do between states in the United States, the legal and acceptability environments also differ greatly from country to country. The following discussion highlights some of these differences and indicates how enforcement is tailored to match them (*4*).

Speeding Penalties

Speeding is a civil offense in most European countries, and is enforced and prosecuted with about the same intensity as it is in the United States. There are, of course, variations in the enforcement efforts between countries and cities, just as there are in the United States.

Generally speaking, a minor speeding offense — one that involves speeding not more than 20 to 30 km/h (12 to 18 mph) over the limit and without other complications — is punishable by a monetary fine, as noted in Table 7. Also, repeated violations result in license suspension. Speeding greatly in excess of the limit or if accompanied by other circumstances (e.g., accident, speeding in school or pedestrian zone) can result in more severe penalties. For example, the fine for speeding in excess of 60 km/h (36 mph) over the limit in Germany is generally 400 DM ($260). Fines in Austria can be as high as 30,000 AS ($2,400). Jail confinement is not usually assessed in association with speeding violations, although in Switzerland, for example, a 10-day sentence accompanies a conviction for driving with a suspended license.

On-the-Scene Fine Collection

In many countries (e.g., The Netherlands, Switzerland, Austria, and Germany), police officers are authorized to collect fines for minor violations at the time of their occurrence. Such procedures are limited to situations where the speeding was not excessive, the driver admits guilt, and the driver has the correct amount (and nationality) of currency. It is to the driver's benefit to pay at that time, because no license action is taken in such situations.

The police agencies take great pains to have a good system of accountability for the collected fines. The officers sign for numbered receipt books, which contain duplicate receipts. After completion, one copy is given to the motorist; the other copy is turned in together with the fines collected.

Evidence Required

For some countries, a conviction can be obtained based solely on a police officer's statement. This is true in England, for example, where the opinion of police officers is highly respected. For example, the officer might state, "I saw the gentleman driving at a high speed, which, in my opinion, was in excess of 50 mph." Even there, however, supplementary evidence is desirable. A speedometer reading, or reading from a speed detection device, is usually the minimum amount of evidence used. In some countries (e.g., Scotland), a witness is required by law; therefore, officers customarily work in pairs. In fact, if a radar plus a stop team are used, a minimum of four police are needed in Scotland: one to operate the radar, one to be his witness, one to stop the offender, and one to witness the stop.

Photographic evidence is not illegal in many European countries and is used, at least occasionally, in most of the countries because such evidence is considered extremely reliable and useful. Agencies believe its use greatly increases the rate of guilty pleas. Although lawsuits have been brought against the use of photographic data in several countries, none have been successful.

The use of multiple photographs carries the process one step further. Pacing with a camera is common practice in Europe, and several exposures are routinely made to provide further evidence

TABLE 7
ILLUSTRATIVE SPEEDING PENALTIES

Country	Minor violation[a] ($)	License suspension
Austria	24	Multiple offenses (judgment of local jurisdiction)
Belgium	20	Serious violation and arrested on the spot (but not if based only on photographic evidence)
England	b	Three convictions in 3 years
The Netherlands	31	Three in "short period" [c]
Sweden	60	Three in "short period" [c]
Switzerland	26	30 km/h over limit, or three lesser violations in "short period" [c]
Germany	35	40 km/h over limit in city, 50 km/h over limit elsewhere

[a] 20 km/h (12.5 mph) over limit.
[b] Up to $225, at the discretion of the court.
[c] The precise time period was not stated.

that the police vehicle was not traveling faster than the suspect. Finally, some radar equipment used in a fully automated mode in a cabinet takes two photographs at $\frac{1}{2}$-sec intervals. One can then roughly calculate the vehicle speed from the two pictures to substantiate the radar reading.

Uses of Photographs

Nearly all European agencies that use photographic systems take mostly rear photos of the suspect vehicles. This is not a legal requirement, but rather a policy decision. Many agencies have had occasional unpleasant repercussions when a frontal photograph showed a motorist in a potentially embarrassing situation. Most agencies, if they use frontal photography at all, do so with a great deal of caution and discretion.

Fully Automatic Systems

Unmanned operations are not legally permitted in some European countries. In England, a police officer must witness the offense. (In Scotland, two must witness it.) In Sweden, a violator must be stopped at the scene and notified of the offense. However, fully automatic systems are in use in The Netherlands, Germany, and Switzerland (among others). Suspected offenders are then notified by mail. Furthermore, in Germany, an officer can detect a speeding violation (e.g., by pacing), note the vehicle registration number, and have the owner notified by mail. This practice negates the need for most high-speed chases.

Device Approval

Many countries require some type of federal approval for the use of speed detection equipment by federal and local police. In England, the Home Office of the British Government has historically tested devices of various sorts, and then supported the local agency use of approved types. At the other extreme, some countries (e.g., The Netherlands, Germany) have not only established rigid performance standards, but require each piece of equipment to be federally inspected, approved, and sealed at regular intervals to ensure its proper functioning. Most of the devices cannot be field-adjusted. They either pass the calibration checks or they do not. Sealing the units guarantees against tampering.

Mail Processing

With fully automatic systems, whether manned or not, it is necessary to communicate with the suspected offender. Typically, this is done by mail or, occasionally, by telephone or by a personal visit to the home of the vehicle owner. The details vary from agency to agency, but the basic process is as described below.

After the film is exposed, it is collected by a police officer and taken to a police processing laboratory. There, a police technician develops the film, usually only to the negative stage. The developed film is then placed in a film reader, where it is greatly magnified for ease of viewing. The film is then reviewed, either by the arresting officer (who witnessed the operation if manned), another police officer, or a technician—the choice is dependent on country and agency policy. The vehicle registration number is recorded, together with other facts of the case. Then, the identification of the vehicle owner is determined through the country's registration files.

At this point a notice is sent to the vehicle owner. The notification may be sent by the police, the prosecutor, or the court, depending on the country. The owner, in turn, generally is given several options (again, depending on the country): he can plead guilty and agree to pay the assessed fine; he can disavow guilt, but agree to pay the fine anyway (in a sense, plead *nolo contendere*); he can plead not guilty and ask for a hearing or trial; or he can claim that another person was driving and provide the person's name and address. Most agencies do not send a copy of the photograph to the owner (although some do). In some countries, the owner, upon receipt of the violation notice, can request a copy of the picture or ask to see it at police headquarters. Elsewhere, the owner can only see it in court, having contested the case. And in some courts, the judge has the discretion as to whether or not to allow the defendant to see the photograph.

Most agencies attempt to notify the owner quickly—3 to 4 days is not uncommon. Switzerland's law requires that the owner or his household be in receipt of the violation notice within 10 days or it is voided.

Driver Identification

The mailing process described above assumes either that the owner was the driver or that the owner will identify the driver. This assumption is valid in most European countries (e.g., Austria, Belgium, England, The Netherlands, and Switzerland). Laws in these countries require the owner to name the driver of the vehicle upon legitimate inquiry. Refusal to do so is punishable by a fine, which typically is greater than that imposed for a speeding violation.

One major European country lacking such a law is Germany. As a result, the German police tend to use frontal photographs more frequently (to help in driver identification) or to deploy stop teams (in which case the driver is immediately identified). Even when using rear photographs, the police attain a very high majority of guilty pleas. Germany does have one rather unique law, however. If the owner claims he was not driving and will not name the driver, he will probably not be convicted. In such cases the police can require the owner to maintain a driver log thenceforth, to be made available to police upon presentation of suitable justification.

The government of Victoria, Australia started using red-light violation detection equipment in 1982 and ASE devices (speed cameras) in 1986. These systems were, and continue to be, operated out of the government's Traffic Camera Office. In March 1986, legislation was passed in Victoria to improve police operations in relation to the use of the red-light and speed cameras. This legislation, the Motor Car (Photographic Detection Devices) Act (1986) or "owner-onus legislation," placed the responsibility for red-light violations and speeding offenses detected by cameras onto the owner of the vehicle rather than the driver. According to Victoria police, the results of this legislation have had beneficial effects on police costs and efficiency (*15*).

It is anticipated that within the next few years, manned ASE systems will be introduced in England for enforcing a number of types of traffic violations. Such equipment is currently under discussion and, in some cases, trial. These steps are being taken in the wake of recent U.K. government proposals to reform road traffic law (*19*).

Foreign Drivers

The European law enforcement agencies must contend with difficulties associated with identifying and locating foreign drivers detected speeding with ASE equipment. These difficulties are particularly acute with totally automatic systems where the photograph provides the only evidence. To resolve these potential problems, many of the countries have formulated cooperative agreements whereby one country will provide vehicle registration and other evidence to another for follow-up activities. In fact, some cooperating police agencies will even physically locate the accused owners and perform other follow-up functions.

The U.S. law enforcement agencies in each state must contend with similar problems as their European counterparts in identifying and locating registered owners/drivers of out-of-state vehicles detected speeding with ASE equipment. In the United States, agreements exist between the states to resolve these identification problems. These agreements are known as the Nonresident Violator Compact (*20*) and the Driver License Compact (*21*).

One practice that is a problem in Europe, but not in the United States, is the use of different currencies. It is particularly troublesome to enforcement teams empowered to collect fines on the spot. In some areas of Europe (e.g., western Austria), a substantial fraction of drivers are from another country and just passing through to a further destination. Such drivers are quite likely not to carry much currency of the passed-through country. Hence, other enforcement strategies prove more useful in such locations.

Public Sentiments

Drivers often oppose speed limits. Speeding is as pervasive, apparently, throughout Europe as it is in the United States. In Germany, there is no general speed limit on the autobahns (freeways). Regardless of safety and energy savings arguments, imposing a speed limit is considered politically unwise.

Despite the unpopularity of speed limits *per se*, speed enforcement practices have not been widely debated. In fact, most law enforcement agencies believe that the use of automated systems meets with less resistance than the less sophisticated manual systems or the heavy reliance on officer testimony.

There has been some adverse publicity (e.g., editorials, special interest group statements) concerning the use of U.S. manufactured radar in England. However, hand-held radars are popular with some police officers there and the units continue to be used along with other devices. In Europe, the media have levied substantial negative publicity against some police agencies for using hidden automatic equipment. The arguments do not oppose the equipment, just the way it is sometimes deployed. As long as it is out in the open, there appear to be no problems. (Indeed, where the fully automatic systems are rotated among a number of cabinets, the cabinets are made very evident, on the assumption that their visible presence will deter speeding regardless of whether they contain a radar.)

Finally, the use of frontal photographs has not generated appreciable adverse publicity, but has caused problems in isolated instances, so is generally not a widespread practice.

LEGAL ISSUES

The legal issues surrounding the use of ASE devices in U.S. speed enforcement are many-faceted and complex. However, to discuss these issues in a rigorous manner is beyond the scope of this synthesis. Instead, a summary is given in this section of the U.S. research regarding important legal issues. The summary is not designed to provide legal advice.

Constitutional Issues

The use of ASE systems does not appear to violate the constitutional rights of privacy and freedom from unreasonable search and seizure. There are not present court cases that specifically discuss a right to privacy under the First Amendment with regard to driving. However, a review of *Griswold v. Connecticut* (381 U.S. 479 (1965)) defines the court's interpretation of the individual's "right to privacy" under the First Amendment. The U.S. Supreme Court in this case evaluated the challenge of a Connecticut statute that prohibited the distribution of birth control information to married persons. The U.S. Supreme Court held that the marital relationship was such that it belongs within a class of fundamental rights worthy of distinctive sanctuary. The Connecticut statute unreasonably intruded into the sanctity of this special relationship. The Supreme Court has not held that driving in open view on a public highway provides protection to an individual's privacy. The courts have long confined protection in upholding a right of privacy to matters relating to marriage, family, and sex (*California v. Belous*, 80 Ca. Rptr. 354, 458 P.2d 194 (1969); *Griswold v. Connecticut*, 381 U.S. 479 (1965)). It would be unreasonable to suggest that driving falls within a protected zone of privacy. In fact, the very nature of an automobile is contrary to such an understanding. An automobile is open to public view and is heavily regulated. Driving is considered a privilege. It is not guaranteed to every individual nor protected as a distinctly intimate right.

Concern has been expressed that the use of ASE equipment to enforce speed limit laws will allow the state to unreasonably intrude upon an individual's right to privacy. In a 1973 publication (*22*), the author concluded that it is unlikely that ASE technology will be forbidden on these grounds.

The Supreme Court enunciated in *Katz v. United States* (389 U.S. 507 (1967)) that the Fourth Amendment protects individual privacy from certain kinds of governmental intrusion. Furthermore, its protection imposes limits on the government's restriction on an individual's freedom to associate. In *Katz*, the Supreme Court held that the government's activities in electronically eavesdropping on and recording the defendant's words violated the privacy upon which he justifiably relied in using the glass enclosed telephone booth and thus constituted a "search and seizure" within the meaning of the Fourth Amendment. The Supreme Court stated:

> The Fourth Amendment protects people, not places. What a person knowingly exposes to the public, even in his own home or office, is not a subject of Fourth Amendment protection. But what he seeks to preserve as private, even in an area accessible to the public may be constitutionally protected, 88 S.Ct. 507 (1967).

In *New York v. Class* (475 U.S. 106, 106 S.Ct. 960, 38 CrL 3128 (1986)), the Supreme Court held that the officer's search for a vehicle identification number (VIN) was reasonable under the Fourth Amendment. Even though the VIN of the car was covered with papers, the Court held that there was not a sufficient privacy interest in the VIN to provide protection. The officer's search for the VIN was reasonable under the Fourth Amendment in light of the pervasive regulation of vehicles by the government.

The courts have long held that it is not a search for a police officer, lawfully present at a given location, to detect something by one of his natural senses, to wit: sight or hearing. In *United States v. Fisch* (474 F.2d 1071 (9th Cir 1973)), the Court held that it is not a search to overhear conversations in an adjoining motel room since they "were audible by the naked ear."

Similarly, when a person is driving in open view, with such person's image clearly visible to the general public, it cannot be argued that he or she has a reasonable expectation of privacy protected by the Fourth Amendment. The driver's appearance and actions remain open to the state's observations. In *People v. Rhoades* (74 Ill. App. 3d 247, 392 N.E.2d 923 (1979)), the Court allowed the position of most courts throughout the country by holding that a defendant parked in a retail lot did not have a reasonable expectation of privacy in the face of observations of his actions and possessions by an Illinois State Trooper, who was standing near the defendant's vehicle.

When a person exposes himself to the general public, he cannot reasonably protect himself from the view of others, including observation through the means of photography. The result is ordinarily the same for those items that are open to public view even when means are used to enhance the senses. For example, the Court has held in *Texas v. Brown* (460 U.S. 730 (1983)) that the use of a flashlight will not activate constitutional protection. Therefore, an officer's observation through the instrument of photography will not infringe the personal privacy of the driver of a vehicle where the face of the driver is open to public scrutiny.

The Supreme Court held that the standard of whether the Fourth Amendment should be applied largely depends on whether or not a person has a reasonable expectation of privacy. In the case of a driver, who is observed in the open view of photographic radar, he or she definitely cannot claim protection of the Fourth Amendment.

In a recent paper (*23*), Alcee, Black, and Lau presented similar arguments that the use of ASE systems does not violate the constitutional rights of privacy and freedom from unreasonable search and seizure. The authors also provided arguments that the systems used do not violate the constitutional rights of freedom of association, equal protection, or due process.

Admissibility Issues

Photographic evidence is generally considered acceptable under two theories: the pictorial testimony theory and the silent witness theory. The pictorial theory is based on the same grounds as that underlying the admission of drawings, maps, and other illustrations. This doctrine is dependent on the testimony of an occurrence witness who testifies that the picture is a reasonably fair and accurate depiction or representation of the object, scene, or person. The witness will be able to testify to this representation from his or her own personal observation. The success of photographic documentation as admissible evidence is greatly dependent on in-court testimony of a witness who observed the object. Under the silent witness theory, the properly authenticated photograph is not merely an explanation of the testimony of a witness, but a substitute for such oral testimony. The photograph is substantive evidence of the person, object, or scene that it portrays without a necessary element of in-court testimony (C. McCormick, *McCormick on Evidence*, 3rd Ed., Sec. 214, at 671 (1984)).

A photograph may prove an essential element of its inherent authenticity by the contents of the picture, together with surrounding evidence that bears on its factual portrayal. These factors may justify its admission assuming that the clarity of the photograph and the foundational requirements are met.

With the advent of modern technological advances, success of photographic radar in the courtroom eventually will depend on the court's willingness to accept the scientific reliability of this evidence. In *Ferguson v. Commonwealth* (212 Va. 745, 187 S.E.2d 189 (1972)), the Supreme Court of Virginia adopted the independent silent witness theory by use of the "regiscope camera" in the conviction of forgery and uttering a forged instrument at a drugstore. The court reasoned that a photograph may be admissible under this theory assuming that the evidence is sufficient to provide an adequate foundation for assuring its accuracy. In this case the photo identified the check casher, identification presented, and check being cashed. Like the regiscope, photo radar provides the following identification: the driver; the driver's license plate; the make, model, and color of the vehicle driven; and the date, time, and location of the alleged speeding incident. Under this framework, typically, the courts require evidence of authenticity, which includes identification of the defendant as the same person shown in the photograph, and a showing of the proper functioning of the camera and processing of the film (*United States v. Gary*, 531 F.2d 933 (8th Cir 1976); *Barker v. People*, 158 Colo. 381, 407 P.2d 34 (1965); *Sisk v. State*, 236 Md. 589, 204 A.2d 684 (1964); *Bergner v. State*, 397 N.E.2d 1012 (1979); *State v. Tatum*, 58 Wash.2d 73, 360 P.2d 754 (1961); and *Ferguson v. Commonwealth*, 212 Va. 745, 187 S.E.2d 189 (1972)).

In *Bergner v. State*, the Appellate Court in upholding the use of photographic evidence for substantive purposes, without in-court witness testimony, stated:

> "Silent witness theory" for the admission of photographic evidence permits the use of photographs at trial as substantive evidence, as opposed to merely demonstrative evidence. Thus, under the silent witness theory, there is no need for a witness to testify a photograph accurately represents what he or she observed; the photograph "speaks for itself."

However, the Court clearly required that there must be a "strong showing" that the photograph's competency and authenticity must be established. The Court pointed out that photography is an inexact science. As the Court stated:

> The image a camera produces on film can be affected by a variety of things that may lead to distortion and misrepresentation. The quality of the camera and lens, type of film, available light, focal length of the lens, lens filter, or even perspective from which the photograph is taken can play a part in producing a truly representative photograph.

Yet, despite the apparent defects, many courts will admit photographic evidence under the silent witness theory. Any misleading qualities of the photograph will not prevent its use in court, but will be a fact in how much weight a court gives to the evidence. Allowing the opposing party to argue that the photo was not clear or had some apparent defects would be permissible to provide a safeguard against inaccurate depictions.

Scientific Reliability Issues

The courts have generally required three steps for admissibility for photographic radar to be considered acceptable evidence for admission: a scientific principle (judicial notice) must be applied, the operator must be trained and experienced, and the instrument must be examined and be working properly (47 ALR3d 822, *Proof, by Radar or Other Mechanical or Electronic Devices, of Violation of Speed Regulations*).

The police must establish that the photograph taken, the speed calculated, and the picture/time simultaneously shown were provided by an instrument that is a scientifically sound method of accurately photographing, measuring, and electronically synchronizing these events.

In *People v. Pett* (178 N.Y.S.2d (1958)), Louis Pett was charged with an ordinance violation of Village Ordinance 2.1 of the Village of Garden City for exceeding the speed limit, traveling at a rate of 41 mph in a 30-mph zone. His car was clocked by a device known as a Foto-Patrol, a speed-measuring device. Foto-Patrol operated on an electronic impulse, which activated a strobe light and a camera. The camera took a photograph of the offender's license plate number and provided a code of the alleged speed. The speeding citation was mailed to the registered owner of the vehicle photographed.

The detection device consisted of two parallel tape switches, 36 in. apart, cemented to the roadway across the lane of traffic. The tapes were connected to two boxes that, in turn, were connected to a camera and strobe light set upon a stanchion on the sidewalk alongside the curb. The device could be set to take a photograph at various threshold speeds and in this particular instance was set at 40 mph. When an automobile passed over the tapes at greater than 40 mph, the strobe light flashed and a photograph of the license plate was taken. Two officers, who set up the device within the village limits, testified that they had received a few days of instructions on the device prior to using it, and that they followed the manual. They also tested the device before and after apprehending the defendant. At the trial, an expert witness testified that the device was operating accurately at the time it was used on the speeder.

The Court, in 1958, stated: "We have passed the horse and buggy days and are living in a new area. The question is, did the defendant do it and was there sufficient proof offered to find the defendant guilty beyond a reasonable doubt." The Court found the defendant guilty beyond a reasonable doubt, concluding that the device was working properly. The Court seemed content to admit the evidence so long as it was found to be scientifically reliable. The Court relied on the proof of the accuracy of the devices as shown by tests, supplemented by in-court testimony of police officer.

In *People v. Hildebrandt* (308 N.Y. 397, 126 N.E.2d 377, 49 ALR 2d 449 (1955)), the lower court convicted the defendant of driving a vehicle at a speed illegal within a restricted speed zone. The police measured the speed through the Foto-Patrol device. In this case the police officer did not identify the driver, nor was an arrest made at the time, and notice was not sent to the defendant until 2 weeks later. Foto-Patrol took a picture of the rear of the vehicle including the vehicle license plate, but without driver identification. The prosecutor in the underlying case argued that there was a "rebuttable presumption" in such cases that the owner was the operator. However, there was no statutory basis for this presumption and the driver had not been identified. The operator of the vehicle appealed the speeding conviction to the New York Court of Appeals, which reversed the conviction and held that it could not be inferred that since the defendant was the owner of the car that he was also the driver at the time of the speeding violation. Furthermore, the identity of the driver of the vehicle was not clearly established by any means (i.e., no photograph identifying driver or other corroborative evidence other than the vehicle and rear license plate).

Unlike the antiquated photo speed enforcement devices used in the Pett and Hildebrandt cases, the ASE equipment today provides a clear depiction of the operator's identity by a frontal photograph of the operator, vehicle, and license plate.

Unfortunately, there is little case law to provide a clear understanding of the court's acceptability of ASE equipment, despite its apparent benefits to law enforcement. Until the equipment is widely used and its accuracy and reliability have become matters of common knowledge, courts are likely to be cautious concerning its admissibility, as was true with the radar instrument in its infancy (see *State v. Dantonio*, 115 A.2d 35, 49 ALR2d 460 (N.J. 1955) and *State v. Finkle*, 319 A.2d 733 (N.J. 1974)).

For ASE equipment to be acceptable in courts that treat speeding offenses as misdemeanors, several requirements appear necessary:

- Identification of the driver's face and the vehicle will need to be made from a frontal photograph.
- Identification of the driver registration or license plate will need to be made.
- Identification of date/time and location of speeding violation will need to be specified.
- A police officer, present at the time of the speeding violation, will possibly need to testify that the photograph was a fair and accurate depiction of the vehicle.
- Some courts may require the testimony of an expert witness who can establish the scientific reliability of the instrument until it becomes a generally acceptable method of establishing speed limit violations.
- An enabling statute that meets the legal and constitutional standards of the courts will need to be enacted.
- Periodic certification of the instrument will need to be made in accordance with any performance specifications/test protocols set forth by NHTSA and the appropriate state agency.
- Evidence will need to be recorded that the instrument was working properly at the time of the offense.
- The operating/monitoring officer of the instrument will need to be trained properly and experienced in the operation of the instrument.

TRENDS IN LEGAL ISSUES ASSOCIATED WITH AUTOMATED SPEED ENFORCEMENT

In two studies conducted for NHTSA in the early 1980s (*4,5*), several legal issues were examined regarding the potential employment of ASE devices in the United States, especially when they involved photography. The issues included the individual's rights to privacy, equal protection, admissibility of photographic testimony into evidence without corroborative testimony of a human being, and vicarious liability. Most of the concerns examined were found not to present formidable legal barriers to employing automated speed detection devices in the United States. The one exception was the vicarious liability problem as it applied to speed law statutes.

This problem concerned the legal issues that might be encountered with the imposition of criminal or civil liabilities on the owners of vehicles observed in violation of speed laws, in the absence of information about the identity of the actual drivers. In using the automated speed detection devices, the vehicle owner can be identified as the offender (via the license plate), but may not be the driver at the time of the offense. A suggested solution to this legal issue was the creation of civil vicarious liability statutes for traffic offenses, including speed violations. The civil statutes designed to impose vicarious liability on the owners of vehicles observed in violation of speed laws would eliminate many of the objections imposed by criminal statutes.

It was noted that the most common vicarious liability vehicular offense was a parking violation. In some states, minor traffic offenses were being decriminalized. This situation presented a legal environment for passage of vicarious liability (civil) statutes for other traffic offenses including speeding and red-light violations. Over the past several years, a number of states have revised their traffic laws to permit the use of photographic radar. Correspondingly, many attorney generals' opinions have been issued supporting the use of photo radar from a legal perspective.

In 1987, Arizona changed its statutes regarding speeding penalties. Drivers caught speeding more than 20 mph over the posted speed limit are charged with a criminal misdemeanor. Drivers caught speeding 20 mph or less over the posted speed limit are charged with a civil infraction. In August 1987, the City Council of Paradise Valley, Arizona passed an ordinance stating that registered owners of vehicles are presumed responsible for certain violations involving the vehicle, including speeding. This legal environment set the stage for what appears to be a relatively successful usage of manned ASE equipment in that community since October 1987.

In Precinct 8 of Galveston County, Texas, the use of manned ASE equipment was stopped after about one year because of adverse public opinion. At the time the equipment was used in Texas, there was no provision in the law to permit vehicle owners to be charged for speed violations committed by any driver of the vehicle. In fact, a bill was introduced in early 1987 in the Texas Legislature to provide the proper legal environment in the state for use of ASE equipment. However, the bill was never released from the subcommittee of the House Transportation Committee. This defeat augmented the legal and public opposition to further use of the ASE equipment in Texas.

The use of manned ASE equipment in Pasadena, California was preceded by news media coverage, public information and education, instructions for city prosecutors and local judges, and consultations with various attorneys to encourage state legislators to consider a modification to the state statutes concerning speeding offenses. A bill was placed before the California Assembly in 1992 to amend the California Vehicle Code to permit the use of photo radar for enforcement of speed limits. The bill was passed in committee meetings but failed in the assembly.

On July 7, 1989, the New York Legislature passed a bill that would authorize New York City to photograph vehicles committing red-light violations at up to 25 intersections, and to mail summonses to the registered owners of the identified vehicles. The act took effect on July 20, 1989, and was to remain in full force for 3 years. At that time, the amendments and provisions were to be repealed unless extended by another act of the legislature, which it was. The law could, with little modification, apply equally well to speed violations detected by automated systems. Equipment manufacturers consider New York to be the pilot state in the United States as far as passing (model) enabling legislation.

The photographic evidence collected or planned to be collected by automated enforcement equipment in many U.S. locations has one thing in common—either frontal or a combination of frontal and rear photographs of the offending vehicles are taken or are planned to be taken. Currently, frontal photography does not have the perceived opposition it had in the early 1980s. It provides the prosecution a means for positive identification of the driver in those cases in which the driver or owner wants to challenge the citation in court.

LEGAL OUTCOME OF AFFIXING ACCOUNTABILITY ON REGISTERED OWNERS FOR MOVING TRAFFIC VIOLATIONS

The legislation most likely to succeed the constitutional considerations maintains civil sanctions, such as fines, for violations of minor traffic offenses, such as speeding (*24*).

In essence, the legislation that makes the registered owner vicariously liable for the offense, though by means of a presumption, will likely be upheld in accordance with the recent trend of the courts' decisions. This concept is very similar to the presumption imposed on the registered owner for a typical parking violation. This would relax the requirement for a frontal photograph of the speeding vehicle so the driver's face could be identified from the photograph.

In *City of Chicago v. Hertz* (375 N.E.2d 1285 (Ill. 1978)), the Supreme Court of Illinois upheld a city ordinance that stated when any vehicle was parked illegally, the registered owner shall be *prima facie* liable for such offense. The ordinance, in effect, imposed vicarious liability on the registered owner. The Court in this case refused to hold that the ordinance created an irrebuttable presumption that the registered owner parked the vehicle. As the Court stated:

> In its statutory context, the words "prima facie" mean that the City has established its case against the registered owner by proving (1) the existence of an illegally parked vehicle and (2) registration of that vehicle in the name of the defendant. Such proof constitutes a prima facie case against the defendant owner. There is no indication in the ordinance that the owner, to be presumed responsible for the violation, must be presumed to have been the person who parked the vehicle (375 N.E.2d 1288).

The language of the 1992 Uniform Vehicle Code 16-214 as it applies to parking violations could be used in drafting a similar statute with regard to speeding violations detected by photo radar. That part of the code states:

> Presumption in reference to illegal parking states in Section (a): In any prosecution charging a violation of any law or regulation governing the stopping, standing, or parking of a vehicle, proof that the particular vehicle described in the complaint was in violation of any such law or regulation, together with proof that the defendant named in the complaint was at the time of the violation the registered owner of such vehicle, shall constitute in evidence a prima facie presumption that the registered owner of such vehicle was the person who parked or placed such vehicle at the point where, and for the time during which, such violation occurred.

The Paradise Valley Ordinance provides that the owner or person in whose name such vehicle is registered pursuant to Arizona State Law shall be held prima facie responsible for any speeding violation. Likewise, the District of Columbia, Maryland, Michigan, Oregon, California, Virginia, and Utah have similar statutes (see Appendix B). An outline of an example law permitting photographic enforcement of traffic laws has been developed from these states and is presented in Appendix C.

SUMMARY OF STATE ATTORNEY GENERAL OPINIONS REGARDING ASE EQUIPMENT

Summaries of attorney generals' opinions from four states and the District of Columbia regarding the use of ASE equipment to enforce speed limit laws are listed below.

District of Columbia

In an October 1989 legal opinion issued with regard to photo radar, the corporate counsel found that District of Columbia regulations establish a rebuttable presumption of owner liability for traffic violations. This opinion did indicate that public notice should be given in advance of the use of photo radar, as well as specific procedures, which meet due process protections.

Michigan

In a 1971 opinion, Attorney General Frank J. Kelley stated that Orbis III, an unmanned photo radar device at that time, if used for speed enforcement purposes or traffic surveying, would not impose an actionable invasion of an individual's right of privacy. Furthermore, he stated that Orbis III would be admissible in evidence as proof of identification and speed provided it met the rules of the evidence for scientific reliability to establish its trustworthiness.

Minnesota

In a 1989 opinion, Assistant Attorney General Nancy Bode discussed the use of photo radar, identifying several issues that would require review prior to its admissibility. These were to conduct sufficient testing to meet the requirements of state law; to create a statutory presumption holding the registered owner liable (in Minnesota, no such statutory scheme existed); to ensure the presence of a police officer; and to immediately arrest or promptly issue a ticket in lieu of arrest.

Nevada

In a 1972 attorney general opinion, the chief criminal deputy indicated that the instrument's results may be legally admissible in Nevada.

Texas

In a letter dated September 14, 1970 (Opinion No. M-692), Texas Attorney General Crawford C. Martin responded to several issues related to the use of photo radar in Texas. His opinions were:

- There is no actionable invasion of the right of privacy for a person whose photo is taken on a public highway. The individual's right of privacy must give way to the state's reasonable exercise of police power.
- The photo radar instrument must be properly set up and recently tested for accuracy to be accepted as proof in a court.
- The unattended photo radar instrument poses a more difficult

question. Yet, assuming the photo radar meets the requirements of the rules of evidence, it should be admissible as proof of identification of the defendant and the speed of the vehicle.

LAW ENFORCEMENT ACCEPTANCE

Interest in ASE equipment by state law enforcement agencies reached a peak in the mid 1980s. A study was conducted at that time for NHTSA that dealt with pilot tests of ASE devices and procedures (*5*). Three state police agencies assisted in the study by conducting preliminary law enforcement field tests of selected ASE devices. The state law enforcement personnel involved in the study generally thought the ASE concept to be excellent and were in favor of implementing a speed enforcement program using the equipment. However, interest in ASE equipment diminished considerably after the NHTSA study because of other enforcement needs.

Interest in ASE equipment was rejuvenated by state and local law enforcement agencies (primarily by local agencies) in the mid 1980s. The resurgence of interest arose from a number of concerns of state and local enforcement agencies, including

- Raising of speed limits to 65 mph on some facilities;
- Decreased effectiveness of conventional radar due to widespread use of radar detectors. (Several million radar detectors per year were being sold in the United States.);
- Difficulty of stopping speeders to issue citations on high-speed facilities;
- Hazards of stopping speeders to issue citations; and
- High manpower requirements per citation issued for conventional enforcement.

The experience and interest in late 1989 of nine law enforcement agencies is documented in another NHTSA report (*6*). The agencies discussed were Precinct 8 of Galveston County, Texas; City Police of Le Marque, Texas; Paradise Valley, Arizona Police Department; Pasadena, California Police Department; Virginia/Maryland State Police; Wisconsin State Highway Patrol; Minnesota State Highway Patrol; and Denver, Colorado Police Department.

Manned ASE equipment was used from about July 1986 to July 1987 in Galveston County, Texas. The same equipment was also pilot-tested in Le Marque, Texas for a 90-day period during early 1987. The operations in both these Texas communities were stopped in July 1987 because of legal concerns and public opposition. At the time the ASE equipment was used in Texas, the law did not provide permitting vehicle owners to be charged for speed violations committed by any driver of the vehicle.

In October 1987, the police department in Paradise Valley, Arizona began using manned ASE equipment to enforce speed limits at approximately 60 locations within this community of about 13,600 inhabitants. The city is located on the northeast edge of Phoenix and contains a number of heavily traveled north-south and east-west routes that connect adjacent communities. The ASE operation in Paradise Valley has continued uninterrupted since it began. The program is the longest running operation in the United States and has been credited for a large reduction in citywide accidents compared to the same period prior to implementation of the device.

In a December 1987 pilot study, the police department in Pasadena, California used a manned ASE device. Warnings were issued during the test period to 1,420 drivers. The study was deemed to be so successful with the public, judges, and law enforcement officers that a decision was made to begin speed enforcement with the device on nonfreeways within this community of about 135,000 inhabitants on June 1, 1988. The program ceased operation in June 1992 because, although the Pasadena police felt the program was an effective deterrent to speeding on high-speed facilities, it could not continue for reasons beyond the police department's control, as described earlier in Chapter 4, under Adjudication Practices Involving Drivers and Owners.

Speeding on the Capital Beltway (I-495 around Washington, D.C.) has long posed a traffic safety and incident management problem for local law enforcement officials. The Beltway has expanded from the original four-lane facility to one with as many as eight lanes in some locations. Shoulders and median areas have been drastically reduced in size or eliminated, thus restricting the space for police officers to pull over speeding drivers. As the traffic volume on the facility increased, the ability of an officer to safely apprehend one vehicle among many for a speeding violation decreased. By 1989, both the Virginia Department of State Police and the Maryland State Police had begun to look for innovative ways to enforce the speed laws.

In October 1989, the Virginia Department of State Police was awarded a grant by NHTSA to study the possible use of ASE equipment on the Capital Beltway (*6,16,17*). The Maryland State Police joined their Virginia counterparts to form a task force under the contract. The task force invited five manufacturers of ASE equipment to demonstrate their equipment during a 2-week series of tests on sections of interstate highways with varying volumes of traffic and differing traffic characteristics. The tests were designed to determine if ASE could be successfully deployed as an enforcement tool on high-speed, high-volume roads. No citations were issued, nor were any contacts made with speeding motorists during the tests. No implementation of ASE equipment on the Beltway is planned until enabling state statutes are passed.

The interest in ASE equipment by the other three law enforcement agencies (Wisconsin, Minnesota, and Denver) has remained constant. However, the agencies have not implemented ASE programs.

Currently, three California communities (Campbell, National City, and Riverside); three Utah communities (Garland, Wellington, and West Valley); and Paradise Valley, Arizona use ASE equipment. Six other western communities have used ASE equipment as recently as April 1993, but all six communities have discontinued ASE operations because of various reasons.

The Washington, Michigan, and New Jersey State Police are completing evaluations of ASE programs in their respective states under grant awards from NHTSA. Warning letters were sent to detected speeders in each of the three states. However, no citations were issued during the studies. The New Jersey State Police was highly in favor of using the equipment to issue citations to detected speeders until that interest was stopped by the state legislature. The Michigan Department of State Police believes ASE technology has an application for traffic safety and should be used as a supplement to conventional traffic patrols. Michigan further believes that an emphasis should be given to using the equipment on high accident locations or where it is difficult or unsafe for an officer to stop a speeding motorist. Other areas of potential use include bridges, construction zones, congested traffic areas, and where speeding by commercial vehicles is a problem. The results of the Washington State Police study are not known.

At the time of this report, more than 50 state and local law enforcement agencies have an active interest in using ASE equipment. Many of these agencies are waiting for enabling legislation to begin an ASE program. Other agencies are proceeding with a program based on favorable state attorney general opinions and, in some instances, city ordinances.

Two U.S. cities (Pasadena, California and New York City) have conducted pilot tests of automated red-light violation equipment, including sensors and photographic capabilities (*6*). The use of red-light violation equipment is continuing in New York City, and equipment will be installed in Jackson, Michigan in August 1992 for enforcement purposes.

Finally, photographic detection equipment has been installed at selected railroad grade crossings of the Los Angeles Metro Blue Light Rail Line in California (*10*), which runs from Long Beach to downtown Los Angeles. Frontal photographs will be taken of drivers going around lowered crossing gates. Violators are being prosecuted in the Compton, California Municipal Court.

PUBLIC ACCEPTANCE

The public acceptance issues pertaining to the use, or potential use, of photographic enforcement of traffic laws in the United States are many-faceted and complex. Thus, an in-depth discussion of this subject is beyond the scope of this synthesis. However, a summary is given below of research by the United States and Canada regarding public acceptance issues as they relate to the use of ASE devices and red-light cameras.

U.S. Studies

A study, Public Acceptability of Highway Safety Countermeasures, was completed in 1981 by Mathematica Policy Research, Inc. (*25-27*). Speed detection systems, including ASE devices, were some of the countermeasures investigated.

The research design for the study consisted of three complementary research procedures: focus group discussions, special interest case studies, and general public survey. The focus group discussions were employed in the design and pilot stages of the study to identify and define relevant variables that should be investigated, to help develop questions that survey respondents would be able to understand and answer without difficulty and that would at the same time measure the relevant variables, and to develop hypotheses concerning the relationship between these variables to be tested by the survey. Nineteen focus group discussions, consisting of 6 to 11 persons each, were held in five U.S. cities.

Members of special interest groups often have access to highway safety policy makers and may be in positions to facilitate or thwart countermeasure implementation. Hence, the special interest case studies were conducted in an effort to obtain expert opinions about possible differences in perceptions of these highway safety countermeasures. Structured interviews were conducted with individuals selected from three major types of groups within each of 10 states (one state was drawn randomly from each of the 10 NHTSA regions). The first major group consisted of representatives of state highway safety departments, state police, and police chief associations. These officials were selected for their safety planning and enforcement activities from a state basis. The second group consisted of members of state bar associations and state civil liberties unions. These individuals were involved to obtain their views on the legal and constitutional rights issues raised by some of the countermeasures. The third group consisted of members of particular consumer or business interests such as the American Automobile Association, leading state insurance companies, state trucking associations, and state automobile dealer associations.

The general public survey was conducted to obtain measures of general public views about highway safety issues and proposed countermeasures. The survey was conducted by telephone and involved three subsamples, each of approximately 500 respondents and constituting a probability sample of the universe being surveyed (the U.S. population of age 18 or older). A different questionnaire was used for each subsample. Also, a randomized procedure was used to select the respondent in each household called.

Of the three research procedures employed in the study, only the general public survey was based on a statistically predictive sample and yielded quantitative data that could be interpreted as reflective of general public opinion on specific issues. Both the focus group discussions and the special interest case studies resulted in qualitative information providing a broad perspective about the kinds of issues and concerns that may be associated with countermeasure implementation. However, the results of the focus and special interest groups cannot be generalized as representative of acceptability concerns in the general population.

Public acceptance of speed detection devices was one of the subjects investigated, but not with all the individuals contacted in the study. The subject of speed detection was broached with slightly more than one-half of the focus groups, with each participant in the special interest case studies, and with only one of the subsamples of the public survey. The detection devices discussed were an ASE device, speedometer measurements, radar, and vascar. The Orbis III device was used as an example ASE device during the focus group discussions. This device was an unmanned ASE system that consisted of roadway sensors, a speed-measuring device, a camera, and a flash unit. The system was used intermittently in the United States in a series of research experiments between late 1973 and early 1976, which were carried out in West Orange, New Jersey and Arlington, Texas. The Multanova and Traffipax devices were used as examples of ASE devices during the special interest case studies. No specific ASE device was named during the general public survey.

It is important to realize that the focus group discussions and the special interest case studies were informal, open-ended discussions. No attempt was made to supply respondents with additional information not included in the prepared countermeasure descriptions or to correct any misunderstandings that respondents may have had. As a result, some of the judgments and reactions may have been based on misunderstandings of the issues. This was particularly the case in discussion of the ASE device. The description of the Orbis III (as well as the Multanova and Traffipax) was vague with respect to how a photograph would be taken. Some respondents interpreted a photograph of the car to mean a photograph of the front of the vehicle showing both the driver and the license plate. Other respondents interpreted this to mean a photograph of the rear of the vehicle, showing the license plate but not the driver. The Multanova and Traffipax devices at that time were designed to primarily take rear photographs of speeding vehicles. The Orbis III system, on the other hand, was designed to take frontal photographs. Some issues relative to the invasion of privacy were raised during the focus group discussions and special interest studies. However, the vague description of how the photographs were taken, plus the incorrect interpretations of the devices and their potential use, casts some doubt on the outcome of study results, especially when they pertained to invasion of privacy issues.

The general public survey regarding speed detection and deterrence was also burdened with the concern of invasion of privacy issues. The respondents were asked during the structured telephone interviews if they opposed the use of an automatic camera device to identify who was actually driving the car and if they thought this form of identification was an invasion of privacy. This preoccupied approach with privacy issues and the misinterpretation of the use of ASE devices conveyed to participants in the public acceptability study prevented the future use of the survey results (*3*). The survey results could not even be used to assess the public acceptability of using ASE devices that photograph only the rear of violating vehicles.

Public Opinion Regarding Photo Radar

A study of the public opinion regarding photo radar was reported in 1989 by the Insurance Institute for Highway Safety (IIHS) (*28,29*). The report describes the results of a telephone survey conducted between August 18 and September 5, 1989 of drivers residing in and around Paradise Valley, Arizona and Pasadena, California.

Paradise Valley is a small community of about 13,600 inhabitants and is located on the northeast edge of Phoenix. The city contains a number of heavily traveled north-south and east-west routes that connect adjacent communities. A manned ASE device has been used in Paradise Valley since October 1987. The device is deployed about 30 hr/week at approximately 60 locations on residential and arterial streets. Signs are posted at the entrances to the community advising that photo radar is used for speed enforcement, and a sign saying "Photo Radar in Use" is placed upstream from the unit giving motorists an opportunity to slow down before they reach the enforcement unit.

Pasadena is a community of about 135,000 inhabitants. A manned ASE device was operated in Pasadena from June 1988 until June 1992. The device was deployed about 15 to 25 hr/week on residential and arterial streets. There were approximately 75 signs posted at the city limits of Pasadena saying "Speed Enforced with Photo Radar." A rectangular-shaped sign with the message "You Have Just Passed Through Photo Radar (You May Be Notified by Mail)" was deployed downstream of the enforcement vehicle to notify motorists of the operation. In both communities, the ASE device was deployed in a vehicle prominently displaying local police markings.

The telephone survey of drivers in and around these two communities was conducted to determine public attitudes about the acceptance of ASE. The surrounding communities were surveyed also because of the possibility that drivers residing in those areas had exposure to ASE but may have had different opinions than residents of Paradise Valley or Pasadena.

Approximately equal numbers of 10-min interviews (around 500 for each area) were conducted with residents of Paradise Valley and nearby areas of Phoenix and Scottsdale. The numbers of interviews conducted with residents of Pasadena were the same as conducted with residents in nearby areas of Glendale, Burbank, South Pasadena, Alhambra, San Gabriel, Temple City, Arcadia, El Monte, Monrovia, Altadena, San Marino, La Canada, La Crescenta, Sierra Madre, and Duarte, California. The maximum expected sampling error at the 95 percent confidence level for each study area is ± 4 percent. Differences of six percentage points or more are statistically significant at $p \leq 0.05$. Respondents were asked questions in three areas: awareness of ASE, attitudes toward its use, and reported behavior in response to ASE.

Respondents were first asked to indicate techniques used by the police to enforce speed limits in areas where they drive. A description of photo radar was then read to respondents: "During the last year a new speed enforcement tool known as photo radar has been used in (Paradise Valley/Pasadena). It automatically photographs the license plate and the driver of only those vehicles traveling significantly faster than the speed limit." Respondents who had not already mentioned photo radar spontaneously were then asked if they had known it was being used.

Table 8 indicates that there was considerable awareness that photo radar was being used in Paradise Valley and Pasadena. Awareness of photo radar was greatest in Paradise Valley, where 72 percent of the respondents mentioned it spontaneously, followed by Pasadena (56 percent). More respondents who lived near Paradise Valley mentioned it spontaneously (39 percent) than those living near Pasadena (24 percent). In all four areas surveyed, the great majority of respondents either mentioned photo radar spontaneously or claimed to know about its use after it was described to them.

In all the areas combined, 58 percent either approved or strongly approved of ASE use (see Table 9). Also, 37 percent disapproved or strongly disapproved, and 5 percent were not sure. The residents of Paradise Valley (62 percent) and of Pasadena (61 percent) were more likely to approve of ASE versus residents of nearby communities. Overall, the same proportion strongly disapproved of ASE as strongly approved (15 percent).

Approximately 66 percent of all those who approve of ASE thought its use should be increased. Finally, almost 50 percent of all the respondents who knew about ASE being used said it had made them drive slower when traveling through Paradise Valley or Pasadena.

The IIHS concludes that there is considerable awareness of ASE usage in the two communities. The survey suggests that some people have changed their driving behavior because of ASE. Also, evidence from the survey suggests that ASE can be an effective speed enforcement tool, and a majority of the public favors its use.

Canadian Studies

The Canadian experiences with ASE systems have raised some public acceptance issues in that country (*4*). In the early 1970s, the Quebec Provincial Police installed some fully automatic Multanova systems on the provincial highways. In normal use, the front of the speeding vehicle was photographed because the driver could then be identified from the photograph. The license number of the speeding vehicle was recorded from the photograph and was used to locate the owner. A speeding citation was then mailed to the owner of the vehicle. At that time all speeding offenses required a court appearance for the fine to be levied. The photograph was used as evidence in court and was corroborated by the police officer's testimony. (Although the units were fully automatic, they were attended by officers at least 75 percent of the time.)

TABLE 8
IIHS SURVEY RESULTS REGARDING AWARENESS OF ASE USE IN PARADISE VALLEY AND PASADENA (*28*)

Question: What kinds of techniques do the police use to enforce speed limits where you drive?

	Paradise Valley		Near Paradise Valley		Pasadena		Near Pasadena	
	%	No. of Responses	%	No. of Responses	%	No. of Responses	%	No. of Responses
Mentioned spontaneously	72	363	39	197	56	283	24	122
Knew when prompted	24	119	47	235	34	170	51	255
Not aware of	4	19	14	68	9	46	25	124
Not sure	0	0	0	0	1	3	0	1
Total	100	501	100	500	100	502	100	502

TABLE 9
IIHS SURVEY RESULTS REGARDING ATTITUDE TOWARD ASE USE IN PARADISE VALLEY AND PASADENA (*28*)

Question: Do you approve or disapprove of photo radar? Would you say you approve, strongly approve, disapprove, or strongly disapprove?

	Paradise Valley		Near Paradise Valley		Pasadena		Near Pasadena	
Attitude	%	No. of Responses	%	No. of Responses	%	No. of Responses	%	No. of Responses
Strongly approve	20	101	12	60	16	82	12	58
Approved	42	212	37	185	45	227	47	234
Disapprove	23	114	26	131	23	113	20	99
Strongly disapprove	12	62	20	99	12	59	15	74
Not sure	2	12	5	25	4	21	7	37
Total	99	501	100	500	100	502	101[a]	502

[a] Caused by roundoff.

The Quebec Provincial Police was very much in favor of using the units. They felt the equipment was not only accurate, but also highly reliable, having only minor problems. However, some of the police did abuse use of the system by concealing the units and using them on roads with unreasonably low speed limits.

After 4 to 5 years, use of the units was challenged in the courts with arguments based on the issue of invasion of privacy and on the abusive use by police. Many drivers were embarrassed by being photographed with other vehicle occupants at certain times and locations. These challenges resulted in the courts banning use of the units' photographic capabilities. The units were used for a period after that for speed enforcement but without the camera. Public opinion essentially stopped use of ASE in Quebec.

The red-light camera and ASE devices were introduced in a trial basis to southwestern British Columbia in 1988. The red-light camera was installed in the city of Vancouver and the ASE device was used in the lower mainland, interior, and southern Vancouver Island areas. Because of these operations, researchers at the Insurance Corporation of British Columbia (ICBC) were concerned with driver's perceptions of fairness of traffic law enforcement and of the effectiveness in reducing violations for both red-light cameras and ASE devices. The researchers also wanted to know how the presence of different driving characteristics might influence the individual's perceptions regarding both systems.

During a 3-year period (1988–1990), telephone surveys were conducted of randomly selected British Columbia (B.C.) drivers in Vancouver and Victoria to assess public attitudes toward red-light cameras. Similar surveys were conducted in smaller communities during a 2-year period (1989–1990) to assess public attitudes toward ASE. The results of these surveys were published in 1991 (*30*).

The proportion of drivers who approve of the use of the red-light cameras has decreased significantly from 82 percent in 1988 when the devices were first introduced to 70 percent in 1990. The proportion of drivers who feel that red-light cameras will reduce violations and accidents also decreased significantly from about 84 percent in 1988 to about 77 percent in 1990. A profile of drivers who think that the use of red-light cameras is unfair would consist of the following characteristics: male, young to middle age, drive more than 10,000 km/year (6,210 mi/year), and have two or more convictions in the last 3 years.

The following major findings with respect to attitudes toward ASE were obtained. No significant changes were observed in the public's acceptance of ASE from 1989 (71 percent) to 1990 (74 percent). No significant changes were found in the effectiveness perception levels of ASE between 1989 and 1990. Drivers who view the use of ASE as unfair are more likely to be a male, be young to middle age, have two or more convictions in the last 3 years, and respond impatiently to frustrating, but typical traffic situations.

The ICBC researchers feel that the future public acceptance of ASE will depend on how the devices are employed. If the B.C. practice of the past years with respect to enforcing speed limits is continued, where only excessive violators are targeted, the public acceptance level may remain stable. However, if more of the every-day transgressors are ticketed, then it is likely the level of positive response will drop. This will be especially so if it is perceived that the devices are being used to generate greater ticket quantities and fine revenues and not just to enforce reasonable laws or limits in critical (from a safety perspective) and hard-to-police areas.

CHAPTER SIX

EFFECTS ON COMPLIANCE AND SAFETY

A number of attempts have been made to assess the impact of ASE enforcement on speed limit compliance. The data presented in the literature indicate that use of ASE devices to enforce speed limits will reduce the incidence of speeding to a certain extent. Most of the speed reduction claims are based on observations and not on scientifically formulated experimental designs. For example, ASE devices were introduced in the State of Victoria, Australia in December 1989. About 23 percent of the vehicles detected that month were speeding. After 15 months of operation, the incidence of speeding had dropped to about 11 percent (*15,31*). The credit for this reduction cannot be attributed totally to the use of ASE because of the large number of uncontrolled variables. However, some of the reduction can be attributed to use of the equipment.

During the first 3 months of the ASE program in Pasadena, about 7.4 percent of the motorists passing the enforcement locations were cited for speeding above the detection setting. Seventeen months after the operation began, the percentage of vehicles cited for speeding dropped to 5 percent (*6*).

The Paradise Valley Police Department estimated that speeds on most roads in the city were reduced by about 8 mph during the first 3 years of operation (*17*). The speed reductions claimed in both Pasadena and Paradise Valley are based on enforcement data and not on controlled experiments.

In March 1988, the Victoria, British Columbia Police Department conducted a study of the effectiveness of an ASE device in reducing traffic speeds (*32*). The study design was developed by ICBC, which also analyzed the data; the design included collecting baseline speed data before the enforcement phase and also two periods of publicity concerning enforcement aspects of the program. The effectiveness of the ASE device was tested under two conditions: when the presence of the ASE device at a particular site was known and when the device was used as a general deterrent whose exact location was unknown. When drivers understood that enforcement was concentrating exclusively at one site, there was a tendency for higher mean speeds at other locations. When people were told that the ASE device would be at any location, mean speeds were between 3 and 13.6 percent lower than during the baseline survey, even when the device was not actually present at the enforcement site. When the ASE device was at a particular site and the public was told it could be operating anywhere, the presence of the ASE device accounted for mean speed reductions of between 9.2 and 19 percent compared to the baseline period.

From September to December 1990, the Ministry of Solicitor General and the Vancouver, British Columbia Police Department conducted a study on the effectiveness of ASE on traffic speeds (*18,33*). Approximately 1 week of pre-intervention, 2 months of intervention, and 2 weeks of post-intervention vehicle speed data were collected on both a test and control section in Vancouver. An autoregressive, integrated, moving average model-building procedure was carried out on the time series speed data for vehicles of the ASE traveling on both sections. The analysis indicated that the average daily vehicle speed and the percentages of vehicles exceeding the 50-km/h speed limit consistently and gradually declined at the enforcement location throughout the intervention. By the end of the enforcement period, these reductions became significantly different from the pre-intervention levels. The average daily speed at the end of the intervention was 57.9 km/h, compared to the average daily speed of 59.1 km/h during the pre-intervention period (2 percent reduction). The mean percentage of vehicles exceeding 50 km/h at the end of the intervention was 81.9 percent compared to the mean percentage of 86.6 percent during the pre-intervention period (5.4 percent reduction).

The effects of ASE on speed compliance and safety in the United States are being investigated under a current, multiyear study funded by NHTSA (*7*). The study involves field evaluation of the effectiveness of selective ASE programs in up to three U.S. communities. The evaluation will seek to determine the effectiveness of each ASE program in reducing speeds and speed-related crashes, both community-wide and at specific sites within those communities.

The effects of ASE programs on speed-related crashes, or crashes in general, are highly publicized but not well supported with scientific evidence. Some examples of the impact claimed are given below.

The State of Victoria, Australia experienced a dramatic reduction in accidents after introducing ASE devices in December 1989 (*15*). During the first year of the ASE program, highway fatalities decreased by 30 percent. Injuries resulting from traffic crashes were down by 21 percent, and the total number of accidents was reduced by 16 percent compared to those recorded in 1989. It is difficult to determine the true impact of the ASE program on these accident statistics because extra breath-testing for drunk driving and a community awareness program for traffic safety were also begun and under way at the same time as the ASE program.

The accident experience in Paradise Valley, Arizona; West Valley, Utah; and National City, California before and after the introduction of an ASE program is presented in Figures 2, 3, and 4, respectively. It is interesting to note the high-percent reductions in crashes. However, such reductions can coincide with program operations and not be caused by them.

Perhaps the best known example of ASE impact on traffic accidents is that associated with the fixed installation of ASE devices at the Elzer Berg in Germany (*4*). The installation is on the autobahn between Frankfurt and Cologne. The particular location is a 7.2-km (4.5-mile) downgrade from a small mountain (berg) near the town of Elz. The roadway is not overly steep (about 5 percent) but is somewhat winding. The combination of low, downgrade truck speeds, high automobile speeds, and poor sight distance made it the most hazardous section of the autobahn.

In 1970, the downgrade section was reconstructed from two to three lanes and the number of accidents decreased from a preceding 9-year average of 273 to 199. This compares to the 9-year average

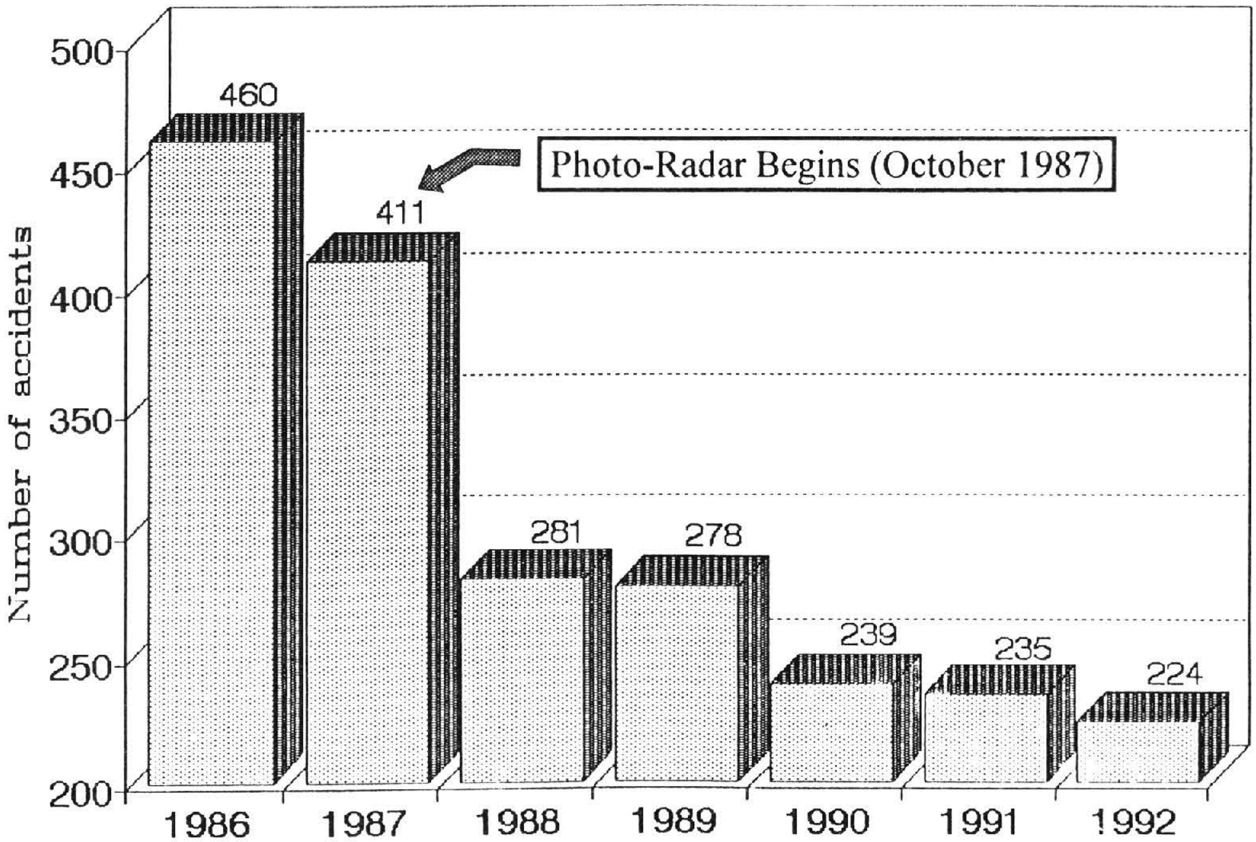

FIGURE 2 Review of traffic accidents 1986–1992, Paradise Valley, Arizona before and during ASE activities. (Source: Paradise Valley Police Department)

of 60 accidents and 50 accidents in 1970 for the upgrade section. The number of downhill accidents in 1971 remained at 199. In April 1972, special large speed limit signs were installed above each downgrade lane (100 km/h for the two inside lanes and 40 km/h for the right lane), and the accidents decreased slightly to 183. In May 1972, stationary ASE devices were installed above each downgrade lane on a temporary basis and on a continuous basis in November 1973. During 1974, the first full year of operation, more than 134,000 speeding citations were issued, and the total number of accidents on the downgrade dropped to 45, compared to 41 on the upgrade section. The average number of downgrade accidents for the time period 1973 through 1978 was 35, while the average number of upgrade accidents for the same period was 28. Since 1974, the number of speeding citations issued each year has varied from 22,000 to 79,000.

The Elzer Berg installation is one good example of the benefits that can be achieved from an automatic installation of ASE devices where manual speed enforcement is difficult, not to mention hazardous. The Elzer Berg ASE installation paid for itself in 1 month's time.

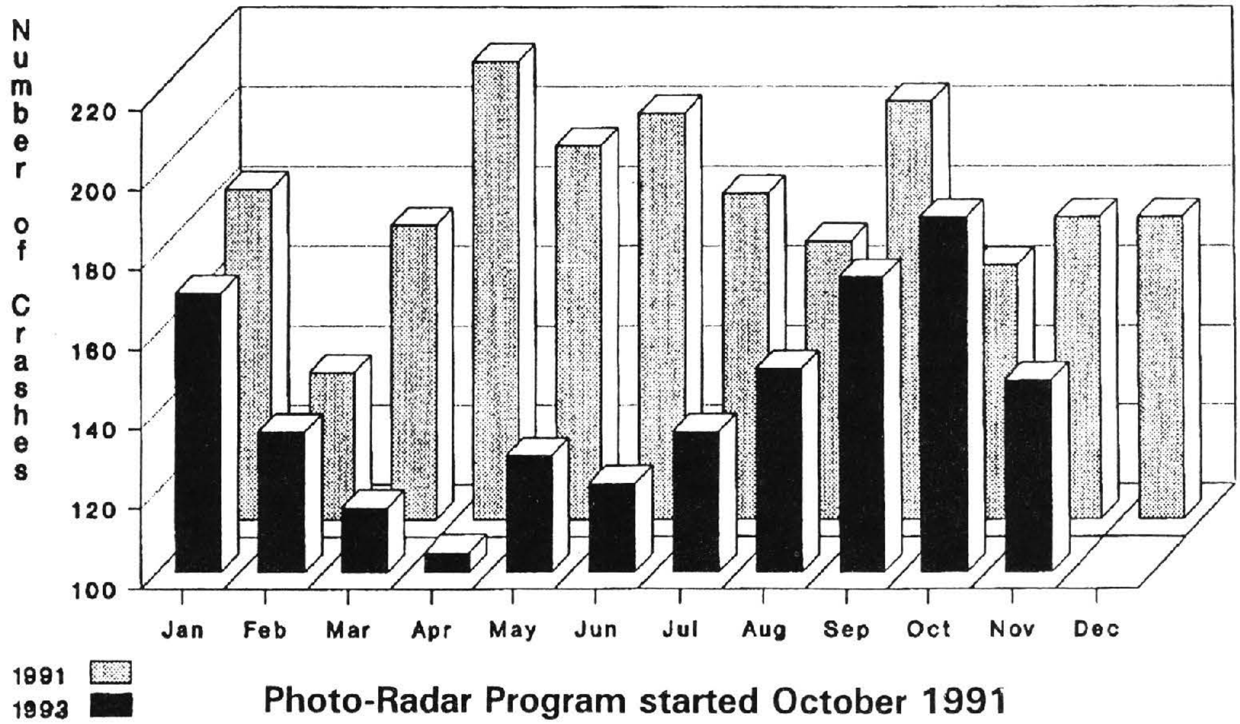

FIGURE 3 Photo-radar crash reduction program 1991–1993 comparison, West Valley, Utah before and during ASE activities. (Source: West Valley City Police Department)

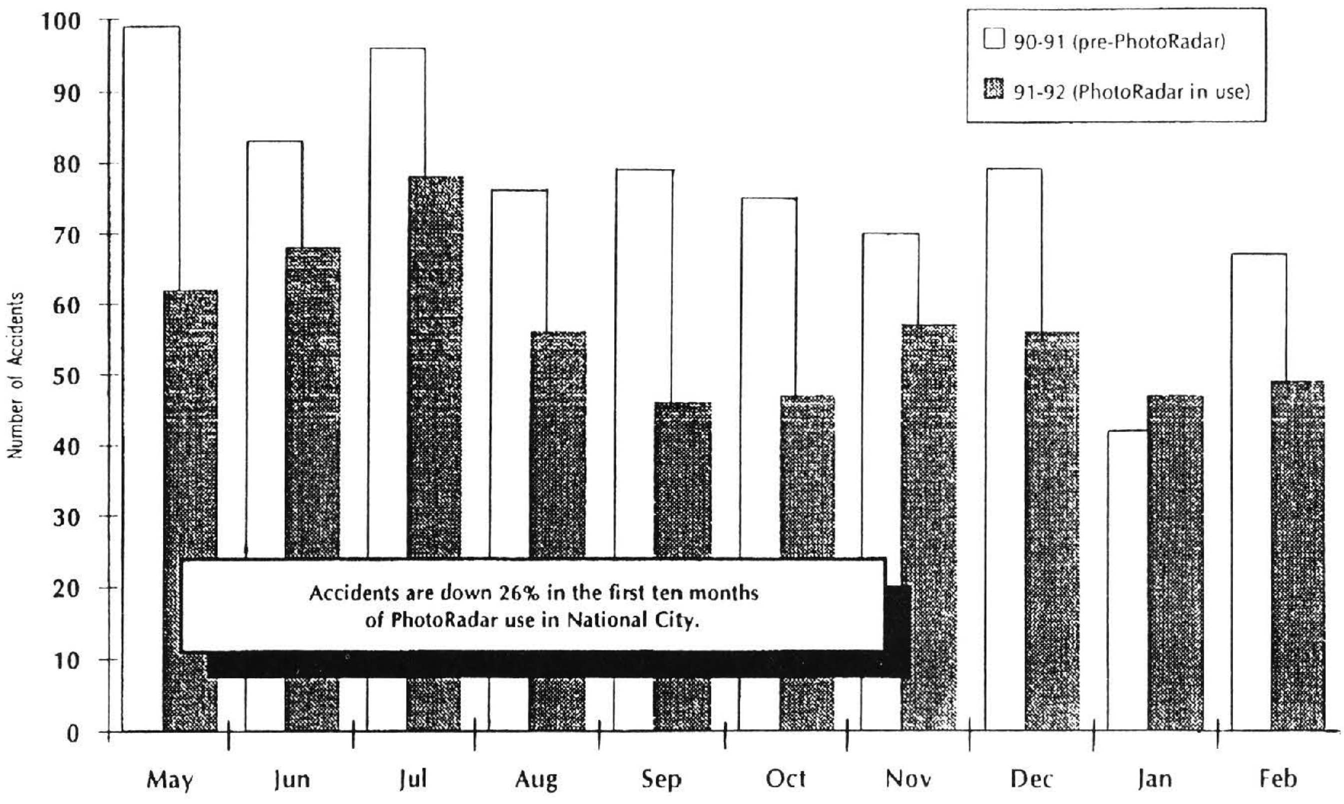

FIGURE 4 Monthly accident data, National City, California before and during ASE activities (Source: National City Police Department, Traffic Unit)

CHAPTER SEVEN

CONCLUSIONS

The subject of enforcement technology, and more specifically automated enforcement of traffic laws using photographic and video equipment, is of widespread interest. This interest is not confined to just the federal government, but to the numerous state and local law enforcement agencies in the United States as well. The following are major conclusions that have been developed from all the information obtained for this synthesis.

- Automated technology that employs photographic and/or video equipment has been identified for use in a number of traffic law enforcement areas.
- Automated speed enforcement (ASE) equipment is important to the future of law enforcement and provides an approach for improving compliance with speed laws and improving traffic safety.
- Widespread interest in ASE is developing more rapidly among local law enforcement agencies than among state agencies.
- Interest in automated enforcement technology for use in detecting and recording signal-light and railroad grade crossing violations is growing, but little evidence exists on the effectiveness of the systems in these areas.
- Law enforcement officers need to be adequately trained to operate the automated enforcement technology, and technical support from the equipment vendors is necessary to troubleshoot problems.
- In evaluating the effectiveness of any enforcement technology as ASE, it is necessary to consider not only the technology itself, but also the operational conditions. The device, the officers, the deployment strategy, and the legal and public opinion environments must be considered together.
- Few technical problems were identified with the processing of citations generated from ASE programs. The main problem in some communities is associated with ignored citations.
- Significant initial cost investments are required if a law enforcement agency decides to purchase an ASE device and administratively operate the ASE program as opposed to contracting with a vendor for equipment lease and processing of citations.
- The legal issues surrounding the use of ASE devices in U.S. speed enforcement are many-faceted and complex.
- The vicarious liability aspects associated with using ASE devices are a legal/legislative issue that needs to be resolved in each state. A state statute or city ordinance is generally needed in most states to be able to cite the registered owner of a vehicle detected of a speeding offense.
- A focused public information and education campaign can enhance the public acceptance of an ASE program in a community. A telephone survey of residents in two communities with an ASE program indicated a considerable awareness that an ASE device was being used to enforce speed limits. Almost one-half of the respondents who knew about the ASE program said it had made them drive slower.

A number of recommendations have been developed based on findings for this synthesis, as follows below.

- Draft specifications and test protocols need to be developed for evaluation of automated enforcement technology.
- Scientifically controlled studies need to be conducted to determine the general deterrence impact of ASE programs on speeding violators and speed-related crashes.
- Certification procedures and training programs related to the use of automated enforcement technology need to be developed for law enforcement agencies.
- Legislation needs to be developed at the state level that will permit local jurisdictions to implement citation-oriented ASE programs.

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APPENDIX A

DESCRIPTIONS OF ENFORCEMENT TECHNOLOGIES

DESCRIPTIONS OF ASE DEVICES

A brief technical description of each of the 11 ASE systems identified is presented in this appendix. The systems were identified through a worldwide search of published and unpublished information and from contacts with known U.S. and foreign manufacturers (*1-3*). The systems employing Doppler radar are presented first followed by those using other concepts for speed determination. A list of 11 ASE systems is given below. Detailed specifications of each system are presented in tabular form in Chapter 2. The systems described are not endorsed nor are any of them recommended over another.

- American Traffic Systems (United States)
- AWA Defense Industries Pty. Ltd. (Australia)
- Gatsometer B.V. (Netherlands)
- Plessey South Africa, Ltd. (South Africa)
- Sensys Traffic AB (Sweden)
- Traffipax-Vertrieb (Germany)
- Zellweger Uster AG (Switzerland)
- Eltraff S.r.l. (Italy)
- Proof Digitalsystemer A/S (Denmark)
- Trans-Atlantic Equipment Pty. Ltd. (South Africa)
- Truvelo Manufacturers (Germany).

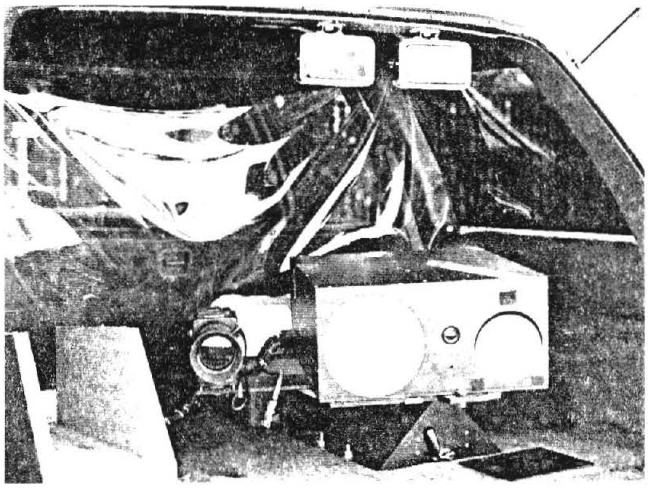
American Traffic Systems

American Traffic Systems is a U.S. firm in Scottsdale, Arizona that manufactures a cross-the-road radar system called PR-100 AutoPatrol. This system is an upgraded version of an ASE system formally marketed by Traffic Monitoring Technologies of Friendswood, Texas under the trade name of PhotoCop$^{(TM)}$. The current system consists of a Doppler radar unit that operates in the Ka band, coupled with three cameras, a flash unit, a control console computer unit, a video display, and a battery power supply. A mobile speed display board is also available that displays measured speeds to those drivers who were photographed.

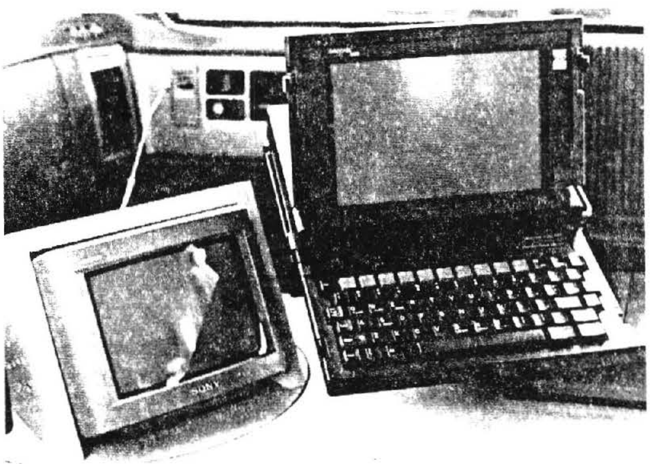
The system is conventionally mounted in a patrol car for stationary operations (see Figure A-1a). In this mode of operation, the patrol vehicle, usually a station wagon or four-wheel drive vehicle, is parked on the right side of the road. The radar unit, a 70-mm camera with its flash unit, and a video camera are mounted in the back of the vehicle to monitor only approaching traffic. The radar unit is aimed at a fixed angle to the roadway. The 70-mm and video cameras take frontal images of approaching vehicles that are detected traveling above a preset speed value. A 35-mm camera is mounted on the front of the patrol vehicle to also take rear photographs of offending vehicles, especially in those areas traveled by vehicles with no front license plate.

A control console computer unit, together with a video display monitor and VCR, are mounted in the front of the patrol vehicle (see Figure A-1b). The rear-facing video camera and associated monitor/VCR are positioned so that the officer can observe oncoming traffic, record the flow of traffic including violations, and check to see that the patrol vehicle's alignment with the roadway is correct.

The radar unit contains two diodes. By analyzing the signals received at the two diodes, the radar unit can determine the



(a)



(b)

FIGURE A-1 (a) PR-100 AutoPatrol mounted in the rear of a patrol car; (b) control console computer unit and video display monitor of the PR-100 AutoPatrol. (Courtesy of American Traffic Systems) direction of travel of the vehicles. Only the approaching traffic is monitored, and stray reflections from receding traffic that could potentially induce errors in the measurement are excluded. The radar unit makes between 100 and 700 measurements of each vehicle as it passes through the radar beam, which is aimed at a fixed angle to the roadway. Any inconsistent readings in the signal are recognized and discarded. The radar unit analyzes the pattern of measurements as the vehicle passes through the radar beam. If the pattern of readings is not within certain limits, dashes are written through the speed recording portion of the photograph to indicate that the measurements are inconclusive.

When speeding is successfully verified, the measured speed value is transferred to the photo of the detected vehicle along with the date, time, and location information. This information is displayed off of the frame and below the photographic image. In this manner, the data elements cannot block any part of the photograph. The speed data are also displayed on the monitor as the detected vehicles pass through the radar beam.

The 70-mm camera supports three types of sprocketless film including 35, 46, and 70 mm.

The ASE system also stores detailed information from each deployment session on a computer diskette. These data can be used by agencies for detailed traffic engineering studies. The data can also be used in traffic court to demonstrate that the detected vehicle was exceeding the speed limit and how this speed compared to a speed histogram for the enforcement period. The data stored on the diskettes include

- Date and time of each vehicle detected by the radar beam
- Vehicle speed
- Name of officer
- Description of enforcement location
- Speed limit
- Preset speed at which photographs were taken
- Weather conditions.

The ASE system can also be attached to fixed structures such as poles or overpasses for automatic, unattended operations. In this configuration, the computer, monitor, and VCR can be hard wired up to 6.4 km (4 mi) from the radar and camera units, according to the manufacturer, for easy access and monitoring. The system can be operated such that it automatically sets the speed at which violations are photographed based on the percentile speed distribution of the traffic flow. The system can also activate and deactivate itself at certain times of the day. When the system is not photographing speeding violations, it will continue to perform its traffic monitoring tasks. This latter characteristic is true whether the system is used in a manned or unmanned operation.

Mobile ASE units of this manufacturer have been used in Paradise Valley, Arizona and West Valley, Utah. Predecessor units (PhotoCop) were used in Peoria, Arizona and Pasadena, California, and were subjected to field evaluation in Michigan.

AWA Defense Industries Pty. Ltd.

This Australian firm, formerly named Fairey Australasia Pty. Ltd. and originally a subsidiary of Fairey Aviation Ltd. of Britain, has manufactured radar speed detection devices for about 14 years. The currently produced Vehicle Speed Radar (VSR) Model 449 is a manned, portable, self-contained device that uses cross-the-road Doppler radar, which is controlled by a microprocessor. The unit can be connected to a camera for obtaining photographic evidence of speeding vehicles. The back of the radar unit with the camera mounted on top is shown in Figure A-2.

The radar used in the VSR has a frequency of 24.15 GHz and a beam width of 4°. The narrow beam enables the detection of closely spaced vehicles commonly found in urban areas. The VSR has an operating range of 50 m (164 ft) and can automatically discriminate between approaching and receding traffic. A switch is provided for the user to select the direction of traffic being monitored. The microprocessor in the VSR is programmed to analyze the Doppler signals and to reject a speed measurement if the instantaneously derived velocities vary more than a preset limit. Built-in automatic testing verifies continuously that the equipment is operating correctly and accurately.

The design of the system is such that the unit can be quickly and easily set up on the roadside or on an overpass. The unit is typically mounted on a tripod. The carrying handle on the radar also incorporates a protractor, which is used to correctly set the angle (25°) of the radar antenna to the road. The unit is self-contained in that it is powered with a rechargeable, sealed battery pack that provides 6 hr of operation.

The optional photographic camera unit provides a record of the speeding vehicle along with the speed, location, direction of travel, time, and date of the offense. An example of a frontal photograph taken with the system is given in Figure A-3. The unit can, alternatively, output speed, time, and date of the offense by way of an RS232 computer interface. Speeds of all traffic detected can also be recorded and downloaded to a data logging system via the computer interface.

The radar performance complies with the current issue of the Standards Association of Australia, Specification Radar Speed Detection 2898, and is approved for use in Australia. Application has been made with the Federal Communications Commission for type acceptance in the United States.

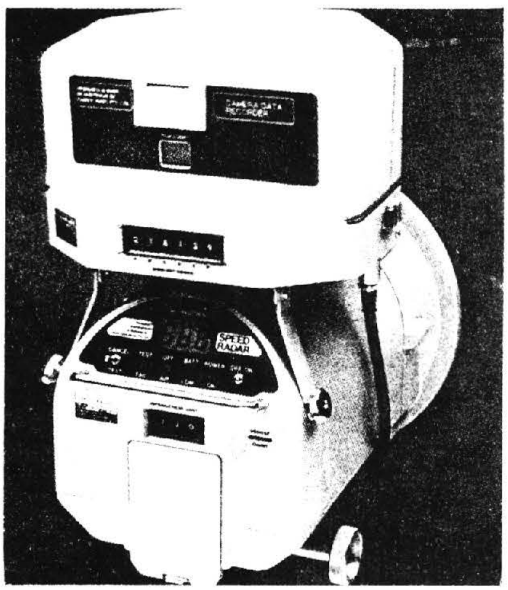


FIGURE A-2 Vehicle Speed Radar. (Courtesy of AWA Defense Industries Pty. Ltd.)

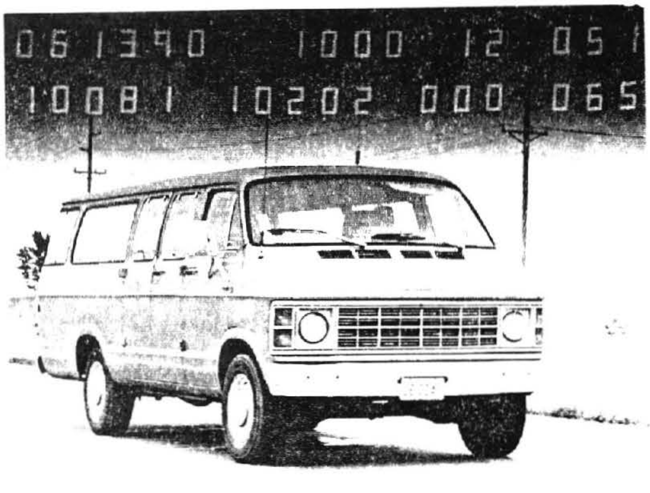


FIGURE A-3 Example of frontal photograph taken with the VSR. (Courtesy of Virginia Transportation Research Council)

Gatsometer B.V.

This firm was founded in The Netherlands in 1958 and manufactures several traffic speed detection and surveillance systems. The firm makes four speed detection systems that are divided into two groups: Gatso mini radar MK3 and MK4, and Gatso micro radar Type 24 and Type RadCam 24. The Gatso mini radar MK3 and MK4 are older units that were described in earlier studies (*1,2*). They are tripod-mounted, roadside ASE devices that use cross-the-road radar operating at 13.45 GHz. The Gatso micro radar Type 24 and Type RadCam 24 are the newest and most advanced ASE systems offered by the firm. The latter two devices are similar in their operations but differ slightly in their components. The Gatso micro radar Type 24 consists of a radar subsystem, which contains a cross-the-road radar operating at 24.125 GHz, an antenna, and a microprocessor control unit; a Robot traffic camera; a flash unit, a flash generator, and an independent electrical power supply; and a hand-held override control unit. The components of the Gatso micro radar Type RadCam 24 are the same as the Type 24, except the microprocessor control unit is somewhat different and the camera used is a motor-driven, single-lens reflex camera with a zoom lens.

When a speeding vehicle has been detected, the camera of each system (Type 24 and RadCam 24) automatically photographs the vehicle. Superimposed in the top right-hand corner of the photograph are the time, date, and speed of the offending vehicle.

The two ASE systems (Type 24 and RadCam 24) can be used for stationary, as well as moving, speed enforcement with only one officer required for each mode of operation. When used for stationary operations, these systems are either mounted on a tripod next to the roadway (see Figure A-4), built into a trailer that is located alongside the roadway, or built into a patrol car (see Figure A-5) that is positioned to monitor traffic. The systems can also be unmanned and located on a fixed installation post. In these stationary operations, the systems can be set to photograph approaching or receding vehicles, or they can be set to automatically photograph speeding vehicles in *both* approaching and receding directions of travel.

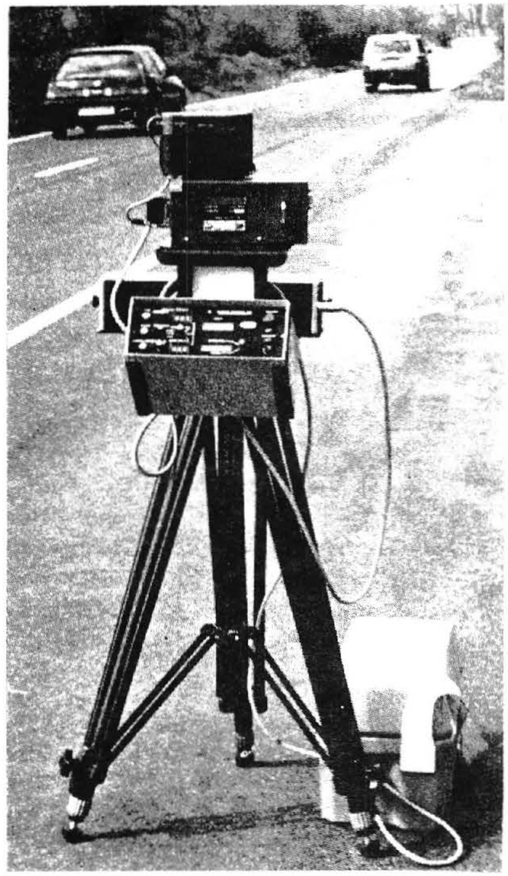


FIGURE A-4 Gatso Micro Radar Type 24 mounted on a tripod. (Courtesy of Gatsometer B.V.)

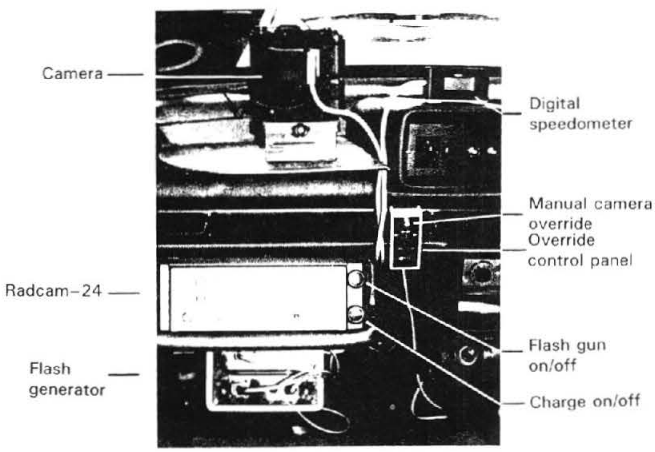


FIGURE A-5 Gatso Micro Radar Type RadCam 24 mounted in a patrol car. (Courtesy of Gatsometer B.V.)

When the systems are used for moving speed enforcement, they are referred to as mobile-radar-camera (MRC) systems. When installed in a patrol car, the antenna is either fitted behind a nonmetal engine grill or on a roof rack, while the flash is incorporated into a fog lamp. The traffic camera and the radar control unit are fitted within easy reach of the driver or in the dashboard of the patrol car. A digital speedometer is provided also with the MRC systems.

In the moving operation, the systems will automatically take rear photos of vehicles passing the patrol car at a speed above a preset limit (threshold speed). In this case, the patrol car needs to be traveling at a steady speed. The speeds of the patrol car and the overtaking vehicle are both displayed in the photo. In this situation, the speed of the patrol car is measured with a digital speedometer and the speed of the passing vehicle relative to the patrol car is measured with the onboard radar unit. The speed of the offending vehicle is the sum of the patrol car's speed plus the relative speed (also displayed on the photograph) of the passing vehicle. The systems' camera is blocked from taking photographs of approaching traffic during moving operations. The MRC systems can also be used, with a hand-held control unit, to photograph speeding vehicles during following conditions. In this case, the photos are taken by hand and show the driving speed of the patrol car and the traffic situation. Examples of photographs taken by the Gatso systems of vehicles abroad and in the United States are shown in Figures A-6 and A-7, respectively. Care must be exercised in aligning the camera so the data elements, superimposed on the photograph, do not cover the driver's face or other important details of the offending vehicle.

Both the Type 24 and RadCam 24 are capable of operating with separate speed limit settings for passenger cars and for trucks. The two speed settings can only be used when observing receding (not oncoming) traffic during either stationary or moving operations. The details of how the two speed limit settings are used in the detection logic were not revealed by the manufacturer.

An accessory is available for the Gatso speed detection devices that provides for storage of information on each vehicle detected by the radar beam. Various information on each vehicle detected, such as time, date, direction of travel, speed, range of detection, photograph number, and location codes are transferred from the computer to a memory card. The card can then be read by a reader attached to a PC for determination of various traffic information and associated traffic flow analysis.

The Gatso speed detection devices are used in many European countries, including The Netherlands, as well as in South Africa, New Zealand, Australia, and Canada. The Gatso system has been used in Folsom, California, and continues to be used in National City and Riverside, California. Units have also undergone evaluation in Washington, Michigan, and New Jersey.

In 1987, the Gatso MRC system (Type RadCam 24) was thoroughly evaluated over a 6-month period by the Nottinghamshire Constabulary Traffic Department in the United Kingdom (*4*). The Gatso MRC system was installed in an unmarked police vehicle and tested on all classes of roads and under different road, weather, and lighting conditions. No citations were issued to speeding motorists during the evaluation. The Constabulary thought the system was a reliable, robust piece of equipment. They also thought the equipment had potential for enforcement use in a variety of different road types and conditions, especially in circumstances where the use of conventional speed detection devices was not practical.

Plessey South Africa Ltd.

This company in South Africa has recently developed a prototype system designed for use in speed enforcement and speed data collection. The device, called the Plessey Dual-Antenna Speed Monitor, is currently being demonstrated to law enforcement agencies in South Africa. The system is composed of a main control unit connected to two Doppler radar units, one operating at a frequency of 24.225 GHz and the other at a frequency of 24.175 GHz. The control unit contains a microprocessor and uses digital signal processing to determine individual vehicle speeds. An RS232 port is provided for connection to a printer, remote display, computer, or camera. As of December 1992, no specific camera had been selected for use with the device.

In operation, the two antennas are deployed about 80 m (262.4 ft) apart, aimed essentially parallel to traffic flow (not cross-the-road radar), and oriented such that they "illuminate" a common or capture area as shown in Figure A-8. The capture area is typically 30 m (98.4 ft) long and two traffic lanes wide. In an attempt to minimize speed detection errors, the antennas are deployed no further than 4 m (13.1 ft) from the nearest point of vehicle travel. A speed is displayed on the main unit only when a vehicle is identified by both antennas. This only occurs when the vehicle is in the capture area. A speed measurement is held on the display for approximately 1 sec.

If vehicle speeds are to be monitored in the curb lane, the antennas need to be aimed at a point midway between the antennas and over the curbside. If two lanes are to be monitored, the antennas need to be aimed at a point midway between the antennas and in the middle of the two lanes. The unit cannot discriminate the direction of travel of the vehicles.

Sensys Traffic AB

This small, relatively young Swedish firm started about 6 years ago under the name Trafikanalys AB to develop a new-generation ASE device under an agreement with the National Swedish Police Board. The device uses down-the-road radar that is based on military radar techniques. In late summer of 1989, the firm introduced into use two systems: a manned system identified as RC 110 and a fully automatic system identified as ASTRO 110. The manned system can be installed in a patrol car, or it can be mounted on a tripod alongside a patrol car. The ASTRO 110 is usually mounted on a pole alongside the highway or on an overpass where it can monitor traffic passing underneath the overpass. From information provided by the manufacturer, it appears that both systems operate similarly. Consequently, the technical description of the systems' configuration and operation will be given for the RC 110 for convenience.

The RC 110 radar system consists of three main components: a laptop control unit, a radar antenna, and a camera system. The radar antenna and camera of the RC 110 are shown in Figure A-9a. The laptop control unit is shown in Figure A-9b and provides an internal storage of individual speeds as well as other traffic data. The unit also contains a keyboard and a diagnostic display of codes used and trouble sensed.

The radar operates at a frequency of 10.53 GHz and has an output power of 3 MW only, roughly an order of magnitude less than U.S. systems. The radar does not use the cross-the-road concept; its antenna is aligned along the direction of traffic. The radar

Stationary control of approaching traffic ▶

--	: range radar beam - = 1-2 lanes -- = 1-4 lanes
F	: front measurement
000	: own speed of the patrolcar km/h
101	: speed of the offending vehicle km/h
101	: total speed km/h
12:07:36	: time; 12 hours, 07 min. and 36 sec.
89.06.20	: date; June 20th 1989

◀ Stationary control of receding traffic

--	: range radar beam - = 1-2 lanes -- = 1-4 lanes
A	: tail measurement
000	: own speed of the patrolcar km/h
103	: speed of the offending vehicle km/h
103	: total speed km/h
12:05:21	: time; 12 hours, 05 min. and 21 sec.
89.06.20	: date; June 20th 1989

Moving control of receding traffic ▶

--	: range radar beam - = 1-2 lanes -- = 1-4 lanes
A	: tail measurement
097	: own speed km/h
075	: overtaking speed of the offending vehicle km/h
162	: total speed km/h
11:31:28	: time; 11 hours, 31 min. and 28 sec.
89.06.20	: date; June 20th 1989

Pursuing control ▲

H	: hand control
134	: speed of 134 km/h
---	: no information
---	: no information
11:40:38	: time; 11 hours, 40 min. and 38 sec.
89.06.20	: date; June 20th1989

Moving Control of receding traffic at night ▼

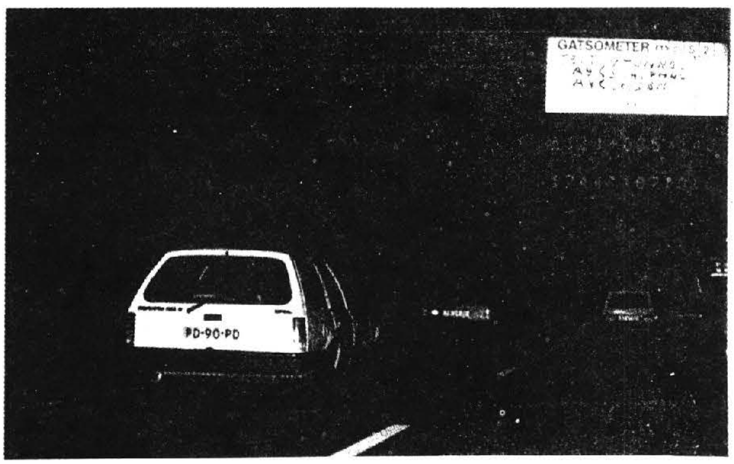


FIGURE A-6 Examples of photos taken abroad with Gatso Systems. (Courtesy of Gatsomter B.V.)

FIGURE A-7 Example of rear photograph taken with the Gatso Micro Radar Type 24. (Courtesy of Virginia Transportation Research Council)

provides full tracking of *all* vehicles between 10 and 75 m (32.8 and 246 ft) away from the radar head. The tracking can be carried out in either direction or both directions simultaneously. Up to three lanes of traffic can be continuously monitored.

The RC 110 operates in two modes. It continually monitors the presence of traffic using rapid pulse transmission. In this standby mode, it transmits a pulse every 0.5 sec to see if anything is moving. If the beam detects something moving, the device automatically switches to a full tracking mode, sending out the beam continuously. In this mode data are collected at a 32-ms rate and are analyzed by digital signal processing (DSP). This method is not new but is a conventional military technique that has now become commercially attractive because of recent developments and access to compact, low-power-consumption DSP processors.

Every vehicle detected in the measurement zone is assigned an identification number and tracked until it exits the zone. Decision-making software controls the tracking and rejects false detections. Once a vehicle is detected exceeding a preset speed limit, its speed and other identifying information are stored on a computer diskette for later analysis. If a camera is used, the offending vehicle is photographed and its speed and other information are optically recorded on the photograph. An example of a frontal photograph taken with the unit is given in Figure A-10.

The system automatically calibrates itself every 15 min. The calibration procedure can be initiated manually at any time; however, the measurement functions have priority so that real-time operation is maintained.

The device can also be used to collect and record traffic and

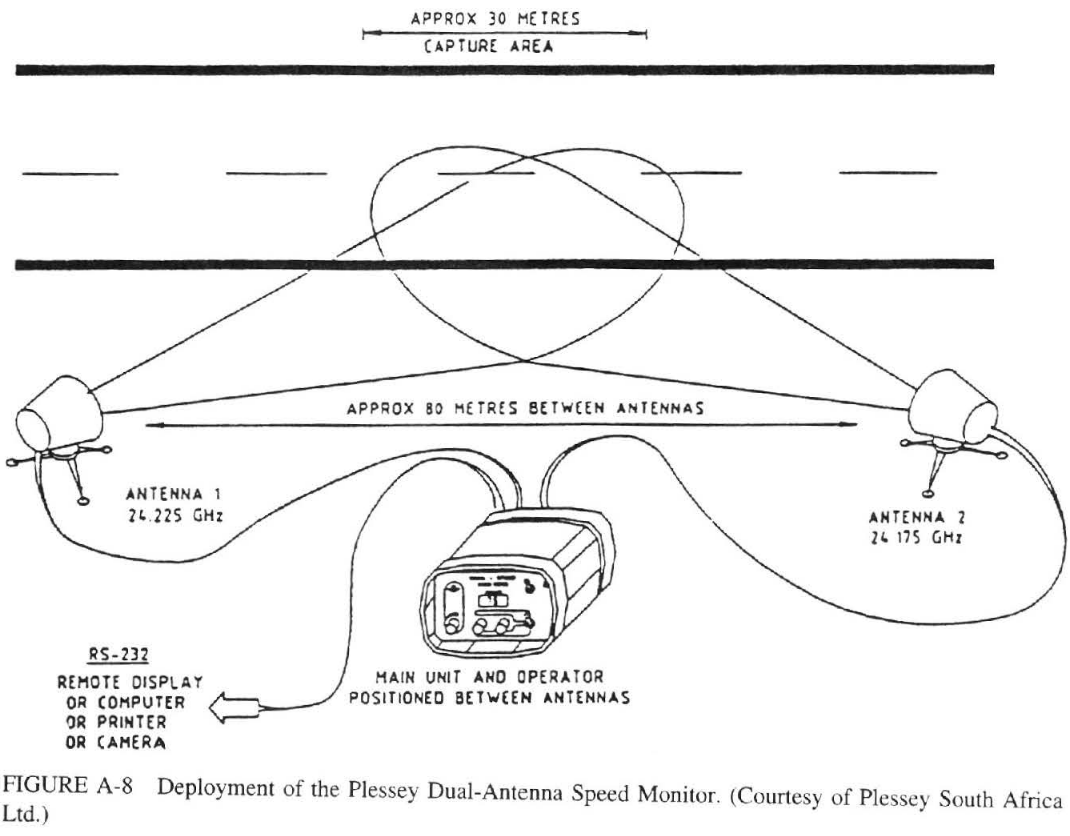
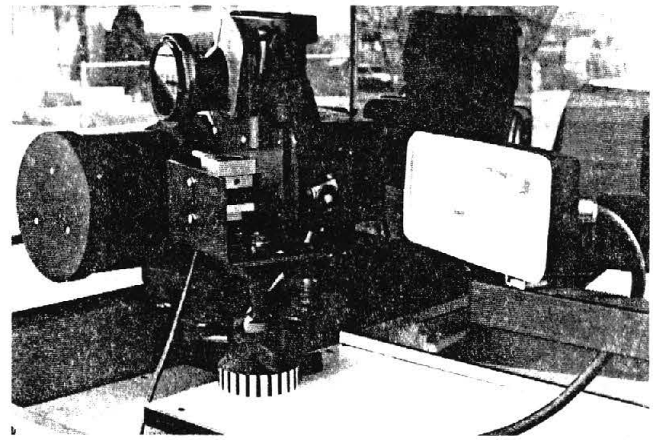


FIGURE A-8 Deployment of the Plessey Dual-Antenna Speed Monitor. (Courtesy of Plessey South Africa Ltd.)



(a)

(b)

FIGURE A-9 (a) Radar antenna and camera system of the Sensys RC 110; (b) laptop control unit of the Sensys RC 110. (Courtesy of Traffic Safety Technologies, Inc.)

speed data. These data can be gathered continuously and can be transmitted to a PC or written to a computer diskette for later analysis.

Currently, the systems are used in Sweden and the United States. The manual system is used in patrol vehicles with one or two officers in the vehicle. Two installations of the ASTRO 110 system have been operating in Stockholm for several years.

Traffipax-Vertrieb

Traffipax-Vertrieb of Germany manufactures multipurpose speed control and traffic surveillance devices. This German firm is a subsidiary of Robot Foto und Electronic, a company best known for its photographic systems. Traffipax-Vertrieb has manufactured several models of speed control devices over the years. The Radar Micro Speed 09 was the model they marketed until recently, when they introduced the Speedophot.

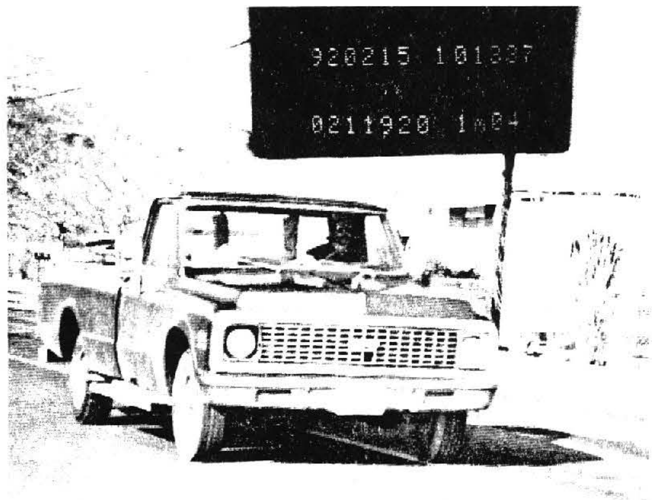


FIGURE A-10 Example of frontal photograph taken with the Sensys RC 110. (Courtesy of Traffic Safety Technologies, Inc.)

The Speedophot consists of a cross-the-road Doppler radar unit that transmits at a frequency of 24.125 GHz, coupled with a Robot recorder camera, a flash unit and generator, a control unit, and a battery power supply. This device can be mounted in a patrol car (see Figure A-11a) for either stationary or moving operation or on a tripod (see Figure A-11b) for stationary operation alongside the roadway.

For a vehicle-mounted configuration, the radar antenna can be located behind the grille of the car, which should be parked parallel to the roadway. The control unit and flash generator can be installed in the trunk of the car, and only the camera with the integrated control box is attached to the dashboard. For stationary use on a tripod, the radar antenna is positioned at a right angle to the road, and the camera, flash, and control unit are placed in a compact, easily moved arrangement with only the power supply separately attached. For mobile use in moving traffic, the unit switches automatically from stationary radar operation to moving radar or speed detection using pacing techniques and the vehicle's tachometer output.

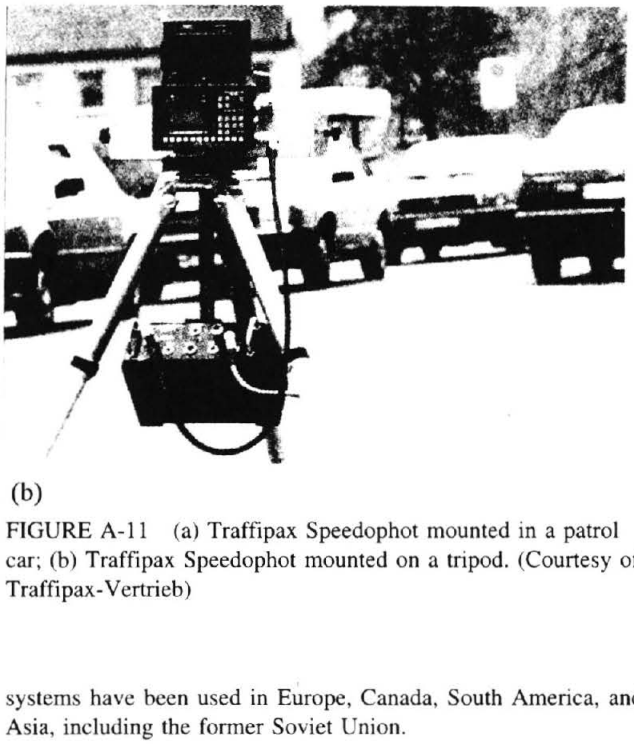
The photographic data displayed by the system include the offending vehicle, detected speed, adjusted range of radar, measured traffic direction, time, a seven-digit code, a frame counter, and the mode of operation.

The operating range of the radar extends from one to four lanes and the radar beam has a 5° width. The equipment can be used either manually or automatically. The device can measure departing or approaching traffic with a manual or automatic switchover. For departing traffic, a separate speed limit can be set for passenger cars and for trucks. No details are provided by the manufacturer on how trucks are identified separately from passenger cars. For oncoming traffic, only one speed limit setting can be used for all vehicles. See Figure A-12 for an example of rear a photograph taken with the Traffipax Speedophot.

Traffipax-Vertrieb is now including in some of its equipment the technology to transfer all of the data recorded on a fully exposed 30-m roll of film (800 exposures) automatically onto a data medium called a memory card.

The manufacturer states that its speed control and surveillance

(a)



(b)

FIGURE A-11 (a) Traffipax Speedophot mounted in a patrol car; (b) Traffipax Speedophot mounted on a tripod. (Courtesy of Traffipax-Vertrieb)

systems have been used in Europe, Canada, South America, and Asia, including the former Soviet Union.

Zellweger Uster AG

Zellweger Uster AG, with headquarters outside of Zurich, Switzerland, is perhaps the most well-known manufacturer of cross-the-road radar systems. These systems have been used by law enforcement agencies in more than 30 countries, including the United States, and some of the company's systems have been in operation for many years.

Zellweger Uster AG has produced several speed detection devices over the last 20 years and a number of these were described in several reports (*1,2*). Their latest ASE device is called the Multanova 6F (*3*).

The Multanova 6F consists of a cross-the-road Doppler radar unit with a transmission frequency of 34.3 GHz, coupled with either a Jacknau recording camera or a Robot camera, a flash unit, a control unit, a hand-held operating unit, and a battery power supply. If required, the control unit can be provided with a standard

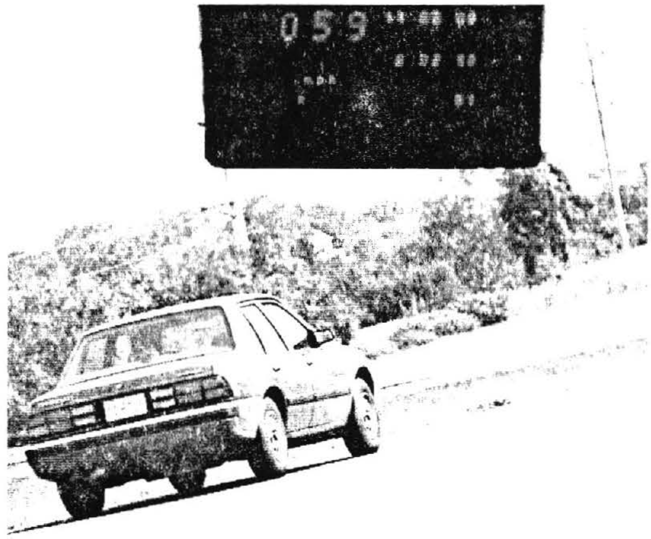


FIGURE A-12 Example of rear photograph taken with the Traffipax Speedophot. (Courtesy of Virginia Transportation Research Council)

RS232 interface for connection to commercial peripheral equipment such as a printer, mass storage unit, or large display panel. Other sensors can be used instead of the radar antenna, such as light barriers or tachometer generators.

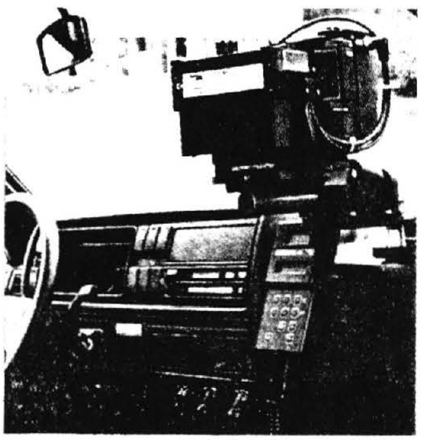
The Multanova 6F can be mounted in a patrol car (see Figure A-13a) for stationary operations or on a tripod (see Figure A-13b) for operations alongside the roadway. The device can also be mounted in a fixed enclosure on a bridge and overlooking a specific lane of traffic passing underneath the bridge.

The radar signal generated from the approaching or departing vehicle is transferred to the control unit, where it is amplified, filtered, and converted into a series of pulses. The direction of travel of the vehicle is determined immediately such that if the signals are part of the receding traffic, then only signals from the receding traffic are fed into the computer during the remainder of the current measurement. Likewise, if the signal is from the approaching traffic, only signals from the approaching traffic are fed into the computer during the remainder of the current measurement. The computer continuously evaluates the Doppler signal checking for a portion of a vehicle that has a uniform length of at least 25.4 cm (10 in.). If a uniform section is found, the frequencies are averaged over the section length and converted into a speed value, which is displayed on the operating unit. As soon as the speed is determined, a verification process is automatically begun. If verification is successful, the measured speed value is transferred to the photo of the detected vehicle along with the date, time, and a description of the site (see Figure A-14). Measurements that cannot be definitely allocated to the vehicle measured are canceled automatically. If several vehicles are recorded on the photograph, a transparent template of the beam pattern can be overlaid on the photograph to permit definite determination of the vehicle measured.

The operating range of the radar extends from one to three lanes and the radar beam has a width of 5°. The equipment can be used either manually or automatically. The device can measure oncoming or departing traffic either selectively or simultaneously. For oncoming traffic, only one speed limit setting can be used for all vehicles. However, for departing traffic, a separate speed limit can be set for passenger cars and for trucks. Any vehicle in the near lanes that supplies a consistent return Doppler signal for a time period equivalent to at least 12 m (39.4 ft) of travel is automatically defined as a truck. It is possible for a car in a lane far removed from the radar unit, where the beam is wider, to produce a consistent return Doppler signal for a long enough time period such that it is evaluated as a truck. In this situation, a review of the photograph would reveal otherwise.

In comparison with older units produced by Zellweger Uster AG, the Multanova 6F represents several innovations. The radar antenna is much smaller than previous antennas and has a good beam concentration. The other components are also much smaller and of lighter weight than before. The radar signals are now tracked and checked by a digital computer in the central control unit. The operation of all of the equipment attached to the central control unit (radar antenna, camera, flash, and printer if necessary) is controlled and displayed on the small hand-held operating unit.

Several vendors in the United States package the Multanova 6F in the rear of a four-wheel vehicle and lease the detection equipment and vehicle for a service fee. These mobile ASE units have been used by law enforcement agencies in Arizona (Paradise Valley), California (Campbell, Danville, Pasadena, and Roseville), and Utah (Garland, Huntington, and Wellington).



(a)

(b)

FIGURE A-13 (a) Multanova 6F mounted in a patrol car; (b) Multanova 6F mounted on a tripod. (Courtesy of Zellweger Uster Ltd.)

Eltraff S.r.l.

This Italian firm manufactures a nonradar ASE device called the Velomatic 103A Speed Meter that is used only in Italy under that government's certification. The Velomatic speed detection device has three main components, which can be mounted inside a patrol car (see Figure A-15) or externally on a tripod. The three components are a control and calculator unit with built-in printer, a sensor, and a photographic system. Two types of sensors can be used with the device: an optoelectronic sensor or a capacitive sensor. The optoelectronic sensing unit appears to be used basically for speed measurement and is very similar to the one made by Elcos in Vienna, Austria about 13 years ago (*1,2*).

The operating principle of the device is based on measuring the time interval taken by a vehicle to pass over a fixed distance of 1,204 mm (47 in.) between a pair of sensors. The optoelectronic sensors are aimed directly across the roadway. Each sensor is entirely passive; no beam of any kind is emitted. Consequently, the unit does not require reflectors on the opposite side of the roadway.

As a vehicle passes in front of one of the optoelectronic sensors, the amount of light detected by the sensor changes in some fashion. If the second sensor experiences the same pattern of change an

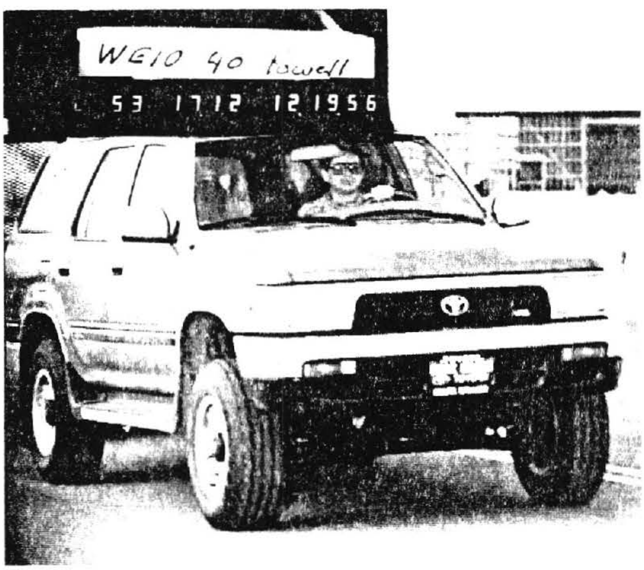


FIGURE A-14 Example of frontal photograph taken with the Multanova 6F. (Courtesy of Traffic Safety Technologies, Inc.)

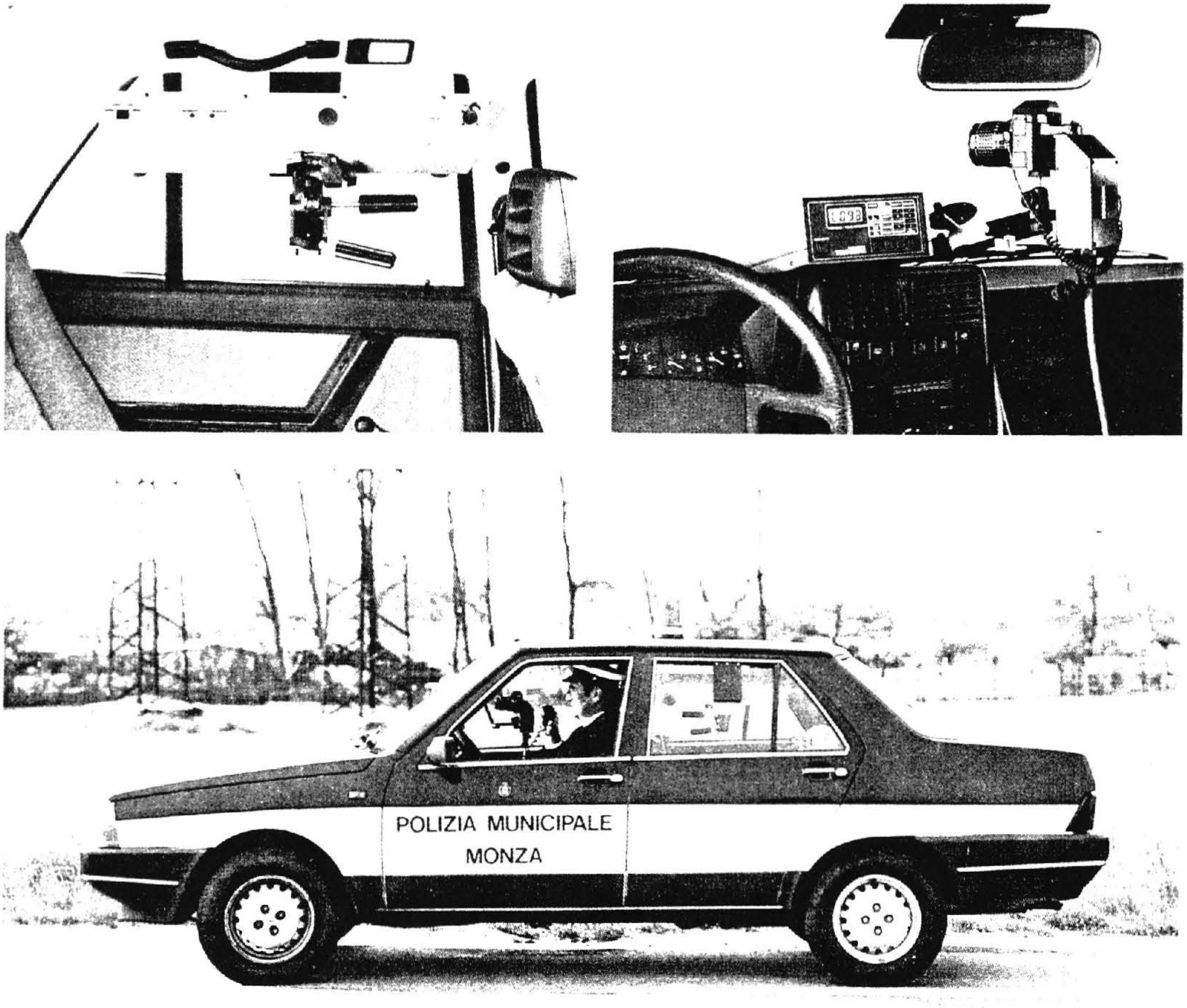


FIGURE A-15 Velomatic 103A mounted in a patrol car. (Courtesy of Eltraff S.r.l.)

instant later, the system logic determines the time lag between them and, hence, the vehicle speed.

Some degree of flexibility is provided to the operator of the system during speed enforcement. The operator can select the direction of traffic to monitor without moving the sensor but by simply using a switch. The device can be set up to selectively monitor trucks by training the optoelectronic sensors upward. Also, the sensors can be directed downward so that they detect only vehicles in an adjacent lane.

The Velomatic device is a computer-based system that can be connected to a computer modem. In addition, the device is equipped with a printer to provide instantaneous printouts of detections. The system is powered by a rechargeable battery with a capacity of 20 hr of operation.

The camera that can be used with the Velomatic is set to photograph the rear of offending vehicles when they are 16 m (52.5 ft) downstream of the camera. The photograph taken shows the date, time of day, location, and speed of the violation (see Figure A-16). An optional flash is available for nighttime usage.

The Velomatic can also be used to collect vehicle count data and will provide a printed output every 10 min of the number of vehicles passing the sensors plus an accumulated total since the count began. With the aid of a small accessory and either coaxial cables or inductive loops, the Velomatic can be used to detect

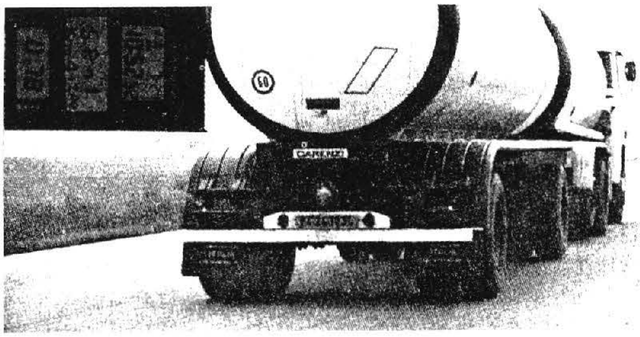


FIGURE A-16 Example of rear photograph taken with the Velomatic 103A System. (Courtesy of Eltraff S.r.l.)

and photograph red-light violations. This version of the device is described later in this section.

Proof Digitalsystemer A/S

This Danish firm has supplied vehicle-mounted speed measurement devices for more than 13 years to law enforcement agencies in Denmark, other Scandinavian countries, and various other European countries. Since 1978, more than 1,500 police vehicles in Europe have been fitted with Proof Digitalsystemer devices.

This company manufactures the ProViDa/PDRS system, which was developed in close cooperation with the Danish National Police. ProViDa stands for Proof Video Data, and PDRS stands for Police Data Recording System. This ASE device is a vehicle-mounted, computerized video/data system and is used to monitor traffic and determine vehicle speeds from time and distance measurements.

The ProViDa/PDRS system consists of five major components: 1) a color video camera, 2) a video/data generator with data/time unit, 3) a PolicePilot speed indicator with data outlet, 4) a ProofSpeed precision speedometer, and 5) a mobile VHS video recorder with a 4 1/2-in. color monitor. Several of the system's components are shown in Figure A-17.

The PolicePilot unit contains two stopwatches, two trip counters, two computation circuits, and an additional control circuit. Time and distance are measured by the stopwatches and trip counters, respectively, which are activated by switches on the PolicePilot.

The device is used either in a pacing strategy or when the patrol vehicle is stationary. During a pacing operation, the stopwatches and trip counters are activated by the patrol officer. When the stopwatches and trip counters are stopped, the time and distance data are measured. These data are then transferred automatically to the computer part of the unit, where the speed of the offending vehicle is calculated and the result is transferred to the display area of the PolicePilot and to the video/data generator. The video/data generator transforms these digital signals to video signals, which are combined with the video signals from the camera and imported to the video recorder. The speed of the police vehicle, determined by the electronic precision speedometer, is also added to the video recording.

The distance unit has an automatic function into which a premeasured distance can be coded. This enables the operator in a parked car to time passing vehicles. When the timing unit is stopped, the speed of a target vehicle is calculated automatically and sent to the video recorder along with the video signals from the camera.

Trans-Atlantic Equipment Pty. Ltd.

This company in Johannesburg, South Africa manufactures the Speed-Guard DeLuxe Model 3000 and the Trafficam Speed Camera, which may be combined to form an ASE device. The sensors used by the Trafficam Speed Camera are pencil-thin rubber tubes permanently installed 2.5 m (8.2 ft) apart in any road surface and connected by cable to 6-V DC transducers. The Speed-Guard apparatus is built into a portable, lightweight, durable, water-resistant aluminum case (see Figure A-18) and contains a microprocessor, built-in rechargeable batteries, and a charger. The Trafficam Speed Camera module used in conjunction with the Speed-Guard sensors records the event of a vehicle traveling in excess of a preset speed limit stored within the Speed-Guard. A rear photograph is taken of the offending vehicle and shows the vehicle's license number, date, time, and speed.

The equipment can be operated automatically in any direction and has been accepted by the Supreme Court of South Africa for use in that country.

Truvelo Manufacturers

This German firm manufactures the Truvelo M4^2 and the Truvelo Combi systems. The Truvelo M4^2 speed measuring device is a time/distance measurement system that uses two sets of roadway cables placed parallel to each other (two fully independent measuring systems in parallel). Coaxial microphone cables are used for portable operations where the cables are roadway surface-mounted. Piezoelectric detector cables are installed into the road surface at fixed locations. In both cases, the distance between two detectors is kept at 1.5 m (5 ft). The control system of the Truvelo M4^2 is housed in a portable attaché case (see Figure A-19). This unit contains a solid-state microprocessor with a digital display, a warning buzzer for vehicles traveling faster than the preset speed limit, an electronic vehicle counter, built-in rechargeable 12-V DC battery, built-in battery charger, and attachments for connection to the Truvelo camera and flash system and/or a Truvelo remote printer. The Truvelo Combi consists of the M4^2 device mounted within the camera housing.

The Truvelo M4^2 makes two simultaneous time/distance measurements using the two sets of roadway cables. The measurements are converted into speeds by the microprocessor in the instrument. The speeds are then compared and, if they agree to within 2 km/h, are accepted and are displayed on the digital readout. Otherwise, they are automatically rejected. The camera and flash system are activated whenever a vehicle is detected traveling faster than the preset speed limit.

The Truvelo camera system permits photographs to be taken from either behind or in front of the vehicle. Frontal photography is accomplished by using the Truvelo red filter flash. The photograph shows the offending vehicle plus data associated with the speed violation, which includes the time, date, location code, and two speed values (see Figure A-20.)

Both systems can be operated totally automatically and can be either tripod-mounted along the roadway or installed in a fixed

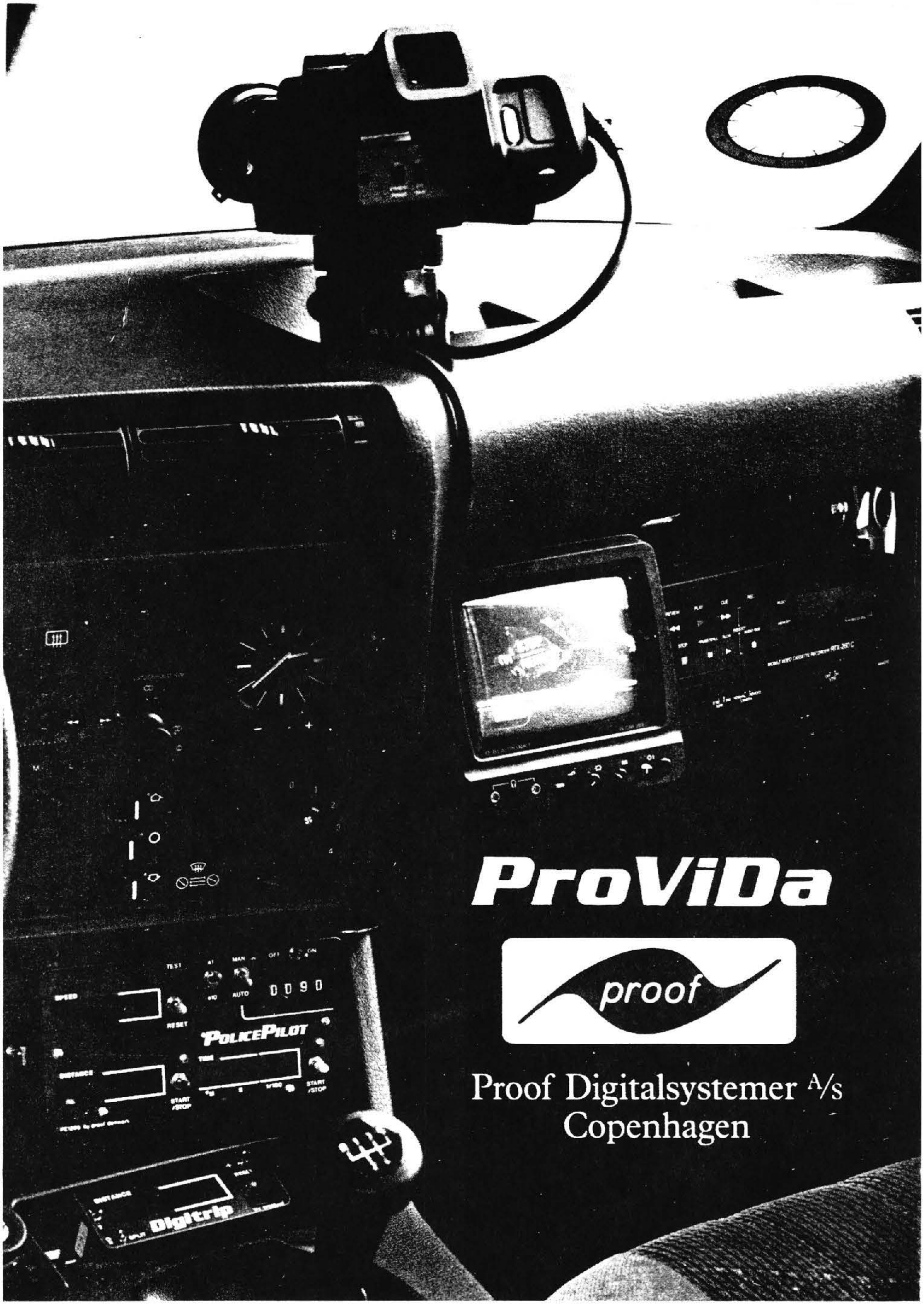


FIGURE A-17 ProViDa/PDRS System installed in a vehicle. (Courtesy of Proof Digitalsystemer A/S)

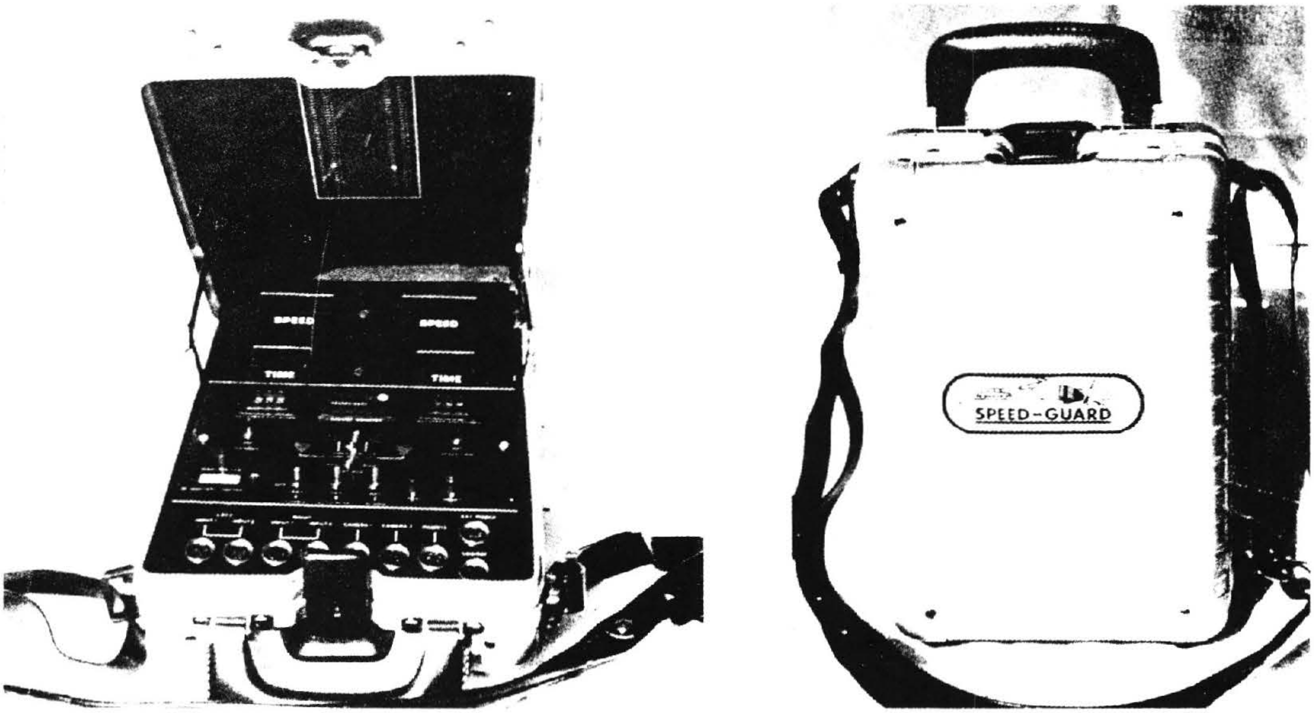


FIGURE A-18 Speed-Guard control unit. (Courtesy of Trans-Atlantic Equipment Pty. Ltd.)

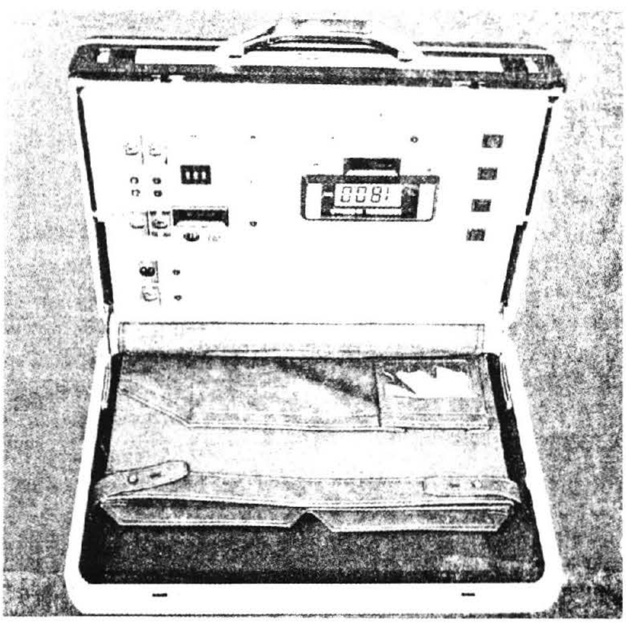


FIGURE A-19 Truvelo M4^2 speed measuring device. (Courtesy of Truvelo Manufacturers)

enclosure. The Truvelo systems are used, under approval, in Germany, Austria, and South Africa.

Descriptions of Red-Light Violation Detection Equipment

Vehicles that run a traffic light represent a potentially dangerous traffic safety problem. This unsafe driving behavior can result in serious crashes that involve other vehicles and/or pedestrians. The detection of red-light violations by enforcement officers can be a very labor-intensive effort with little impact. The monitoring and detection of red-light violations are well suited for automated enforcement technology.

Six manufacturers were identified during the study as producing red-light violation detection systems. The six manufacturers also produce ASE equipment that is described in the preceding section. The six red-light violation systems (more than six if the various models of each manufacturer are counted) use roadway sensors (inductive loops, cables, or tubes) for vehicle detection and 35-mm cameras to record photographic evidence of the violation. The six systems are discussed below in alphabetical order of the manufacturer's name. In these descriptions the term "red-light violation detection" is abbreviated as RLC (red-light camera).

Eltraff S.r.l.

This Italian firm produces accessories for its Velomatic 103A Speed Meter that convert the unit from an ASE device to one that documents traffic light offenses. The RLC system consists of a control and calculator unit; a photographic unit, including flash; roadway sensors; and a photocell unit. The control and calculator unit and photographic unit are the same as are used in the Speed Meter version of the device. Either a coaxial cable laid on the pavement surface or an inductive loop embedded in the pavement surface is used to detect the passage of traffic relative to the red-light phase of the traffic signal. A coaxial cable is used for mobile operations while the inductive loop is used for fixed installations. The cable or loop is installed downstream of the stop line. A special photocell fixed on the traffic signal is used to record the state of the traffic lights.

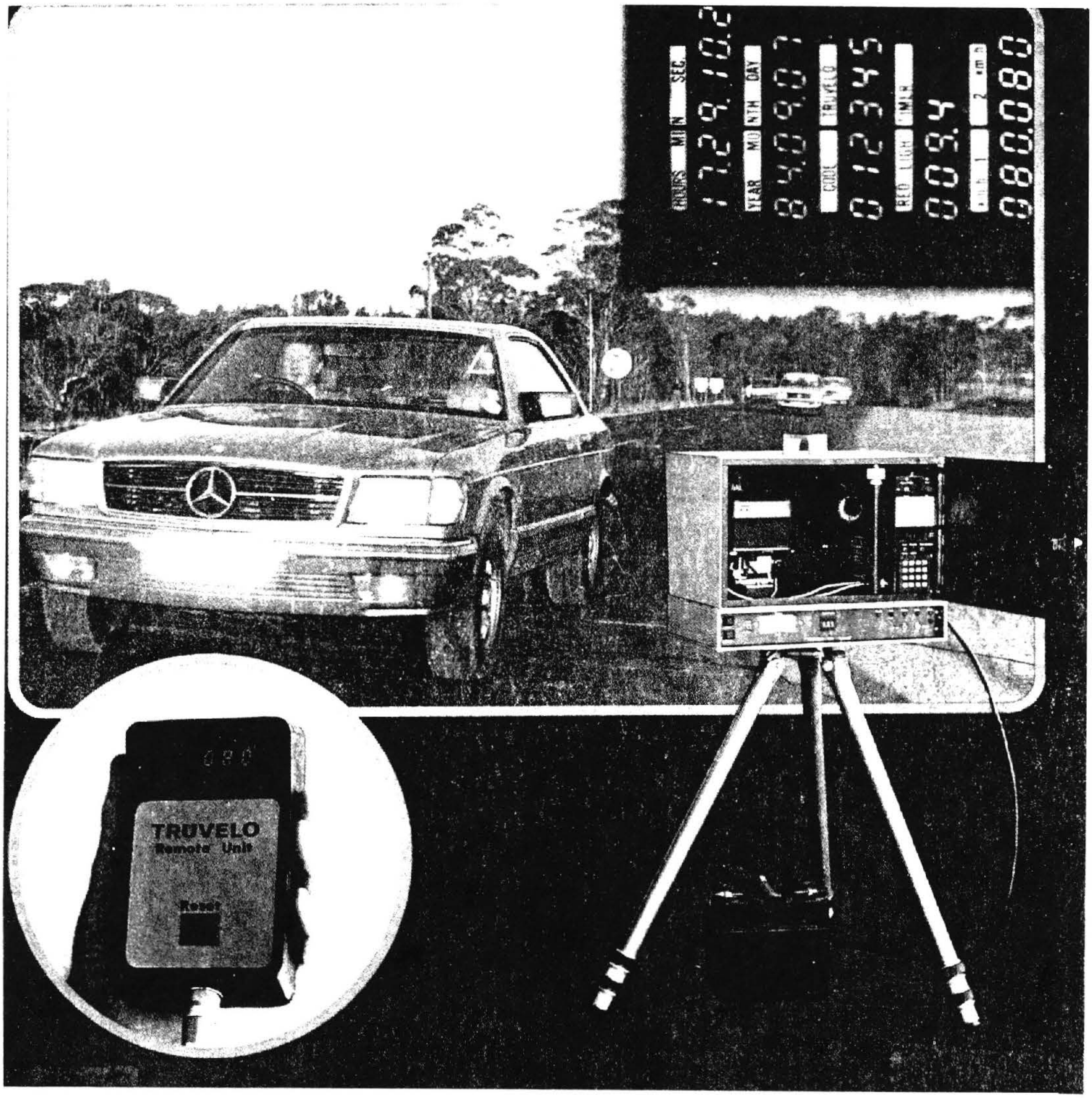


FIGURE A-20 Example of frontal photograph taken by Truvelo Combi System. (Courtesy of Truvelo Manufacturers)

In operation, the camera will photograph the rear of a vehicle detected crossing the roadway sensor whenever the red-light is on. A second rear photograph will be automatically taken 1.5 sec after the first photograph. The information shown on photographs includes a rear view of the vehicle; the traffic light; the time, in tenths of a second, that has elapsed since the traffic light has changed to red; the date; the time; and a hand-written location description. An example of the two photographs taken of a red-light offense is shown in Figure A-21. The minimum interval between two offending vehicles is 1.3 sec.

Gatsometer B.V.

This Dutch firm produces four models of RLC systems designated as RLC Type 36-m, Type 36-4m, Type 36-ms, and Type 36-msg. The four systems differ in their capabilities, but all have the same basic three components: a control unit, a photographic unit (including flash), and a set of roadway sensors (inductive loops). The control and photographic units are installed in a double-walled stainless steel cabinet that is mounted on top of a hinged pole positioned alongside the roadway. The

FIGURE A-21 Example of photographs taken with the Velomatic 103A Red-Light Violation Detection System. (Courtesy of Eltraff S.r.l.)

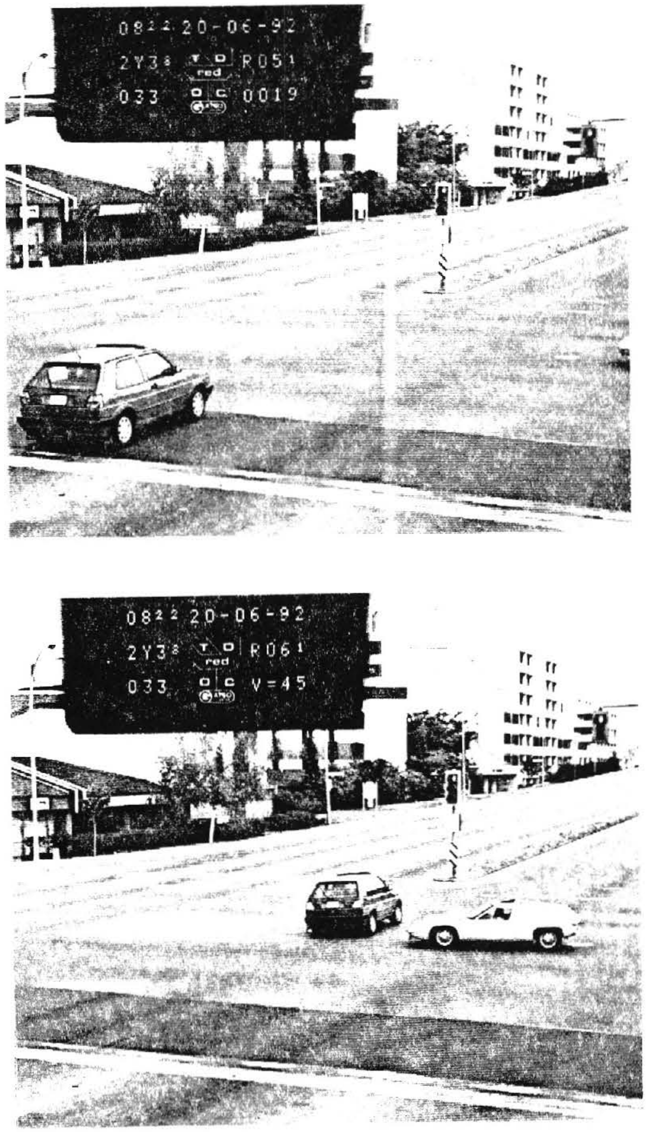


FIGURE A-22 Example of Photographs Taken with the Gatsometer RLC Type 36-ms. (Courtesy of U.S. Public Technologies, Inc.)

hinged pole allows one person to change the camera's film magazine without the need for a ladder. The inductive loops are installed downstream of the stop line and are connected, along with buried power and signal phase lines from the traffic lights, to the control unit.

The configuration of the roadway sensors is determined by the model type. RLC Type 36-m uses one loop per lane and can monitor red-light violations in either one or two lanes of receding traffic. RLC Type 36-4m uses one loop per lane and can monitor red-light violations in one to four lanes of receding traffic. RLC Type 36-ms uses two loops per lane and can record the speed of every red-light offender detected in either one or two lanes of receding traffic. RLC Type 36-msg also uses two loops per lane and can detect speeding vehicles, independent of the traffic light phase, as well as red-light violations in either one or two lanes of receding traffic.

Two rear photographs are taken of each vehicle detected of a red-light or speeding violation (see Figure A-22). The time interval between the first and second photograph is adjustable, with the minimum interval being 0.8 sec. The data shown on the first photograph include the time, date, traffic lane, amber light elapse time in tenths of a second, red-light elapse time in tenths of a second, offense number, and location code number. The type of data shown on the second photograph is the same as shown on the first photograph for RLC Types 36-m and 36-4m. With RLC Types 36-ms and 36-msg, the vehicle speed is recorded on the second photograph in the space allocated for the location code number.

The Gatsometer RLC Type 36-ms was field-tested under the general direction of the Nottinghamshire Constabulary in the United Kingdom over an 11-week period, beginning the middle of December 1987 (*5*). Two intersections in Nottingham were used in the field tests. Vehicles violating the red-light phase were photographed for 7 of the 11 weeks. The first phase of the two-phase study was conducted by the Planning and Transportation unit of Nottingham, which publicized the use of the detection equipment and monitored the violation rate over the testing period. The second phase was a prosecution period and was operated by the Nottinghamshire Constabulary.

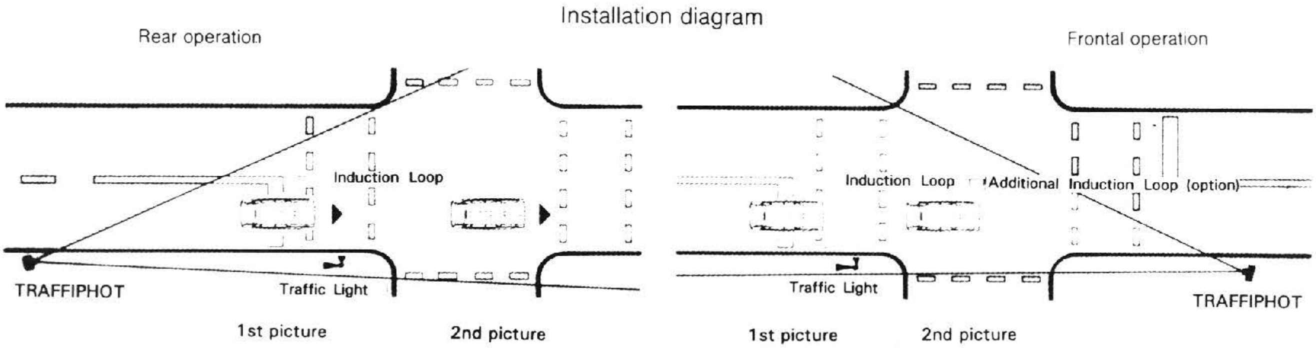


FIGURE A-23 Installation diagram for taking rear and frontal photographs with the Traffiphot III System. (Courtesy of Traffipax-Vertrieb)

Videotape recordings were taken at both intersections prior to the installation of the equipment. Thirty-nine hours of video recording were used for the analysis of driver behavior prior to the installation of the signal-activated camera. The videotaping of the intersections was continued after the activation of the detection camera and was used in the analysis of the RLC system. A 64 percent drop in the frequency of red-light violations before and after installation was noted at one intersection, and a 57 percent drop was noted at the other intersection (*5*). The police felt that publicizing the presence of the RLC system proved effective in reducing red-light violations.

In August 1992, a Gatsometer RLC system was installed at an intersection in Jackson, Michigan. Only warning letters were issued to motorists detected running the red light. It is not known what impact the warnings had on the accident experience at the intersection.

Traffipax-Vertrieb

This German firm manufactures an RLC system designated as Traffiphot III. This fully automatic system consists of a control unit, a photographic unit including flash, and roadway sensors (inductive loops). The control and photographic units are installed in a weatherproof enclosure that is mounted on a steel pipe mast positioned alongside the roadway. The control and photographic units can be removed as a single assembly from the enclosure for insertion into other enclosures. This modular design permits the use of a single control and photographic unit for several intersections on a rotational basis. Simultaneous monitoring of up to three lanes of traffic with different red-light phases and varying red-start times is possible.

An automatic aperture control device is provided with the camera. An integrated flash is switched on automatically in low light conditions. The camera can be adapted to a range of photographic conditions by means of an adjustable flash capacity of 100 to 300 Ws.

The system can be installed to take either rear or frontal photographs. An installation diagram for each operation is given in Figure A-23.

The system is triggered by a vehicle crossing the induction loop located immediately downstream of the stop line during the red phase. Two photographs are taken of the violation. The time between the two exposures can be set between 0.5 and 5 sec. Digital data are recorded on two lines on the upper margin of both photographs and include the time, date, a code location number, the red-light elapse time to the nearest one-hundredth of a second, the violation number, and either an A or B for the first or second exposures of the sequence.

When frontal photographs are taken, the Traffiphot is equipped with red filters in front of the flash reflector and camera lens. The red flash illuminates the inside of the car without blinding the driver. A red sensitive black-and-white film has to be used in this case. Also for frontal photographs, the second photograph can be taken independently from the present exposure interval when the vehicle crosses an additional induction loop in the intersection. This optional inductive loop ensures that vehicles are always recorded in a preset position, thus providing a clear identification of the driver.

An option with the equipment is a memory card that preserves automatically all digital data recorded on the film. These data can be analyzed separately and used to select photos from which only the license plate needs to be manually recorded.

This system was field tested at an intersection in New York City during an RLC demonstration project between January 1988 and early 1989.

Trans-Atlantic Equipment Pty. Ltd.

This South African firm manufactures a portable RLC system called the Trafficam. The components of the Trafficam system are roadway rubber tube sensors, a photographic unit including flash, a control unit, and a rechargeable power supply. The pencil-thin rubber tubes are stretched across the surface of one or two lanes and downstream of a stop line. The tubes are placed 2.5 m (8.2 ft) apart and are connected to 6 VDC transducers, which in turn are connected to the control unit. The control unit and power supply are housed in a portable case that rests on the ground and alongside the roadway. The camera and flash are housed in a cabinet mounted on a pole which is attached to the portable case. The system is connected to the red-light phase.

One or two rear photographs are taken of each vehicle detected of a red-light violation. The second photograph, if required, is taken 0.5 sec after the first. The time and date of the offense, the violating vehicle, and the traffic signal are displayed in the photograph(s). The exposure time for the photograph(s) is automatically determined from prevailing light conditions.

Truvelo Manufacturers

This German firm produces a red-light violation module that can be incorporated into the control unit of the Truvelo Combi system converting it from an ASE to an RLC system. The RLC version of the Combi system can be either tripod mounted alongside the roadway or it can be installed in a weather- and vandal-proof enclosure that is mounted on top of a fixed pole alongside the roadway.

The tripod and fixed installation configurations differ somewhat. For the tripod installation, one piezoelectric cable is placed across the stop line of the intersection and a photocell detector is clipped onto the housing of the red-light. The moment the red light comes on, the detector cable is activated. A vehicle crossing the stop line (and piezoelectric cable) during the red-light phase will trigger the camera and two photographs will be taken. The second photograph will be used to determine if the vehicle progressed further into the intersection during the red-light phase. For a fixed installation, the control unit is connected to an inductive loop embedded in the roadway surface at the stop line. The red-light status is picked off directly from the traffic light controller at the intersection. The inductive loop and camera activation for the fixed installation is accomplished the same way as for the tripod installation.

The photographs taken of the red-light violation show the offending vehicle and the traffic light plus data, which include the time, date, location code, and the red-light elapse time.

Zellweger Uster AG

This Swiss firm manufactures an RLC system called MULTAFOT. This fully automatic system consists of an operating control unit, a photographic unit including flash, and roadway sensors (inductive loops). The control and photographic units are installed in a weather- and vandal-proof cabinet that is mounted on a steel pipe mast positioned alongside the roadway. The control and photographic units can be moved from one cabinet to another because of the plug-in type of connections. Special mounting poles are available that provide for the raising and lowering of the cabinet by electric motor for convenience of film changing and equipment maintenance.

The loop detectors are installed in the pavement surface either just upstream or downstream of the stop line depending on the intersection configuration. A variety of loop configurations can be used so that simultaneous surveillance is possible of up to three separately signalized traffic lanes with different red-light phases and varying red start times. The loop detectors are connected to the system, which in turn is connected to the controller for the signal system.

The RLC system can be installed to take either rear or frontal photographs.

The RLC system is synchronized with the red-light phase(s) of the traffic control system. When a vehicle is detected by the pavement loop during the red-light phase, the camera is activated and two photographs are taken. The first photograph is taken when the camera receives a signal from the loop detector. The second photograph is taken at a preset time interval after the first that can be adjusted between 0.5 and 2 sec in increments of 0.1 sec.

The system will register and provide photographic documentation on any number of successive offenders. If a subsequent red-light violation is detected between the first and second photographs of a preceding violation, the photo sequence will be extended by a third picture. This sequence can be repeated numerous times.

The camera's aperture and electronic flash are automatically controlled to match the prevailing light conditions. In addition, the electronic flash has two energy levels: 300 and 150 Ws. The flash can automatically switch the power level between photographs. For instance, the higher level is used when the vehicle is furthest away from the camera (first photo for frontal photographs and second photo to rear photographs) and the lower level is used when the vehicle is closest to the camera.

The photographs show the scene at the intersection and various digital data, which data include the time, date, red-light elapse time to the nearest tenth of a second for each controlled traffic light(s) (up to three), number of registered violations, photograph number, and location code number. An example of the digital data recorded on a rear photograph is shown in Figure A-24.

When frontal photographs are taken, the red light is not visible automatically in the photographic sequence as it is for rear photographs. The red light illuminated at the time of the frontal photograph can be captured photographically with a fiber optic element. Light taken directly from the properly illuminated red signal can be captured and routed via a fiber optic line to a position in the picture where its location is in full view of the camera and will not detract from the effort to view the license plates of the offending vehicles.

The system has been field-tested in two U.S. cities. It was tested at an intersection in New York City during an RLC demonstration project between January 1988 and early 1989. The system was also field-tested at two intersections in Pasadena, California during the first half of 1989.

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1. Glauz, W.D., and R.R. Blackburn, *Technology for Use in "Automated" Speed Enforcement*, Report No. DOT-HS-805454, National Highway Traffic Safety Administration, Washington, D.C., June 1980.
2. Blackburn, R.R., and W.D. Glauz, *Pilot Tests of Automated Speed Enforcement Devices and Procedures*, Report No. DOT-HS-806573, National Highway Traffic Safety Administration, Washington, D.C., February 1984.
3. Blackburn, R.R., R. Moran, and W.D. Glauz, *Update of Enforcement Technology and Speed Measurement Devices*, Report No. DOT-HS-807584, National Highway Traffic Safety Administration, Washington, D.C., December 1989.
4. Pierce, R., and R.P. Milliken, *Evaluation of the Gatso Mobile Radar Speed Detection Device*, Nottinghamshire Constabulary, United Kingdom, October 1987.
5. *Gatso Traffic Light Camera*, Nottinghamshire Constabulary, United Kingdom, 1988.

FIGURE A-24 Example of rear photograph taken with Multafot. (Courtesy of Zellweger Uster)

APPENDIX B

SUMMARY OF PROPOSED LEGISLATION

A summary is given in this Appendix of proposed legislation in six states (Michigan, Utah, Oregon, California, Maryland, and Virginia) concerning the use of ASE. Sections of the Uniform Vehicle Code are also discussed.

Proposed Statute—Michigan

Section 1. Section 742 of Act No. 300 of the Public Act of 1949, as amended by Act No. 89 of the public Acts of 1989, being section 257.742 of the Michigan Compiled Laws, is amended and section 631a is added to read as follows:

Section 631A. (1) A PHOTOGRAPH IS ADMISSIBLE AS EVIDENCE OF A SPEEDING VIOLATION OCCURRING ON THE MACKINAC BRIDGE OR IN A DESIGNATED WORK AREA IF ALL OF THE FOLLOWING CIRCUMSTANCES EXIST:

(A) THE PHOTOGRAPH SHOWS ON ITS FACE THE SPEED OF THE VEHICLE AND THE TIME, DATE, AND LOCATION OF THE VIOLATION.

(B) THE PHOTOGRAPH IS TAKEN BY AN ELECTRICAL OR MECHANICAL DEVICE OPERATING UNDER STANDARDS SET BY THE DEPARTMENT OF STATE POLICE.

(C) THE OPERATOR OF THE CAMERA ESTABLISHES THAT THE DEVICE WAS OPERATING PROPERLY AT THE TIME THE PHOTOGRAPH WAS TAKEN.

(2) A PHOTOGRAPH THAT DOES NOT SATISFY THE REQUIREMENTS OF SUBSECTION (1) IS ADMISSIBLE AS EVIDENCE OF A VIOLATION OF A LAW OF THIS STATE AS OTHERWISE PROVIDED BY A LAW OF THIS STATE OR BY A RULE OF THE COURT.

(3) IN A PROSECUTION FOR SPEEDING BASED UPON EVIDENCE OBTAINED PURSUANT TO SUBSECTION (1), IT IS A REBUTTABLE PRESUMPTION THAT THE REGISTERED OWNER OF THE MOTOR VEHICLE WAS OPERATING THE MOTOR VEHICLE AT THE TIME AND IN THE PLACE THE VIOLATION OCCURRED.

(4) THE DEPARTMENT OF STATE POLICE SHALL PROMULGATE RULES ESTABLISHING STANDARDS FOR THE USE AND OPERATION OF PHOTOGRAPHIC DEVICES FOR PURPOSES OF SUBSECTION (1)(B).

(5) AS USED IN THIS SECTION, "MACKINAC BRIDGE" MEANS "BRIDGE" AS DEFINED IN SECTION 1 OF ACT NO. 21 OF THE PUBLIC ACTS OF THE EXTRA SESSION OF 1950, BEING SECTION 254.301 OF THE MICHIGAN COMPILED LAWS.

(6) AS USED IN THIS SECTION, DESIGNATED WORK AREA MEANS AN AREA WHERE A NORMAL LANE OR PART OF A LANE HAS BEEN CLOSED DUE TO HIGHWAY CONSTRUCTION, MAINTENANCE, OR SURVEYING ACTIVITIES.

Sec. 742. (1) A police officer who witnesses a person violating this act or a local ordinance substantially corresponding to this act, which violation is a civil infraction, may stop the person, detain the person temporarily for purposes of making a record of vehicle check, and prepare and subscribe, as soon as possible and as completely as possible, an original and 3 copies of a written citation, which shall be a notice to appear in court for one or more civil infractions. If a police officer of a village, city, township, or county, or a police officer who is an authorized agent of a county road commission, witnesses a person violating this act or local ordinance substantially corresponding to this act within that village, city township, or county and that violation is a civil infraction, that police officer may pursue, stop, and detain the person outside the village, city, township, or county where the violation occurred for the purpose of exercising that authority and performing the duties prescribed in this section and section 749, as applicable.

(2) A POLICE OFFICER OF THE MACKINAC BRIDGE AUTHORITY WHO WITNESSES A PERSON VIOLATING THIS ACT ON THE BRIDGE, WHICH VIOLATION IS A CIVIL INFRACTION, MAY STOP THE PERSON, DETAIN THE PERSON TEMPORARILY FOR PURPOSES OF MAKING A RECORD OF VEHICLE CHECK, AND PREPARE AND SUBSCRIBE AS SOON AS POSSIBLE AND AS COMPLETELY AS POSSIBLE AN ORIGINAL AND 3 COPIES OF A WRITTEN CITATION, WHICH SHALL BE A NOTICE TO APPEAR IN COURT FOR ONE OR MORE CIVIL INFRACTIONS. IF A POLICE OFFICER OF THE MACKINAC BRIDGE AUTHORITY WITNESSES A PERSON VIOLATING THIS ACT ON THE BRIDGE AND THAT VIOLATION IS A CIVIL INFRACTION, THAT POLICE OFFICER MAY PURSUE, STOP, AND DETAIN THAT PERSON OFF OF THE BRIDGE FOR THE PURPOSE OF EXERCISING THE AUTHORITY AND PERFORMING THE DUTIES PRESCRIBED IN THIS SECTION AND SECTION 749, AS APPLICABLE.

(3) Any police officer, having reason to believe that the load, weight, height, length, or width of a vehicle or load are in violation of section 717, 719, 719a, 722, 724, 725, or 726 which violation is a civil infraction, may investigate, weigh, or measure the vehicle or load. If, after personally investigating, weighing, or measuring the vehicle or load, the officer determines that the load, weight, height, length, or width of the vehicle or load are in violation of section 717,719, 719a, 722, 724, 725, or 726, the officer may temporarily detain the driver of the vehicle for purposes of making a record or vehicle check and issue a citation to the driver of owner of the vehicle as provided in those sections.

(4) A police officer may issue a citation to a person who is a driver of a motor vehicle involved in an accident when, based upon personal investigation, the officer has reasonable cause to believe that the person is responsible for a civil infraction in connection with the accident. A police officer may issue a citation to a person who is a driver of a motor vehicle when, based on personal

investigation by the police officer of a complaint by someone who witnessed the person violating this act or a local ordinance substantially corresponding to this act, which violation is a civil infraction, the officer has reasonable cause to believe that the person is responsible for a civil infraction and if the prosecuting attorney or attorney for the political subdivision approves in writing the issuance of the citation.

(5) A certified police officer may issue a citation to a person by first-class mail for a speeding violation occurring on the bridge or designated work area if evidence of the violation is obtained pursuant to Section 631A. The citation shall be mailed to the person not later that two days after the date of the citation. A citation issued under this subsection shall be processed in the same manner as a citation issued personally to a defendant pursuant to subsection (2).

(6) The form of a citation issued under subsection (1), (2), (3), OR (4) shall be as prescribed in sections 727c and 743.

(7) The officer shall inform the person of the alleged civil infraction or infractions and shall deliver the third copy of the citation to the alleged offender.

(8) In a civil infraction action involving the parking or standing of a motor vehicle, a copy of the citation need not be served personally upon the defendant but may be served upon the registered owner by attaching the copy to the vehicle. A city may authorize personnel other than a police officer to issue and serve a citation for a violation of its ordinance involving the parking or standing of a motor vehicle. A city may authorize a person other than personnel or a police officer to issue and serve a citation for a violation of an ordinance pertaining to handicapped parking if the city has complied with the requirements of section 675d. State security personnel receiving authorization under section 6c of Act No. 59 of the Public Acts of 1935, being section 28.6c of the Michigan Compiled Laws, may issue and serve citations for violations involving the parking of standing of vehicles on land owned by the state or land of which the state is the lessee when authorized to do so by the director of the department of state police.

(9) If a parking violation notice other than a citation is attached to a motor vehicle, and if an admission of responsibility is not made and the civil fine and costs, if any, prescribed by ordinance for the violation are not paid at the parking violations bureau, a citation may be filed with the court described in section 741(4) and a copy of the citation may be served by first-class mail upon the registered owner of the vehicle at the owner's last known address. A parking violation notice may be issued by a police officer, including a limited duty officer,or other personnel duly authorized by the city, village, township, college, or university to issue such a notice under its ordinance. The citation filed with the court pursuant to this subsection need not comply in all particulars with sections 727c and 743 but shall consist of a sworn complaint containing the allegations stated in the parking violation notice and shall fairly inform the defendant how to respond to the citation.

(10) A citation issued under the subsection (6) or (7) for a parking or standing violation shall be processed in the same manner as a citation issued personally to a defendant pursuant to subsection (1) or (3).

(11) As used in THIS SECTION:

(A) "BRIDGE" MEANS THAT TERM AS DEFINED IN SECTION ONE OF ACT NO. 21 OF THE PUBLIC ACTS OF THE EXTRA SESSION OF 1950, BEING SECTION 254.301 OF THE MICHIGAN COMPILED LAWS.

(B) "Parking violation notice" means a notice, other than citation, directing a person to appear at a parking violations bureau in the city, village, or township in which, or of the college or university for which, the notice is issued and to pay the fine and costs, if any, prescribed by ordinance for the parking or standing of a motor vehicle in violation of the ordinance.

(C) "Parking violations bureau" means a parking violations bureau established pursuant to section 8395 of the revised judicature act of 1961, Act No. 236 of the Public Acts of 1961, as amended, being section 600.8395 of the Michigan Complied Laws, the violations bureau established within the traffic and ordinance division of the recorder's court of the city of Detroit, or a comparable parking violations bureau established in a city or village served by a municipal court or established pursuant to law by the governing board of a state university or college.

Section 2. This amendatory act shall not take effect unless Senate Bill No. ________ or House Bill No. 6287 (Request No. 04987'90) of the 85th Legislature is enacted into law.

Proposed Statute (SB# 59)—Utah

Section 1 Section 41-6-52.5, Utah Code Annotated 1953, is enacted to read:

41-6-52.5 **Photo radar — Restrictions on use.**

(1) "Photo radar" means a device used primarily for highway speed limit enforcement substantially consisting of a low doppler radar unit and camera mounted in or on a vehicle, which automatically produces a photograph of a vehicle traveling in excess of the legal speed limit, with the vehicle's speed, the date, time of day, and location of the violation printed on the photograph.

(2) Photo radar may not be used except:

(a) (i) In school zones; or
 (ii) In other areas where speed related incidents have been documented by a law enforcement agency;
(b) When a peace officer is present with the photo radar unit;
(c) When signs are posted on the highway providing notice to a motorist that photo radar may be used; and
(d) When use of photo radar by a local authority is approved by the local authority's governing body.

(3) The restrictions under Subsection (2) on the use of photo radar do not apply when the information gathered is used for highway safety research or to issue warning citations not involving a fine, court appearance, or a person's driving record.

(4) A contract or agreement regarding the purchase, lease, rental, or use of photo radar by the department or by a local authority may not specify any condition for issuing a citation.

(5) The department and any local authority using photo radar, upon request, shall make the following information available for public inspection during regular office hours:

(a) The terms of any contract regarding the purchase, lease, rental, or use of photo radar;
(b) The total fine revenue generated by using photo radar;
(c) The number of citations issued by the use of photo radar; and
(d) The amount paid to the person providing the photo radar unit.

Proposed Statute (SB #764)—Oregon

SECTION 1 ORS 810.420
810.420 (1) When the speed of a vehicle has been checked by radiomicrowaves or other electrical device, the driver of the vehicle may be stopped, detained, and issued a citation by a police officer if the officer is in uniform and has either:

(a) Observed the recording of the speed of the vehicle by the radiomicrowaves or other electrical device; or
(b) Probable cause to detain based upon a description of the vehicle or other information received from the officer who has observed the speed of the vehicle recorded.

(2) When the speed of a vehicle has been recorded by radiomicrowaves or other electrical device and the driver and registration number of the vehicle have been photographed at the same time, a citation may be delivered to the registered owner of the vehicle in person or by mail addressed to the owner's last-known address.

Proposed Statute (SB #824)—California

Definition
SECTION 1. Section 471 is added to the Vehicle Code, to read:
471. "Photo radar" is a device used to enforce any speed limit which utilizes radar or any other electronic device which measures the speed of a moving vehicle, takes a photograph of the vehicle, and has superimposed upon the photograph the speed of the photographed vehicle in miles per hour, as determined by the radar or other electronic device.
Amendments would be made to Section 40802 of the Vehicle Code, as amended by Section 1 of Chapter 833 of the Statutes of 1986.

Proposed Statute—State of Maryland

AN ACT concerning

Vehicle Laws—Photo-Radar Devices—Speeding Citations

For the purpose of requiring a police officer who, based on evidence obtained by means of a photo-radar device, has probable cause to believe that the driver of a vehicle has exceeded the posted speed limit, to mail a citation to the registered owner of the vehicle and to keep a copy of the citation; charging the registered owner, lessee, or identified driver of the vehicle with violation of this Act; providing that certain requirements relating to the signing of a citation by the person charged do not apply to a citation issued under this Act; defining a certain term; making stylistic changes; and generally relating to the issuance of citations for speeding based on evidence obtained by photo-radar devices.

SECTION 1. BE IT ENACTED BY THE GENERAL ASSEMBLY OF MARYLAND, That the Laws of Maryland read as follows:

21-807

In each charge of a violation of any speed regulation under the Maryland Vehicle Law, the charging document shall specify:

(1) The speed at which the defendant is alleged to have driven;
(2) If the charge is for exceeding a maximum lawful speed, the maximum speed limit applicable at the location; and
(3) If the charge is for driving below a minimum lawful speed, the minimum speed limit applicable at the location.

26-201

(a) A police officer may charge a person with a violation of any of the following, if the officer has probable cause to believe that the person has committed or is committing the violation:

(1) The Maryland Vehicle Law, including any rule or regulation adopted under any of its provisions;
(2) A traffic law or ordinance of any local authority;
(3) Title 9, Subtitle w of the Tax—General Article;
(4) Title 9, Subtitle 3 of the Tax—General Article.

(b) A police officer who charges a person under this section, except for a violation of Title 21, Subtitle 8 of this article detected by a "photo-radar device," shall issue a written traffic citation to the person charged. A written traffic citation shall be issued by the police officer or authorized representative of any other state agency or contractor designated by the State for any violation of Title 21, Subtitle 8 of this article detected by a "photo-radar device" as described in this section.
(c) A traffic citation issued to a person under this section shall contain:

(1) A notice to appear in court;
(2) The name and address of the person;
(3) The number of the person's license to drive, if applicable;
(4) The State registration number of the vehicle, if applicable;
(5) The violation charged;
(6) Unless otherwise to be determined by the court, the time when and place where the person is required to appear in court;
(7) A statement acknowledging receipt of the citation, to be signed by the person;
(8) On the side of the citation to be signed by the person a clear and conspicuous statement that;
(i) The signing of the citation by the person does not constitute an admission of guilt; and
(ii) The failure to sign may subject the person to arrest; and
(9) Any other necessary information.

(d) Unless the person charged demands an earlier hearing, a time specified in the notice to appear shall be at least 5 days after the alleged violation.
(e) A place specified in the notice to appear shall be before a judge of the District Court, as specified in Sec. 26-401 of this title.
(f) An officer who discovers a vehicle stopped, standing, or parked in violation of Sec. 21-1003 of this article shall:

(1) Deliver a citation to the driver or, if the vehicle is unattended, attach a citation to the vehicle in a conspicuous place; and
(2) Keep a copy of the citation, bearing [his] the officer's certification under penalty of perjury that the facts stated in the citation are true.

(g) (1) A law enforcement officer who discovers a motor vehicle parked in violation of Sec. 13-402 of this article shall:

(i) Deliver a citation to the driver or, if the motor vehicle is unattended, attach a citation to the motor vehicle in a conspicuous place; and

(ii) Keep a copy of the citation, bearing the law enforcement officer's certification under penalty of perjury that the facts stated in the citation are true.

(2) In the absence of the driver, the owner of the motor vehicle is presumed to be the person receiving the citation or warning.

(h) (1) The Maryland State Police are authorized to use "photo-radar" technology on the Maryland portion of the Capital Beltway (I-495) and I-95 for the purpose of detecting speeding violations. The authorization will expire July 1, 1994, unless re-enacted prior to that date.

(2) In this subsection, "Photo-Radar device" means a device that:

(i) Uses radiomicrowaves to measure and indicate the speed of a moving object; and

(ii) Photographs the moving object for which speed is being measured.

(3) Photographs by a photo-radar device must be of the vehicle's registration plate and of the driver of the vehicle and must be of sufficient quality to identify the driver of the vehicle.

(4) Such photographs shall be accepted as prima facie evidence of the speed of the motor vehicle in any court or legal proceeding under this section where the speed of the motor vehicle is at issue provided that the police officer or authorized representative of any other state agency or contractor designated by the State who activated the equipment shall testify as to the placement of the camera and the accuracy of the scene depicted.

(5) A person is in violation of Title 21, Subtitle 8, of this article if the person is the registered owner of the lessee of the vehicle driven in excess of the posted speed limit. In the case of leased or rented vehicles, the companies holding title to such vehicles shall inform the police, under authority of Sec. 18-103(d), as to the identity of the lessee.

(6) It shall be an affirmative defense to a violation of Title 21, Subtitle 8 of this article if the registered owner or the lessee of the photographed vehicle identifies another person who drove the vehicle at the time of the violation or that the vehicle was stolen or used by an unauthorized person at the time of the violation.

(7) In the event that the registered owner or lessee of the photographed vehicle identifies the person who drove the vehicle at the time of the violation of Title 21, Subtitle 8 of this article, that person will be charged with driving the vehicle in excess of the posted speed limit.

(8) If a police officer or authorized representative of any other state agency or contractor designated by the State, based on photographic evidence obtained by means of Photo-Radar Device, has probable cause to believe that a vehicle has been driven in violation of Title 21, Subtitle 8 of this article by being driven in excess of the posted speed limit, the police officer or any other state agency or contractor designated by the State shall:

(i) Promptly send a citation by certified mail to the registered owner or lessee of the vehicle charging the registered owner or lessee with the violation or promptly send a citation by certified mail to the identified driver of the vehicle charging the identified driver with the violation in the event that the registered owner or lessee of the vehicle identifies the person who was driving the vehicle at the time of the violation; and

(ii) Keep a copy of the citation, bearing the police officer's certification under penalty of perjury that the facts stated in the citation are true.

(9) A person charged with violation of this section who does not elect to contest the charge must sign the citation and return it along with any fines that the State assesses for violation of Title 21, Subtitle 8 of this article. If a person wishes to contest a charge for violation of Title 21, Subtitle 8 of this article, that person must sign the citation and appear in court at the time and place designated in the citation.

(10) Signs to indicate the use of photo-radar devices for measuring speed shall be clearly posted along the Capitol Beltway at locations selected by the Department of Transportation Commissioner.

(11) The penalties for violations under this section shall be as prescribed under the Schedule of Pre-set Fines and/or Penalty Deposits set out in Sec. 21, Subsect. 801.1.

26-203

(a) This section applies to all traffic citations issued under this subtitle, unless:

(1) The person otherwise is being arrested under Sec. 26-202 (a) (1), (2), (3) or (4) of this subtitle;
(2) The person is incapacitated or otherwise unable to comply with the provisions of this sections;
(3) The citation is being issued to an unattended vehicle in violation of Sec. 21-1003 of this article; or
(4) The citation is being issued to an unattended motor vehicle in violation of Sec. 13-402 of this article; or
(5) The citation is being issued by certified mail to the registered owner, lessee, or identified driver of a vehicle in accordance with Sec. 26-201(h) of this subtitle.

(b) On issuing a traffic citation, except a traffic citation issued by certified mail to the registered owner, lessor, or identified driver of a vehicle in accordance with Sec. 26-201(h) of this subtitle, the police officer shall request the person to sign the statement on the citation acknowledging its receipt. If the person refuses to sign, the police officer shall advise the person that failure to sign may lead to the person's arrest.

(c) On being advised that failure to sign may lead to his arrest, the person may not refuse to sign. If the person continues to refuse to sign, the police officer may arrest the person for violation of this section or, as provided in Sec. 26-202(a)(5) of this subtitle, for the original charge, or both.

(d) If a person acknowledging receipt of a citation through certified mail refuses to sign the citation, the issuing authority shall advise the person that failure to sign may lead to the person's arrest. On being advised that failure to sign may lead to his arrest, the person may not refuse to sign. If the person continues to refuse to sign, the police officer may arrest the person for violation of this section, as provided in Sec. 26-202(a)(5) of this subtitle, for the original charge, or both.

Proposed Statute—Virginia

Sec. 46.2-882.1 Presumption that registered owner is driver; summons by mail.

A. In the prosecution of an offense of exceeding the posted speed limit, or of reckless driving in violation of Sec. 46.2-862, proof that the vehicle described in the summons was operated in excess of the posted speed limit, together with proof that the defendant was at the time of such violation the registered owner of the vehicle, shall constitute in evidence a rebuttable presumption that such registered owner of the vehicle was the person who committed the violation. Such rebuttable presumption shall not arise when the registered owner of the vehicle is a rental or leasing company.

B. Notwithstanding the provisions of Sec. 19.2-76, whenever a summons for operating a motor vehicle in excess of the posted speed limit, or for reckless driving in violation of Sec. 46.2-862, is served in any county, city, or town, it may be executed by mailing by first-class mail a copy thereof to the address of the owner of the vehicle as shown on the records of the Department of Motor Vehicles. If summoned person fails to appear on the date of return set out in the summons mailed pursuant to this section, the summons shall be executed in the manner set out in Sec. 19.2-76.3. No proceedings for contempt or arrest of a person summoned by mailing shall be instituted for his failing to appear on the return date of the summons.

Uniform Vehicle Code Sections

The Uniform Vehicle Code does not currently have specific legislation which would permit the use of automated speed enforcement.

ARTICLE VIII—SPEED RESTRICTIONS

§ 11-801—Basic rule

No person shall drive a vehicle at a speed greater than is reasonable and prudent under the conditions and having regard to the actual and potential hazards then existing. Consistent with the foregoing, every person shall drive at a safe and appropriate speed when approaching and crossing an intersection or railroad grade crossing, when approaching and going around a curve, when approaching a hill crest, when traveling upon any narrow or winding roadway, and when special hazards exist with respect to pedestrians or other traffic or by reason of weather or highway conditions (REVISED, 1968).

§ 11-802—Maximum limits

Except when a special hazard exists that requires lower speed for compliance with § 11-801, the limits hereinafter specified or established as hereinafter authorized shall be maximum lawful speeds, and no person shall drive a vehicle at a speed in excess of such maximum limits.

1. Thirty miles per hour in any urban district;
2. Fifty-five miles per hour in other locations.

The maximum speed limits set forth in this section may be altered as authorized in §§ 11-803 and 11-804 (SECTION REVISED, 1975; RENUMBERED, 1986).

§ 11-803—Establishment of State speed zones

Whenever the (State highway commission) shall determine upon the basis of an engineering and traffic investigation that any maximum speed hereinbefore set forth is greater or less than is reasonable or safe under the conditions found to exist at any intersection or other place or upon any part of the State highway system, said (commission) may determine and declare a reasonable and safe maximum limit thereat, which shall be effective when appropriate signs giving notice thereof are erected. Such a maximum speed limit may be declared to be effective at all times or at such times as are indicated upon the said signs; and differing limits may be established for different times of day, different types of vehicles, varying weather conditions, and other factors bearing on safe speeds, which shall be effective when posted upon appropriate fixed or variable signs (REVISED, 1962; RENUMBERED, 1986).

§ 11-804—When local authorities may and shall alter maximum limits

(a) Whenever local authorities in their respective jurisdictions determine on the basis of an engineering and traffic investigation that the maximum speed permitted under this article is greater or less than is reasonable and safe under the conditions found to exist upon a highway or part of a highway, the local authority may determine and declare a reasonable and safe maximum limit thereon which:

1. Decreases the limit at intersections; or
2. Increases the limit within an urban district but not to more than 55 miles per hour; or (REVISED, 1975)
3. Decreases the limit outside an urban district, but not to less than 35 miles per hour.

(b) Local authorities in their respective jurisdictions shall determine by an engineering and traffic investigation the proper maximum speed for all arterial streets and shall declare a reasonable and safe maximum limit thereon which may be greater or less than the maximum speed permitted under this act for an urban district.
(c) Any altered limit established as hereinabove authorized shall be effective at all times or during hours of darkness or at other times as may be determined when appropriate signs giving notice thereof are erected upon such street or highway.
(d) Any alteration of maximum limits on State highways or extensions thereof in a municipality by local authorities shall not be effective until such alteration has been approved by the (State highway commission).
(e) Not more than six such alterations as hereinabove authorized shall be made per mile along a street or highway, except in the case of reduced limits at intersections, and the difference between adjacent limits shall not be more than 10 miles per hour (SECTION REVISED, 1956; RENUMBERED, 1986).

§ 11-805—Minimum speed regulation

(a) No person shall drive a motor vehicle at such a slow speed as to impede the normal and reasonable movement of traffic except when reduced speed is necessary for safe operation or in compliance with law.
(b) Whenever the (State highway commission) or local authorities within their respective jurisdictions determine on the basis of an engineering and traffic investigation that slow speeds on any highway or part of a highway impede the normal and reasonable move-

ment of traffic, the (commission) or such local authority may determine and declare a minimum speed limit below which no person shall drive a vehicle except when necessary for safe operation or in compliance with law and that limit shall be effective when posted upon appropriate fixed or variable signs (REVISED, 1971; RENUMBERED, 1986).

APPENDIX C

OUTLINE OF A LAW PERMITTING PHOTOGRAPHIC ENFORCEMENT OF TRAFFIC LAWS

This example is provided as a research service. It does not purport to furnish legal advice or assistance. Each enacting state must be careful to assure that any law drafted is consistent with the rules, regulations, and laws of the state. Legal decisions on specific issues may vary from jurisdiction to jurisdiction. This outline provides a general synopsis of a photo traffic law.

A. Definition
xx "Photo radar" means a device used primarily for highway speed limit enforcement substantially consisting of a low Doppler radar unit and camera mounted in or on a vehicle, which automatically produces a photograph of a vehicle traveling in excess of the legal speed limit, with the vehicle's speed, the date, time of day, and location of the violation printed on the photograph.

B. Any restrictive use should be included within the draft
xx Photo radar may not be used except:

(a) (i) in school zones; or
(ii) etc.

(b) when a police officer is present with the photo radar unit; (If officer is not present, certain evidentiary and related legal issues may pose a problem for your state. Drafter should carefully research state law to determine which appropriate additional provisions are necessary.)

(c) when signs are posted on the highway providing notice to a motorist that photo radar may be used; and

(d) when use of photo radar by a local authority is approved by the local authority's governing body and certifying authority.

(e) etc.

C. Description of photographic evidence
xx Photographs by a photo radar device must be of the vehicle's registration plate and of the driver of the vehicle and must be of sufficient quality to identify the driver of the vehicle.

D. Prima facie evidence of speed
Such photographs shall be accepted as prima facie evidence of the speed of the motor vehicle in any court or legal proceeding under this section where the speed of the motor vehicle is at issue provided that the police office or authorized representative of any other state agency or contractor designated by the State who activated the equipment shall testify as to the placement of the camera and the accuracy of the scene depicted.

E. Rebuttable presumption that registered owner is driver
xx In the prosecution of an offense exceeding the posted speed limit (or of reckless driving or related traffic law violation), proof that the vehicle described in the summons was operated in excess of the posted speed limit, together with proof that the defendant was at the time of such violation the registered owner of the vehicle, shall constitute in evidence a rebuttable presumption that such registered owner of the vehicle was the person who committed the violation. Such rebuttable presumption shall not arise when the registered owner of the vehicle is a rental or leasing company.

F. Provisions for summons by mail
Whenever a summons for operating a vehicle in excess of the posted speed limit, or for (specified traffic violation), is served in any county, city, or town, it may be executed by mailing by first-class mail a copy thereof to the address of the owner of the vehicle as shown on the records of the Department. If summoned person fails to appear on the date of return set out in the summons mailed pursuant to this section, the summons shall be executed in the manner set out in (appropriate section) of the state law. No proceedings for contempt or arrest of a person summoned by mailing shall be instituted for his failing to appear on the return date of the summons.

G. Penalty provisions
Specific penalty or fine provisions may be included in this section.

DUE DATE	DUE DATE

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