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16. Abstract

Law enforcement is considered an important contributor for maintaining traffic safety. However, limited resources, such as staff and funds, constrain the efforts of police in traffic law enforcement. New technologies such as automated enforcement may offer a partial solution to this problem. Information on automated enforcement devices currently being used in the areas of speed enforcement, red-light traffic signal enforcement, and high-occupancy vehicle (HOV) lane enforcement is provided in the report through summaries and discussions of current technology, experiences in the use of automated enforcement devices, legal issues, and public acceptance of automated enforcement. Examples of experiences include the use of portable billboard speed displays in Richardson, Texas, and Glendale, Arizona, as well as the use of automated speed enforcement devices in Arlington, Texas; Galveston County and LaMarque, Texas; Paradise Valley, Arizona; Pasadena, California; and Peoria, Arizona. Automated HOV lane enforcement experiences from Virginia, California, and Seattle, Washington, and red-light enforcement in Pasadena, California, and New York City are also discussed. Legal issues associated with automated enforcement include photographing of the driver, mailing the citation to the owner of the photographed vehicle, and requiring the owner of the vehicle to identify the driver at the time of the offense.

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A REVIEW OF AUTOMATED ENFORCEMENT

by

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Research Report 1232-5

Research Study No. 2-18-90/4-1232
Urban Highway Operations Research and Implementation Program

Texas Transportation Institute
The Texas A&M University System
College Station, Texas 77843

Prepared for the

Texas Department of Transportation

November 1991

METRIC (SI*) CONVERSION FACTORS

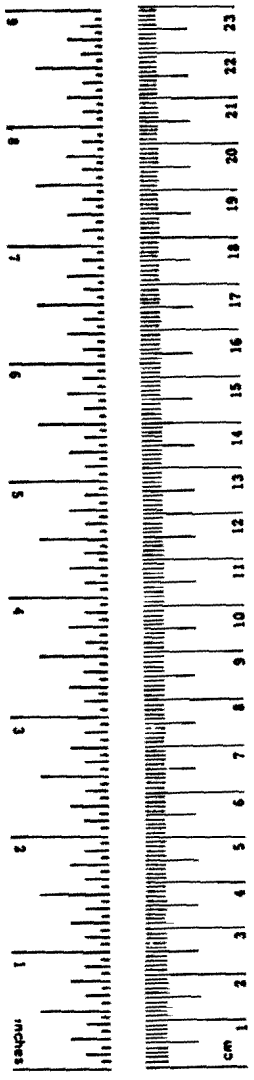
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	centimetres squared	cm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

TEMPERATURE (exact)

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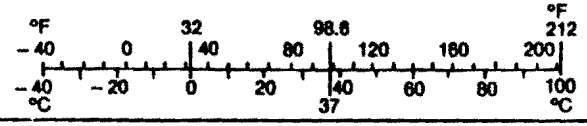

These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

ABSTRACT

Law enforcement is considered an important contributor for maintaining traffic safety. However, limited resources, such as staff and funds, constrain the efforts of police in traffic law enforcement. New technologies such as automated enforcement may offer a partial solution to this problem. Information on automated enforcement devices currently being used in the areas of speed enforcement, red-light traffic signal enforcement, and high-occupancy vehicle (HOV) lane enforcement is provided in the report through summaries and discussions of current technology, experiences in the use of automated enforcement devices, legal issues, and public acceptance of automated enforcement. Examples of experiences include the use of portable billboard speed displays in Richardson, Texas, and Glendale, Arizona, as well as the use of automated speed enforcement devices in Arlington, Texas; Galveston County and LaMarque, Texas; Paradise Valley, Arizona; Pasadena, California; and Peoria, Arizona. Automated HOV lane enforcement experiences from Virginia, California, and Seattle, Washington, and red-light enforcement in Pasadena, California, and New York City are also discussed. Legal issues associated with automated enforcement include photographing of the driver, mailing the citation to the owner of the photographed vehicle, and requiring the owner of the vehicle to identify the driver at the time of the offense.

IMPLEMENTATION STATEMENT

The information contained in this report should be useful to agencies considering the use of automated enforcement. The report provides information on speed limit enforcement, red-light traffic signal enforcement, and high-occupancy vehicle lane enforcement. It contains a summary of the current technology and the experiences different agencies have had in using automated enforcement devices. The Legal Issues section provides an introduction to legal issues associated with the use of automated enforcement devices by providing information on existing and potential legal challenges to the use of these devices. The Public Acceptance section, as well as information from the Experiences section, provides insight into issues that an agency may want to consider prior to using automated enforcement.

DISCLAIMER

The contents of this report reflect the views of the author who is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. This report is not intended for construction, bidding, or permit purposes. This report was prepared by Kay Fitzpatrick (PA 037330-E).

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CHAPTER 1
INTRODUCTION

Law enforcement is considered an important contributor for maintaining traffic safety. Violating red-light traffic signal indications and traveling at excessively high speeds can cause accidents to occur. Also it is recognized that accidents occurring at higher speeds can result in more severe injuries and more fatalities than accidents occurring at lower speeds. However, limited resources, such as staff and funds, constrain the efforts of police in traffic law enforcement. New technologies such as automated enforcement (AE) may offer a partial solution to this problem. Areas where the use of automated enforcement has been used include:

- speed limit enforcement,
- red-light traffic signal violation enforcement, and
- high-occupancy vehicle lane enforcement.

Automated enforcement devices typically consist of detection equipment (such as a radar device or inductive loops), a processing unit (that determines whether the vehicle is in violation), and a camera. When the processing unit determines that the vehicle is in violation, for example, exceeding a preset speed, a photograph is taken. The photograph typically records the driver's face, the vehicle's license plate, and the time and date of the exposure. Information from the license plate is used to identify the owner of the vehicle while the photograph of the driver is used to identify the individual committing the violation. A citation or warning is mailed to the owner of the vehicle.

Other examples of non-traditional enforcement techniques include the use of mailing citations or warnings to vehicle owners observed violating a high occupancy vehicle (HOV) lane restriction or a red-light traffic signal. These systems reduce the number of pursuits needed to apprehend violators, remove the officer from a potentially hazardous situation of writing a citation along a busy highway, improve traffic flow by eliminating a cause of rubbernecking (i.e., the ticketing activity), save officer time, and provide enforcement in areas that do not have adequate space for pulling a violator over.

Chapter 1: Introduction

Automated enforcement is a rapidly changing field. Governmental agencies across the county are trying different techniques to aid in their enforcement efforts. While some of these techniques have proven successful in other countries or by other agencies, some of the techniques are innovative and must be developed before being useful to a particular enforcement agency.

The objective of this report is to provide information on automated enforcement devices currently being used in the areas of speed enforcement, red-light traffic signal enforcement, and high-occupancy vehicle lane enforcement. This report contains information on current technology, experiences in the use of automated enforcement devices, legal issues, and public acceptance of automated enforcement.

CHAPTER 2
TECHNOLOGY

2.1 SPEED LIMIT ENFORCEMENT

The National Highway Traffic Safety Administration (NHTSA) has sponsored several studies to identify technologies that may be applicable to speed enforcement and to evaluate their possible utility in the United States (1, 2, 3). The 1980 report (2) identified Automated Speed Enforcement (ASE) devices not in use in this country but which were commonly employed at that time elsewhere in the world. The report concludes that the technology, the deployment options, and their demonstrated productivity suggest that these devices could be highly cost effective in increasing speed limit compliance even with their relatively high initial costs. Based on the findings from this study, the second phase of the project was conducted. The second phase (3) involved the theoretical, engineering, and preliminary law enforcement evaluation of selected automated speed enforcement strategies.

In April 1987, when Congressional legislation permitted states to raise their speed limits to 65 mph on rural interstate roads, the Senate Appropriations Committee directed, among other things, that NHTSA assess: the current state of monitoring/enforcement methodologies; information strategies that support enforcement efforts; and new radar enforcement technologies. To implement this directive, NHTSA sponsored a study to document state of the art usage of speed measurement and enforcement technologies being used around the world. In that study, Blackburn et al. (1) updated their previous assessments (2, 3) on speed measurement devices and enforcement technology.

The speed detection devices reviewed by Blackburn et al. (1) fit into three categories: down-the-road doppler radar, cross-the-road doppler radar, and time/distance measuring concepts. These devices are described in Tables 1, 2, and 3, respectively. All devices reviewed have the capability of automatically photographing the vehicle that the equipment identifies as being in violation. Blackburn et al. emphasized that the systems described are not endorsed, nor are any of them recommended over another.

Table 1. Down-The-Road Doppler Radar Devices.

COMPANY (COUNTRY)	DEVICE	COMMENTS
Plessey South Africa, Ltd. (South Africa)	Plessey Dual-Antenna Speed Monitor (no camera system)	• Prototype recently developed. Currently being demonstrated to South Africa law enforcement agencies. • System is composed of a main control unit connected to two Doppler radar units. • Two antennas are deployed about 80 m apart, aimed essentially parallel to traffic flow and to each other such that they "illuminate" a common or capture area. A speed is displayed on the main unit only when a vehicle is identified by both antennas (vehicle is in capture area).
Trafikanalys AB (Sweden)	RC 110 (manned system) ASTRO 110 (fully automatic)	• The 2.5 year old Swedish firm was asked to develop a new-generation ASE device under an agreement with the National Swedish Police Board. • System consists of control unit, radar antenna, and camera. • Radar provides tracking of all vehicles between 10 and 75 m away from the radar head. • System automatically calibrates itself every 15 minutes.

Source of material: Reference 1.

2.1.1 Down-The-Road Doppler Radar

Down-the-road radar is commonly used in the United States. It emits a microwave beam that is directed down the road, usually head-on into oncoming traffic (see Figure 1). The reflected Doppler frequency is then converted into a speed measurement. While the radar principle is highly accurate, the down-the-road concept has some operational limitations. Although the radar often can determine vehicle speeds at long range (1/4 to 1 mile), they are not able to discriminate between vehicles. If two or more vehicles are visible to the beam, officer judgement must be used as to which vehicle is producing a "reading". The long range of the radars, coupled with their moderately high power, enable them to be detected by drivers with radar detectors. (1)

Table 2. Cross-The-Road Doppler Radar Devices.

COMPANY (COUNTRY)	DEVICE	COMMENTS
AWA Defense Industries Pty. Ltd. (Australia)	Vehicle Speed Radar (VSR) Model 449	• Manufactured radar speed detection devices for 14 years. • Narrow beam detection of closely spaced vehicles. • Microprocessor analyzes Doppler signals. • Continuously automatic testing. • Application has been made with Federal Communication Commission for type acceptance in the US.
Gatsometer B.V. (Holland)	Gatso Micro Radar Type 24 and Type RadCom 24	• Company also has two older units: Gatso Mini Radar MK 3 and MK 4. • Devices can be used for stationary and moving speed enforcement. • Moving operation - take rear photos of vehicles passing the patrol car (using a hand-held unit). • Capable of operating with separate speed limit settings for passenger cars and for trucks. • In 1987, Type RadCam 24 was evaluated for 6 months in the U.K. Constabulary thought the system was a reliable, robust piece of equipment.
Traffipax-Vertrieb (West Germany)	Speedophot	• Can be used in either stationary (patrol car or tripod) or moving operation. • Departing traffic -- PC and trucks speed limits; oncoming traffic -- one speed limit. • Technology available to transfer all the data recorded on a fully exposed 30-m roll of film (800 exposures) automatically onto a data medium called a memory card.
Zellweger Uster AG (Switzerland)	Multanova 6F (most current device offered by company)	• Mountable in a patrol car (stationary operations) or on a tripod (operations alongside the roadway). • Device can measure oncoming or departing traffic either selectively or simultaneously. Can measure one speed limit for oncoming traffic and separate speed limits (truck and passenger car) for departing traffic. Any vehicle in the near lanes that supplies a consistent return Doppler signal for a time period equivalent to at least 12 m of travel is automatically defined as a truck. • Traffic Monitoring Technologies (Friendswood, Texas) packages the Multanova 6F in the rear of a four-wheel drive vehicle and leases the detection equipment and vehicle for a service fee.

Source of material: Reference 1.

Table 3. Time/Distance Measurement Devices.

COMPANY (COUNTRY)	DEVICE	COMMENTS
Eltraff S.r.l. (Italy)	Velomatic 103A	• Three components: control and calculator unit, a sensor, and a photographic system. Two types of sensors can be used with the device: an optoelectronic sensor or a capacitive sensor. • 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 instant later, the system logic determines the time lag between them and, hence, the vehicle speed.
Proof Digitalsystemer A/S (Denmark)	ProViDa/PDRS	• Vehicle-mounted, computerized video/data system. Used to monitor traffic and determine vehicle speeds from time and distance measurements. • 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 ½-in color monitor. • Device is used either in a pacing strategy or when the patrol vehicle is stationary.
Trans-Atlantic Equipment Pty, Ltd. (South Africa)	Speed-Guard DeLuxe Model 3000 and Trafficam Speed Camera	• Sensors are pencil-thin rubber tubes permanently installed 2.5 m apart in any road surface and connected by cable to 6-V DC transducers. • Takes rear photographs of offending vehicle. • Speed Guard contains a micro-processor, built-in rechargeable batteries, and a charger. • Equipment can be operated automatically in any direction.
Truvelo Manufacturers (West Germany)	Truvelo M4[2] Combi	• Device uses two sets of roadway cables placed parallel to each other (two fully independent measuring systems in parallel). The speeds are compared and are accepted and displayed if within an acceptable tolerance (2 km/hr). The camera and flash system are activated whenever a vehicle is detected traveling faster than the preset speed limit. • Photographs can be taken from either behind or in front of the vehicle. • Can be operated totally automatically or tripod-mounted or installed in a fixed enclosure.

Source of material: Reference 1.

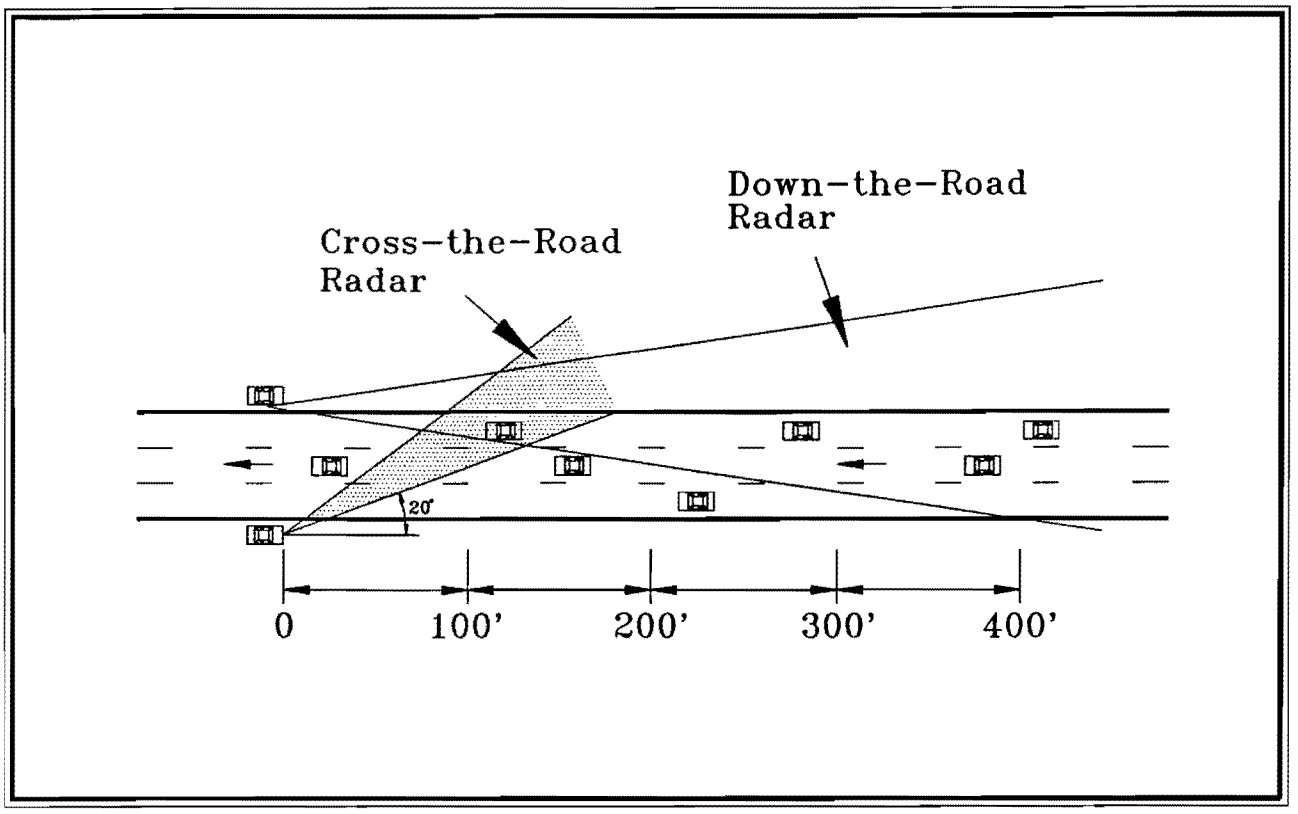

Figure 1. Comparison of Doppler Radar Devices.

2.1.2 Cross-The-Road Doppler Radar

The cross-the-road radar systems use a very narrow, low-power beam directed at an angle on the order of 20° from the direction of traffic (see Figure 1). Then, signal-processing logic determines whether a stable speed is being observed. Upon passing the logic tests designed by the particular manufacturer, a speed reading is displayed. The vehicle to which it 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. Advantages of cross-the-road radar systems include their ability to make positive identification of speeding vehicles, to detect nearly all speeders (even in dense traffic), to be relatively free from effects of electrical and other interferences, and to be effective even against vehicles with radar detectors (the vehicle is in the beam and its speed is noted before a driver can react). (1)

2.1.3 Time/Distance Measuring Devices

Time/distance measuring devices use sensors near, on, or in the pavement to determine the time interval taken by a vehicle to pass a specific distance. An example of a sensor used near the pavement is an optoelectronic sensor. As a vehicle passes in front of an optoelectronic sensor, the amount of light detected by the sensor changes in some fashion. If the second sensor experiences the same pattern of change an instant later, the system logic determines the time lag between them. Sensors used on the surface of the pavement for temporary installation include coaxial microphone cables. Sensors imbedded in the pavement at a fixed location include piezoelectric detector cables. (1)

2.1.4 Testing of Devices

Blackburn and Glauz (3) tested four ASE devices from Europe in 1978. Three devices (Gatso Mini Radar MK4, Multanova Radar MU VR 4FA, and Traffipax Model V/R) use radar aimed diagonally across the road while the fourth ASE device (Truvelo Model 4) uses piezoelectric roadway sensors to determine a vehicle's speed. All four devices can be used with a camera to obtain photographic evidence of a violation, and some can operate automatically with only minor periodic maintenance. The Multanova ASE device was judged to be the best of the four examined, but all of the devices were subject to periodic malfunctions, especially film jamming, tearing in cold weather, and blown fuses. The vehicle owners could be identified in 90 percent of all case where the license plate number could be read and the state identified. Usually, however, the state name and expiration date were too small to be read, so substituting a longer focal length lens was suggested.

2.2 RED-LIGHT TRAFFIC SIGNAL ENFORCEMENT

During the Blackburn et al. (1) study, six manufacturers were identified as producing red-light violation detection systems. These manufactures also produce ASE equipment described previously. The red-light violation detection systems use roadway sensors (inductive loops,

cables, or tubes) for vehicle detection and 35-mm cameras to record photographic evidence of the violation. Table 4 describes the systems marketed by the six manufactures.

2.3 HIGH OCCUPANCY VEHICLE LANE ENFORCEMENT

Miller and Deuser (4) in 1978 reported on various "innovative" techniques that may aid in the enforcement of HOV facilities. These techniques were innovative in the sense that they were not widely used within the context of traffic law enforcement practice current at that time. The techniques identified include:

- Use of photographic systems and instrumentation in detecting HOV violations and identifying the violators.
- Use of law enforcement para-professionals (a trained aide who assists a professional person) in detecting HOV violations and identifying the violators.
- Mailing of traffic citations and warning letters to the registered owner (identified through the license plate) of a vehicle violating the HOV facility.
- Remote apprehension of the HOV violator on an exit ramp or other downstream location by an enforcement officer working in tandem with another officer detecting the HOV violation.
- Mass screening of license tags to identify habitual violators.

In 1990, Billheimer et al. (5) reported on the attempted use of videotape in HOV lane surveillance and enforcement in California. The report described the results of tests using video equipment to determine vehicle occupancy, document violator identity, and aid enforcement on high-occupancy vehicle lanes. Cameras were set up on and under freeway overpasses, and the findings from observers using video were compared with those of police officers downstream and observers on the overpasses not using the equipment. The tests showed that it is technologically possible to record several accurate views of vehicles traveling in mainline HOV lanes. Polarizing filters help to solve problems with glare from shiny cars and windshields. No combination of recorded views currently provides enough information to support prosecution for occupancy violations on that evidence alone; although, the authors concluded, the technique can support on-line enforcement and lane performance monitoring.

Table 4. Red-Light Violation Devices.

COMPANY (COUNTY)	DEVICE	COMMENTS
Eltraff S.r.l. (Italy)	See Comments	• Accessories convert Velomatic 103A Speed Meter to document traffic light offenses. • Coaxial cable on pavement or inductive loop detects passage of traffic. • Camera photographs rear of vehicle crossing sensor whenever red light is on. Second rear photograph is taken 1.5 sec later.
Gatsometer B.V. (Holland)	RLC Type 36-m, 36-4m, 36-ms, and 36-msg	• Four systems differ in capabilities, but all have the same basic components. • Time interval between first and second rear photograph is adjustable (minimum interval 0.8 sec). • Gatsometer Red-Light Camera Type 36-ms was field-tested in the U.K.
Traffipax-Vertrieb (West Germany)	Traffiphot III	• System can take either rear or frontal photographs. Time between the two exposures can be set between 0.5 and 5 sec. • When frontal photographs are taken, the Traffiphot is equipped with red filters. Red flash illuminates inside of car without blinding driver. Also for frontal photographs, the second photograph can be taken when the vehicle crosses an additional induction loop in the intersection (thus aiding in providing a clear identification of the driver). • System was field tested in New York City between Jan 88 and early 89.
Trans-Atlantic Equipment (South Africa)	Trafficam	• Roadway sensors are rubber tube sensors (pencil thin). • Second photo is taken 0.5 sec after the first.
Truvelo Manufacturers (West Germany)	See Comments	• Red-light violation module converts Truvelo Combi from a ASE to an Red-Light Camera system. • Tripod installation: one piezoelectric cable is across the stop line and a photocell detector is clipped onto the housing of the red light. • Fixed installation: control unit is connected to an embedded inductive loop.
Zellweger Uster AG (Switzerland)	Multafot	• Can be installed to take either rear or frontal photographs. • Second photograph is taken at a preset time interval (0.5 to 2 sec) after the first. • System was field tested in two U.S. cities: New York City (Jan 88 to early 89) and Pasadena California (first half 89).

Source of material: Reference 1.

CHAPTER 3
EXPERIENCES IN USING AUTOMATED ENFORCEMENT DEVICES

3.1 SPEED LIMIT ENFORCEMENT

Innovative speed enforcement strategies used over the last several years in the United States include:

- portable billboard speed display,
- automated speed enforcement, and
- unattended radar (or drone radar).

Portable billboard speed displays have been used in some areas as an enforcement measure but mainly as a public relations measure to inform motorists of their speeds in the hope that the speeding motorists would voluntarily reduce their speed. Following are observations made on the use of portable billboard speed displays in Richardson, Texas, and Glendale, Arizona, and the findings from a study on driver behavior beyond the point when enforcement or an enforcement symbol is observed. Also, following are summaries on the use of automated speed enforcement devices in Arlington, Texas; Galveston County and LaMarque, Texas; Paradise Valley, Arizona; Pasadena, California, and Peoria, Arizona. Unattended radar, as a deterrent, has been examined in Kentucky and Virginia (1). Some law enforcement agencies have experimented with this deterrence idea, attended or unattended, to see if the simple presence of microwave transmissions would slow traffic. Section 3.1.10 discusses a recent Federal Communications Commission (FCC) policy change that will now permit law enforcement agencies to use unattended radar units.

3.1.1 Portable Billboard Speed Display in Richardson, Texas

A trailer with a radar speed gun and an electronic display showing an approaching vehicle's speed in real time (see Figure 2) is in use in Richardson, Texas. The electronic display on the S.M.A.R.T. (Speeding Monitoring Awareness Radar Tool) trailer shows an approaching motorist's speed, for direct comparison with the posted speed limit which is also

displayed on the trailer. The City of Richardson transportation engineer found the following benefits when using the trailer (6):

- Over 90 percent of the speeding motorists reduce their speed immediately when they see they are traveling above the speed limit.
- When a police officer is posted a distance beyond the SMART trailer, the issuing of speeding fines is better accepted by the speeding motorist than without the trailer.
- Judges hearing traffic speeding cases are showing very little sympathy for appeals as they feel that the motorists have received more than adequate warning.
- Extremely positive attitude from local residents. Generally there is a waiting list of residents wanting to have the SMART trailer placed in their neighborhood.
- The trailer acts as a "teaching" device for local residents, who often see that their claims of speeding motorists in their neighborhood are exaggerated. By observing the actual speeds of vehicles as indicated by the SMART trailer, residents have commented that their perception of how fast a vehicle is traveling was often too high.
- Very positive attitude from the police, who feel they are doing something residents appreciate very much.

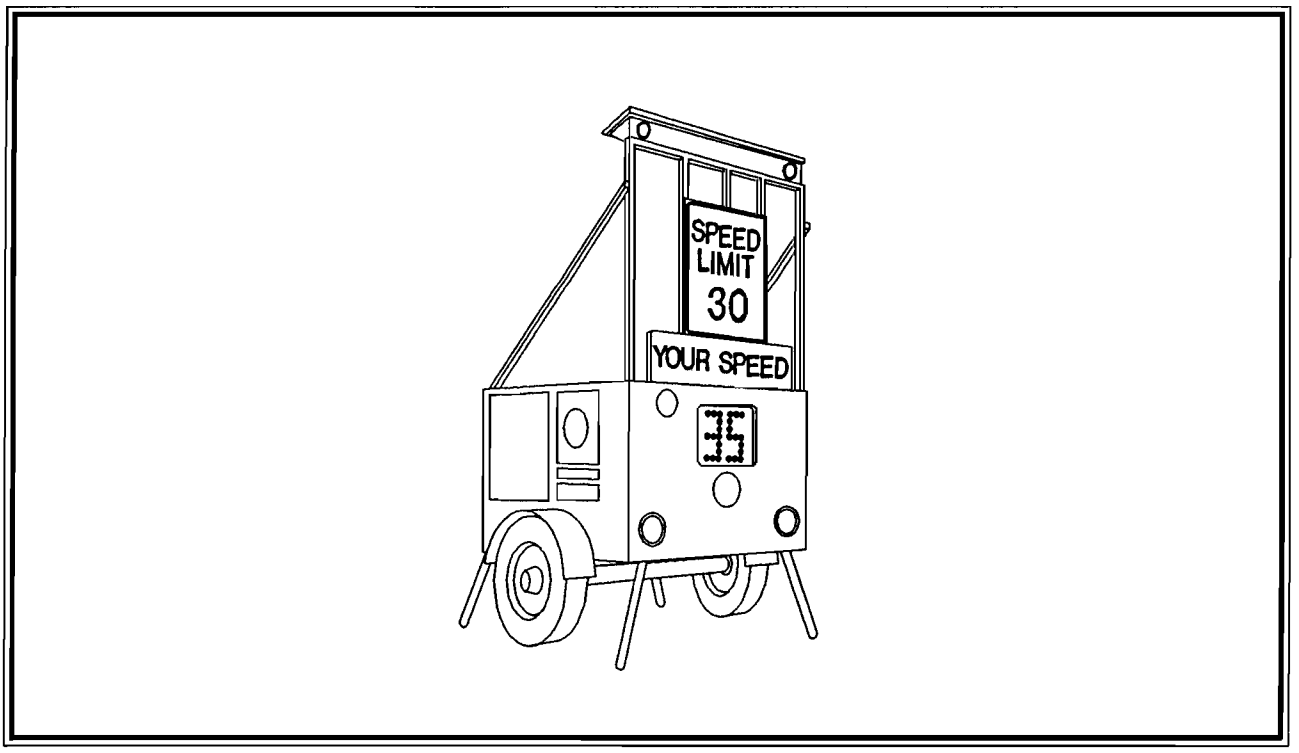

Figure 2. Speeding Monitoring Awareness Radar Tool Trailer.

3.1.2 Portable Billboard Speed Display in Glendale, Arizona

The device used in Glendale, Arizona, consists of a monitor attached to a radar gun that displays a vehicle's speed in bright red numbers. The display is used throughout the city, particularly on major thoroughfares, in residential areas where police have received speeding complaints, and at road construction sites. Although the device has been used primarily to educate the public, some motorists clocked by the unit have been ticketed for speeding. The city accident investigation supervisor states that the purpose of the device is to reduce traffic accidents. There were 978 traffic accidents in Glendale during the first three months of 1990 compared with 1,084 accidents for the same period in the previous year, a difference of 106 accidents. The department plans on purchasing at least one more display at an estimated cost of $2,200. (7)

3.1.3 Evaluation of the Halo Effect in Speed Detection and Enforcement

The halo effect is the effect on driver behavior beyond the point and time when enforcement is applied or when an enforcement symbol, such as a patrol vehicle, is observed. Research indicates that driving behavior is affected for about 1 to 4 miles. Dart and Hunter conducted a study (8) that determined if specific treatments on a section of a two-lane rural roadway could extend the halo effect. The use of a speed enforcement scene (patrol unit with roof flasher activated to simulate an arrest), a speed-check zone (included a sign designating the zone and a partially concealed radar-equipped enforcement unit), or a marked patrol vehicle parked along the road produces substantial and significant reductions in mean, median, and 85th percentile speeds in the vicinity of the enforcement unit. All three enforcement techniques significantly reduce (and almost eliminate) the percentage of vehicles traveling faster than 55 mph and reduce the variability of speeds at the enforcement location. Dart and Hunter found that the visual speed indicator sign (displays the message YOUR SPEED IS _____) had no significant effect on vehicle speed and was no substitute for actual enforcement activity. The halo effect began to disappear 1000 feet past the enforcement treatment and was completely gone at a point 2 miles downstream.

3.1.4 Orbis III Use in Arlington, Texas

Orbis III, which detects and photographs speeders, recording speed, time, date, driver, and license plate, was used on four roadway segments in Arlington, Texas, from mid-January to mid-April, 1976. Dreyer and Hawkins (9) examined the effectiveness of a mobile Orbis III unit in increasing driver compliance with posted speed limits. The sites were selected to provide data on the impact of the mobile Orbis III unit in various roadway environments (rural, residential, urban, and urban thoroughfare) with various posted speed limits. The greatest impact in reductions of percent speeders was realized on the urban roadways at high levels of enforcement. Significant, but less dramatic reductions were also observed at the rural and residential sites. Speed distribution profile data showed a small decrease in mean speeds at three of the four sites, with the impact of the unit lasting for some time after the equipment was removed from operation.

In 1978, Miller and Deuser (4) reported that an Orbis III officer was required to testify extensively as to the innermost workings of the Orbis unit and its acceptability in the scientific realm during court cases. They also reported that the Orbis III system was discontinued in 1978 partially because of the court's requirement that an expert witness testify at each case concerning the unit's technical operation.

3.1.5 ASE Use in Galveston County and LaMarque, Texas

The following is a summary of Blackburn et al. (1) comments on the experience of using ASE equipment in Galveston County and LaMarque, Texas. Manned ASE equipment was used from about July 1986 to July 1987 in Precinct 8 of Galveston county. The device used was a Multanova 6F rented from Traffic Monitoring Technologies (TMT). The system, which included a Robot camera, was mounted in the rear of a four-wheel-drive vehicle. An auxiliary, manually operated camera was used to photograph the rear of the vehicle if the vehicle had no front license plate. The speed enforcement was confined to a portion of interstate highway between Houston and Galveston and outside of incorporated areas.

TMT provided the equipment and vehicle, the film, film processing, film review for identification of the license plate number, printing of the citations (including second mailings as a follow-up), and mailing of the citations (using the county stationery). For this service, the Constable's Office was charged $20 for each fine collected. Between 4,000 and 5,000 citations were issued over the one-year period resulting in about $70,000 in fines collected. Between 40 and 48 percent of the vehicle owners responded with payment to the first letter. The follow-up letter said those refusing to pay would be arrested, and some were. Owners of commercial vehicles and out-of-state vehicles were difficult, it not impossible, to track and prosecute.

Sixteen of the speeding cases went to jury trial. The prosecution won all of the cases. Four speeding convictions were appealed to the County Court of Appeals where the convictions were overturned. The County Attorney then decided not to prosecute any more of these cases. The operation was stopped by the District Attorney's office in July 1987. Also at the time, public opinion developed against the use of the equipment, and some irate motorists were even detected throwing rocks at the enforcement vehicle to knock out the flash, which was claimed to be blinding the motorists. The citations issued are under judicial review, and it is possible that the $70,000 in fines collected may have to be refunded.

At the time the ASE 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. The ASE equipment was used because no law prohibited its use. A bill (House Bill 830) was introduced in early 1987 in the Texas legislature to provide the proper legal environment in Texas for use of ASE equipment. However, the bill was never released from the subcommittee of the House Transportation Committee.

The same equipment was also pilot-tested by the city police of LaMarque, Texas for a 90-day period during early 1987. The problems in Precinct 8 of Galveston County impacted the equipment's use in LaMarque, and several city officials reportedly lost their jobs over the pilot tests (1).

3.1.6 ASE Use in Paradise Valley, Arizona

In October 1987, the police department in Paradise Valley, Arizona, began using a Multanova 6F leased from TMT. TMT's services include leasing the equipment and vehicle, film review, and mailing of the citations for which they receive $20 for each paid ticket or owner attending a defensive driving course. The "Photo Radar" unit is deployed at various times of the day and night and is used about 25 to 30 hrs/week. A diamond-shaped warning sign with the message "Photo Radar in Use" is deployed upstream of the enforcement vehicle to notify motorists of the operation.

In 1987, Arizona changed its statutes regarding speeding penalties. Prior to the law change, 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.

During 1990, about 10,000 speeding citations were issued. The department was recording 55 violations per hour when the device was first used, currently the number of violations have dropped to 15 citations per hour of deployment. Approximately 68 percent of the owners sent the speeding citations either pay the fine or agree to attend the defensive driving school. The city police believe the use of the equipment has contributed to a 43 percent reduction in citywide accidents compared to the same period prior to implementation. (1,10)

3.1.7 ASE Use in Pasadena, California

The police department in Pasadena, California, used a Multanova 6F photo radar system during a pilot study in December 1987. Warnings were issued during the test period to 1,420 drivers. The pilot 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

roads other than freeways on June 1, 1988. A press release concerning the operation was distributed on May 17, 1988. A news conference involving radio, TV, and newspaper coverage was held on June 2 to further explain the operation and safety benefits of the equipment.

The "Photo Radar" unit is deployed at various locations and is used about 16 hrs/week. A rectangular-shaped sign with the message "You Have Just Passed Through Photo Radar (You May be Notified by Mail)" is deployed downstream of the enforcement vehicle to notify motorists of the operation. Informational signs are also posted at the city limits of Pasadena to alert motorists that the speed limit is enforced with photo radar.

Pasadena police like the equipment and claim very few problems with the equipment, the courts, or adverse public opinion. During the first three months of operation, about 7.5 percent of the motorists passing the enforcement locations were "speeding" (exceeding the speed limit by a predetermined amount). Seventeen months after the operation began, the percentage of vehicles detected as speeding dropped to 5 percent. During the first seven months of operation, 4,082 speeding citations were issued out of 9,728 violations detected from 160,354 vehicle passages. Citations 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 citations had been issued. About 84 percent of the owners sent the speeding citations either paid the fine or identified who was driving at the time of the offense. None of the 283 court cases have been lost by the city, and none of the decisions have been appealed (1).

3.1.8 ASE Use in Peoria, Arizona

In January 1990, the City Council of Peoria, Arizona, approved a three-year contract with TMT. Police began using the device in the last week of March, 1990. TMT was paid $22 for each ticket paid or for each driver sent to traffic school. The contract also included a $50,000 penalty for cancellation during the first year, $35,000 if canceled during the second year, or $20,000 if canceled during the third year. During the first month of operation, 557 citations were issued.

A petition drive was initiated soon after the device began operating. The petition requested a public vote on the use of "Photo Radar." The petition, with 3,175 signatures, was presented to the city council in September 1990. Even though the petition was declared invalid because of its wording, the city council members agreed unanimously to include the issue in the March 19, 1991, election to let voters decide on the fate of using photo radar in the city. The voters approved the proposition by a vote of 5,014 to 2,200 to give the city manager the authority to terminate the city's three-year contract with TMT. The contract was terminated on April 1, 1991 (11).

3.1.9 Other Interest in Automated Speed Enforcement Devices

Other states have expressed interest in using automated speed enforcement devices. The Wisconsin State Highway Patrol in 1987 performed an in-house study of the possible use of manned ASE equipment. The main emphasis behind the requested study was to see if some of the patrol's force could be freed from enforcing speed limits on certain interstate highways and used to enforce speed limits and drunk driving violations on other facilities. A detailed two-year plan was developed and is currently on hold until ways can be found to make use of state data to identify highway segments with high traffic volumes and where substantial speeding and accidents occur. Minnesota Governor's Office and Colorado Office for Highway Safety are both in favor of using automated speed enforcement technology and are developing plans for implementing their use (1).

3.1.10 Current Studies in Automated Speed Enforcement Devices

Based on findings from previous studies (1, 2, 3), NHTSA wanted to determine whether an Automated Speed Enforcement Program designed to maximize general deterrence effectiveness would reduce speed limit violations and related crashes. Potential components of an ASE Program could include a publicity campaign to maximize public awareness and utilization of one or more ASE devices deployed in a specific manner. The project, initiated in October 1990, is being performed by the Midwest Research Institute. The measures-of-

effectiveness proposed to determine the impact of ASE Programs include average speed, speed variation, percent exceeding the speed limit and, if measurable, speed related crashes.

Maryland State Police, Virginia State Police, FHWA, and NHTSA formed a task force to sponsor a pilot study of using ASE equipment on the Capitol Beltway. The study, initiated in 1988, is being performed by the Virginia Transportation Research Council.

The Texas Transportation Institute will be performing some limited tests to determine the application of a Truvelo M4[2] "Combi" System for enforcement potential of both speed and vehicle occupancy violations of High-Occupancy Vehicle Lanes. The device, which is primarily used for speed enforcement, was obtained as a loan from AVIAR Inc. The use of equipment for speed enforcement appears to have merit where it is not possible to put transit police on the lanes to measure speeds.

3.1.11 Drone Radar

During a Traffic Safety summit, police executives asked the NHTSA to develop operational guidelines for the use of drone radar. Drone radar is the unconventional use of police traffic radar in either an attended or unattended mode for speed deterrent purposes. Except for a few specifically authorized test programs, the Federal Communications Commission had previously prohibited the use of unattended drone radar operations unless the reflected radar signal served some purpose, such as activating signs and warning devices.

Based upon a review of the NHTSA guidelines, the FCC has revised its policy and will now permit law enforcement agencies to use unattended radar units, without the requirement that the return signal be used for a specific purpose. This approval is contingent upon a police department's adherence to the limited and controlled use as recommended in the NHTSA proposal. The NHTSA report (12) includes recommendations for police departments to use in establishing policy, specific guidelines on the use of drone radar as a speed deterrent tool, and a model policy that can be adopted by individual police departments. Components that should be considered when developing a department policy on drone radar include:

- It must be part of an agency's speed enforcement efforts.
- The selection of a site should be based on problem identification.
- It must adhere to Federal Communications Commission rules.
- It must be under local control and supervision.
- Program evaluation must be included as part of the policy.

3.2 HIGH-OCCUPANCY VEHICLE LANE ENFORCEMENT

3.2.1 California

Enforcement of California's HOV lanes requires substantial commitments of California Highway Patrol personnel and equipment. Personnel costs for enforcing the state's ten mainline HOV lanes alone exceeded $400,000 in 1990 (5). California DOT sponsored a study (5) to demonstrate and test the use of video equipment in determining vehicle occupancy, documenting violator identify, and aiding enforcement of HOV lanes. Cameras were set up on and under freeway overpasses, and the findings from observers using video were compared with those of police officers downstream and observers on the overpasses not using the equipment. Six days of field tests were undertaken to explore the use of videotape in HOV lane surveillance and enforcement.

Videotape reviewers cannot currently identify the number of vehicle occupants with enough certainty to support citations for HOV lane occupancy violations. In tests with three cameras located on an overpass, subsequent videotape review produced a false alarm rate of 21 percent. That is, 21 percent of those vehicles identified as violators by videotape reviewers which had been checked by officers on site actually had the required number of occupants. In later tests with the third camera moved to the freeway itself, the false alarm rate rose to 51 percent. The chief cause of false alarms appeared to be small children and sleeping adults located out of view of all three cameras.

Even though the investigated combinations of recorded views cannot currently provide enough information to support prosecution for occupancy violators, videotape surveillance of

HOV lanes can provide support of on-line enforcement, remote ticketing, and performance monitoring. In cases where refuge areas adjacent to mainline HOV lanes are not present, videotape surveillance provides a means of alerting officers stationed downstream from the cameras to the presence of oncoming violators. Although videotape by itself does not appear to be accurate enough to provide a basis for citation, the combination of videotape and an observing officer could conceivably provide the accuracy needed for a system of mailed warnings and citations. If a system of mailed warnings or citations can be installed, the officer would not have to pursue violators, and a videotape record of driver, occupancy, and license plate would be available for court hearings.

Billheimer (5) concluded that such a system would be more cost-effective than the current system of freeway pursuit and roadside citing and would reduce the congestion caused by rubbernecking. Legal impediments to citing the registered owner of a vehicle by mail would need to be cleared before HOV tickets by mail could be used in California. Also, public information issues associated with a ticket-by-mail campaign and the campaign's impact on the public acceptance of HOV lanes should be investigated.

3.2.2 Seattle, Washington

In February 1984, the Washington State DOT implemented a public telephone hotline, called HERO, for reporting HOV facility violators and discouraging the illegal use of the HOV lanes. Signs (see Figure 3) encourage motorists to report violators of the HOV restrictions. These signs provide a phone number that other drivers use to provide the descriptions of violating vehicles. Owners of the violating vehicle are sent a letter from the Washington DOT; Figure 4 shows a copy of the letter sent to Seattle drivers. The process of issuing warnings or tickets by mail to registered owners is permitted in Washington (5).

Studies done before and immediately after the HERO's implementation in 1984 showed that the HERO hotline reduced violation rates by 33 percent (from 28.3 to 19.1 percent averaged over four mainline I-5 locations). A study in 1990 reported that although the project could not demonstrate that the HERO program has kept the violation rate lower than it might otherwise

have been, the violation rate was below pre-HERO levels despite a substantial increase in traffic demand (13). The study made specific recommendations for increasing the effectiveness of the HERO hotline program. These recommendations included implementing a marketing and education campaign about the hotline and arranging for calls from cellular phones to be free of charge to the driver.

A telephone survey performed during the 1990 study contacted 551 residents in areas near HOV facility. The HERO program was known by 81 percent of the people sampled. While only 6.3 percent of the respondents who knew about the hotline said they had actually used it to report an HOV violation, the majority (71 percent) nonetheless thought the program was a good idea. About half of those who knew about the HERO program felt that it helps to reduce HOV violations.

The number of HERO calls received between November 1988 and April 1989 was typically between 100 and 200 calls per week. Because the phones are only staffed between 8 a.m. and 5 p.m., over half of the calls were reported to an answering machine. Callers who left messages on the answering machine were more likely to leave incomplete information than were callers who reported violations directly to a staff member. Over one-third of those who spoke to a staff member had at least one incomplete item (e.g., no violation time, vehicle occupancy not specified, no route, etc.), and almost half of those who left messages on the machine did so.

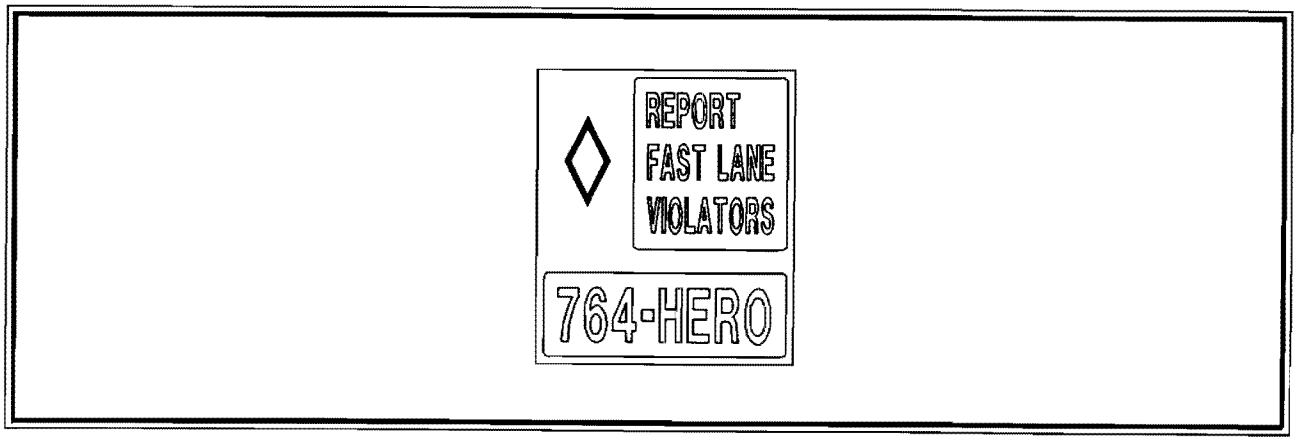

Figure 3. Hero Sign.

JOHN SPELLMAN
Governor

DUANE BERENTSON
Secretary

STATE OF WASHINGTON
DEPARTMENT OF TRANSPORTATION
Office of District Administrator • D-1, 6431 Corson Ave. So., C-81410 • Seattle, Washington 98108

Date

Name
Address
City, State, Zip

Dear:

At approximately time on date your vehicle, license number ORH606 was observed in violation of the bus/carpool lane restrictions on Location.

State law restricts usage of these lanes to buses, motorcycles or vehicles carrying three or more persons. This restriction is in effect 24 hours a day. If your vehicle is observed again in violation of the bus/carpool lane restrictions, the State Patrol will be notified.

We are concerned with the unauthorized use of the bus/carpool lanes.

More new freeways cannot be built because of high cost, environmental factors, and land consumption. Therefore, alternative means of travel must be found to relieve present congestion and to accommodate future growth in the Seattle area.

The bus/carpool lanes increase the people-moving capacity of Interstate 5. Running at only a quarter of their capacity, the bus/carpool lanes carry 2700 people in the peak hour. The other lanes each carry 2200 people in four times as many vehicles and run virtually at capacity.

Because there are fewer vehicles in the bus/carpool lanes, speeds are higher than in the other lanes. Higher speeds provide the commuter with a shorter travel time — an incentive to carpool or take a bus. Each time someone shares a ride, everyone benefits since fewer vehicles are competing for space in the other freeway lanes.

If you did not violate the bus/carpool lane restrictions, or would like to discuss the bus/carpool lanes or our actions, please call me at (206) 764-4376.

Sincerely,

Traffic Systems Management
Washington State Department
of Transportation

Source: Reference 5.

Figure 4. Warning Letter to Seattle Drivers.

3.2.3 Virginia

Virginia Department of State Police mails citations to registered owners of vehicles that law-enforcement officers have observed violating HOV restrictions (14). The ability to mail citations frees officers from the task of pursuing and apprehending violators on the spot, which can slow traffic in both the HOV lanes and adjoining lanes. Legislation was passed to allow this type of ticketing process and to make the violation a traffic infraction. Therefore, no points are assigned toward revoking the driver license. The registered owner of the vehicle is responsible for the $50 fine and the $20 court cost. However, the ticket is rebuttable if the registered owner wishes to appear in court and testify under oath that they were not operating the vehicle. The Virginia State Police reports that the ticket by mail program has increased by 4 or 5 times the number of tickets one officer can issue. He also states that while the program has not been without problems, Virginia State Police feel that most of these problems can be addressed and that the program has resulted in a number of benefits. Benefits include reduced violation rates, traffic flow that is not interrupted as much as it is with normal enforcement methods, and enhanced safety of the police officer and the motorist.

Approximately 80 percent of all observed violators are mailed tickets. Some vehicles, such as rental cars, some out-of-state vehicles, and company owned vehicles are not sent tickets. Officers are also now momentarily stopping the vehicles to obtain the drivers license or social security number to ensure that the proper individual receives the ticket. The ticket is then sent by mail to this individual. Even stopping the vehicle to obtain this information is much shorter than the 15 minutes or so it normally takes to issue a citation. However, there are limited areas to pull vehicles over on some of the facilities, restricting this method.

The Virginia State Police are looking at additional ways to improve the program. A recent evaluation within the agency recommended continuing the ticket by mail program and expanding its capabilities through automation. Initially, the agency was not prepared for the large volume of summons the program generated. Automation of the whole system would greatly improve its efficiency, especially in terms of writing the tickets and mailing the letters.

In 1989, Northern Virginia implemented a HERO program (14) modeled after the program in Seattle (see previous section). Signs are located along the facilities encouraging motorists to call a toll free number to report violators of the HOV requirements. During the first seven months, the response was very high. When a call is received, an initial informational letter and brochure is sent to the owner of the vehicle reported to be in violation of the HOV occupancy requirements. The attempt here is to inform the individual about the purpose and requirements of the lanes, and the types of transit and rideshare services available in the area. If the violator is reported a second time, a second letter is sent from the department. The wording of this letter, while still informational in nature, is a little stronger. The letter indicates that if the violations continue, the individuals name will be turned over to the state police for enforcement. The third letter comes from the state police indicating the vehicle has been placed on the enforcement list. The results of the program indicate that it has been successful at lowering violation rates. Seventy-six percent of the calls were on first time violators, with 21 percent second time violators, and only 3 percent were reported a third time. Thus, it seems that the program has reduced the number of repeat offenders.

3.2.4 San Francisco-Oakland Bay Bridge Priority Lane Project

In 1978, Miller and Deuser (4) reported on enforcement of the San Francisco-Oakland Bay Bridge Priority Lane. Observers were stationed in the priority lanes at the toll booths and recorded license plate numbers of all lane violators. After the same license plate was observed more than once, the plate number was sent to the Department of Motor Vehicles for identification. About 1 percent of the lane users were constant violators. Letters were then sent to the registered owners of the vehicles informing them of the Vehicle Code violation and indicating that the driver of the vehicle could be apprehended and cited by the California Highway Patrol. Further observations indicated that the response of the owners to the letter was very good. Only about one violator in ten was observed in the lane after receiving the letter. While the warning letters did discourage future violations from most of these individuals, they did little or nothing to reduce the overall violation rate. Apparently new violators moved into the HOV lane to replace the removed violators and more direct means of enforcement were considered necessary.

3.2.5 Southeast Expressway (Boston) Concurrent-Flow HOV Lane

Miller and Deuser (4) made the following report on the enforcement efforts of the Southeast Expressway Concurrent-Flow HOV Lane located in Boston. The project reserved the median northbound (inbound) lane for the exclusive use of buses and carpools of three or more persons. The HOV lane operated from 6:30 to 9:30 am, and at all other times the HOV lane was open to general traffic. The length of the HOV lane was eight miles, and there was no priority treatment for southbound (outbound) traffic in the afternoon peak period.

The HOV lane was implemented on May 4, 1977, on a voluntary, unenforced basis and operated under that strategy until the HOV lane restrictions were enforced beginning October 18, 1977. As a result of this announced change in enforcement strategy, travel times in the general travel lanes increased and varied from day to day. On November 2, 1977, the project was terminated because of the public outcry and concern by the public officials regarding the deteriorated travel conditions in the general travel lanes brought on by the enforcement of the HOV lane.

Enforcement occurred by mailing citations to the registered owners of vehicle violating the HOV lane. About five police officers in vehicles were assigned over the three-hour period per day. Massachusetts General Laws make it possible for a police officer, who upon observing a moving violation and being unable to give the original citation to the violator at the time of the offense, to mail the citation to the registered owner of the vehicle. (Massachusetts law provides that the registered owner of a vehicle shall be prima facie evidence that the owner was the operator at the time of the violation.) This mailing procedure was used because police could not apprehend the HOV violator safely at the time of the violation because of the requirement to weave across several lanes of congested traffic. During the 12 operating days of this enforcement program, a total of 1,583 citations were mailed for an average of 132 citations per day (44 citations per hour). There was no accounting of these citations, because once the HOV project was terminated, the court system decided (not on a legal basis) not to hold the persons responsible for the HOV citation.

3.3 RED-LIGHT VIOLATIONS ENFORCEMENT

3.3.1 Pasadena, California

Pasadena, California, in early 1989 participated in two trials of the Multafot automated red-light surveillance system (1,15). The surveillance system included a camera, a microcomputer, and a set of magnetic sensors embedded in the road. The two intersections selected for the trials -- Fair Oaks Avenue and Union Street and California Boulevard and Hill Avenue -- were chosen based on the high incidence of right-angle collisions and high traffic volumes. Several operational problems were experienced during the trials. About 95 percent of the photographs taken were of nonviolating vehicles, partly because of the 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. Left turning vehicles that were forced to pass through the red light after waiting for oncoming traffic to come to a halt were typically also photographed. Positioning the sensors in the optimal location proved difficult and expensive because each repositioning of the sensors required a work crew to saw into the street. No tickets were issued during the test periods.

3.3.2 New York City

Two demonstrations of red-light violation detection equipment have taken place in New York City. The first demonstration was conducted from June 1985 through March 1986 using a Traffiphot unit. During the 44 days of full operation, approximately 4,000 red-light offenses (an average of 90 violations per day) were clearly detected and recorded on film. No citations were issued during the demonstration. The second demonstration took place January 1988 through early 1989 and involved three intersections and used the following equipment: Traffiphot, Multafot, and a system made by Alex Jacknau Filmaufrahme. Photographs of red-light violations were obtained from the first two intersections (40 and 56 percent of the photographs taken recorded a readable red-light violation, respectively). No usable film was obtained from the equipment made by Alex Jacknau Filmaufrahme. Summonses were not issued for the detected violations.

While both studies were being performed in New York, there was no legislative approval to issue tickets based on photographic evidence. However, during the second study, the New York Legislature passed a bill that allowed photographs as evidence and summonses to be mailed to the registered owner. New York City DOT now has plans for installing red-light violation detection equipment at 25 intersections in the city. Citations for red-light violations will be issued through the mail to the registered owners of the vehicles identified. It was anticipated that the program will start in January 1990 (1).

3.3.3 Nottinghamshire County Council, United Kingdom

Casings to hold a signal-activated camera were installed in December 1987 at two Nottinghamshire County sites selected based on reported accidents which involved signal violations (16). The camera was supplied by the Dutch company Gatsometer BV. The proportion of drivers committing red-light violations, of those who had the opportunity to do so, was similar both before and three months after the introduction of the camera. However, the number of violations 0.8 seconds or more after the onset of the red sequence of the traffic signal was reduced. This reduction was greatest during the period of extensive publicity just after the camera was officially switched on. The more recent observations have indicated that the violation rate is returning towards that observed prior to the introduction of the camera.

3.3.4 Singapore

In 1989, Chin (17) reported on automatic red-light surveillance cameras that had been installed at a number of intersections in Singapore. These cameras were part of an overall effort to reduce accident rates at signalized intersections. Cameras were to be installed at 120 locations over a five-year period beginning in 1986. To evaluate the cameras' effectiveness, a before-and-after study investigated the change in red-running violation rates at 16 locations selected for the second phase of the project. The results of the study showed that generally the violation rates have been reduced, especially among heavier vehicles. A drop in violation rates was also observed along approaches which were not under camera surveillance.

CHAPTER 4
LEGAL ISSUES

The use of automated enforcement devices has resulted in several questions, debates, and court cases over legal issues. For example, several issues concern the photograph of the driver. Does it violate an individual's right of privacy and will it be admissible as evidence? Other legal questions surround the mailing of the citation to the owner of the vehicle as identified from the license plate. Is the owner vicariously liable for the violation committed by the vehicle regardless of who was driving? Can the owner of the vehicle be required to identify the driver if the photograph proves that the owner was not the driver at the time of the offense?

Some of the legal issues have been tested in the courts, while others may present future limitations on the use of automated enforcement in certain areas of the country. Previous reports (18, 19, 20) have provided in depth discussions of the legal aspects of automated enforcement. Following is an overview of court cases and legal issues to provide the reader with an introduction to legal issues to be consider.

4.1 COURT CASES

The implications of court cases on the use of automated enforcement devices is discussed in several reports (3, 18, 21). Following is a summary of court cases relevant to the implementation of unmanned automated enforcement.

In Commonwealth v Buxton (1910) 205 Mass 49, 91 NE 128, a speeding conviction was sustained on evidence derived from electronic devices involving the use of photography. The evidence was obtained by a "Photo-Speed-Recorder" which operated by taking two pictures, at a measured time interval, of the speeding automobile, and then calibrating the difference in the size of the automobile in the two photographs so as to determine, by a mathematical formula, the distance traveled in the time elapsed. The Recorder was found legally successful; however, logistically it was impractical for continued use.

In People v Hildebrandt (1955) 308 NY 395, 126 NE 2d 377, 49 ALR 2d 449, a speeding conviction based upon evidence obtained by a "photo-traffic" camera (takes two photographs of a moving vehicle at a set time interval) was reversed because of the absence of any evidence to show that the defendant, who was not notified of the alleged offense until two weeks after it was supposed to have happened, was operating the car at the time the pictures were taken. The courts of appeals held that it could not be inferred that the owner of the automobile was the driver at the time of the speed violation. The defendant could not be convicted of the traffic infraction without evidence that he was the driver at the time of the infraction. Since the device only took photographs of the rear of the vehicle to obtain the license plate number, the identity of the driver could not be established. This case clearly established the requirement that the operator of the vehicle must be identified in order to prosecute for speeding.

In July 1990, Paradise Valley dismissed a misdemeanor charge against a man who refused to identify the driver of his speeding vehicle (22). An attorney for the Arizona Civil Liberties Union argued successfully that the charge violates the separation-of-powers doctrine in the Arizona Constitution. He claimed that "the judge was being asked to do the prosecutor's job" in that the town court was helping to determine the identity of the speeder. The Town Attorney stated that the only effect of the case will be to prompt him to file "John or Jane Doe" charges against those who do not own the vehicles in which they are caught speeding. The prosecutors then will search through drivers' licenses of those suspected of being the driver, such as relatives, to match the license pictures with the photo-radar pictures. The Town Attorney also said that "The biggest flaw in my case, and the reason I dropped it and agreed with the motion, is that we had not filed a Jane Doe complaint" against the driver. Paradise Valley's photo-radar statue mandates that charges be filed against a speeder within 30 days.

Another 1990 case in Paradise Valley had an attorney for the Arizona Civil Liberties Union arguing that "nobody can be convicted by default" when improperly notified by mail of the alleged violation (23). The owner of a photographed vehicle had been notified by mail that his car was captured by photo radar and to pay a $100 fine or appear in court. Instead, the driver wrote back to the town officials saying that the mailed citation did not meet legal

requirements. The town magistrate responded by trying the owner in absentia. The owner was convicted and ordered to pay the fine within 30 days or have his driver's license suspended. The Civil Liberties Union attorney said Paradise Valley officials have to personally serve the individual with the charge or deliver the complaint at the time of the alleged violation. Maricopa County Superior Court Judge agreed that it was improper for a town magistrate to automatically rule a photographed driver guilty of speeding after he was mailed notice of the alleged law violation. The judge ruled that anyone accused of speeding must be legally notified and that a mailed notice is not sufficient.

Another successful challenge to photo radar occurred in 1989 in Pasadena, California (24). The defense attorney argued that the police vehicle containing the photo radar unit was painted the wrong color. State law requires police vehicles be painted either all white or white with a sharply contrasting color. The Pasadena Police Department painted its radar vehicle white and gold which is a color scheme not used on any of its other vehicles. The Municipal Court judge agreed with the defense attorney's argument and dismissed the case. The city prosecutor's office later agreed to dismiss all photo radar cases in which the white-and-gold car was used. This led to the dismissal of more than 900 speeding tickets. The photo radar car was later repainted all white.

4.2 LEGAL ISSUES FOR SPEED-LIMIT ENFORCEMENT

4.2.1 Orbis III

In the late 1960s, Orbis III was tested in a demonstration project by the City of Arlington. The legal acceptance of Orbis III was not raised during the demonstration project. Glater (18) and Dreger and Hawkins (9), however, reviewed the legal aspects of certain potential challenges to its use. Glater focused on three legal issues: violation of an individual's right to privacy, equal protection, and admissibility of the photographs into evidence. Dreger and Hawkins discussed two problems that could be associated with an Orbis case: issuance of citation or warrants requiring court appearance and the introduction of photographs as evidence.

Glater concluded that Orbis is not an invasion of privacy as defined by Supreme Court's decisions, because it does not interfere with an especially "fundamental right" or "zone of privacy" and it does not constitute an "unreasonable invasion." The photograph taken by Orbis is not an unreasonable search because it does not invade an area which may reasonably be expected to be free from public view. The author also concluded that Orbis does not interfere with the rights of association guaranteed by the First Amendment. Glater indicated that the photographs must cause a "specific present objective harm" and not a specific or general future harm, or in other words, the harm must be actual not hypothetical, before the courts would rule against Orbis. Orbis does not contradict state statutes pertaining to the right of privacy because most of these statutes are for preventing the unauthorized use of a person's name or likeness for advertising or business purposes.

The inability of Orbis to photograph every speeder may be considered as denying equal protection of the law. Glater concluded that Orbis' limitations (e.g., can monitor only one lane of traffic at a time and requires 4 seconds to rewind) do not result in the intentional discrimination prohibited by the Fourteenth Amendment's Equal Protection Clause.

Defendants may claim that the photographs taken by Orbis are not admissible evidence. To be admissible, the prosecution would have to show that "the photograph is relevant and material to issues raised at trial and must show that the photograph is an accurate, authentic representation of the scene it contains"(18). Glater concluded that the Orbis photograph is obviously relevant, and all of the people handling the film can testify to its accuracy to the extent that no tampering occurred. However, he argues, human testimony is normally needed to confirm the authenticity of a photograph by claiming personal perception of what the photograph purports to portray. To overcome this obstacle, the prosecution must describe the techniques used to ensure the photograph's authenticity and the official who loaded the film should testify as to the familiarity of the background. Because this does not always work, he recommends that officials encourage the legislature to pass statutes authorizing the admission of Orbis photographs in speeding prosecutions.

Included in Dreger and Hawkins' discussions on the issuance of citation or warrants requiring court appearance were such issues as the methods usable to ensure the defendants appearance in court and the owner's refusal to identify the driver. Included in the discussion on the introduction of photographs as evidence were legal issues such as establishment of judicial acceptance of Orbis; proof of proper calibration and maintenance of the system by police officers; invasion of right to privacy; and rights of the defendant to cross-examination. The authors concluded that there are no unique problems associated with Orbis photographs which should preclude their being accepted as valid evidence of speeding violations, and that if a photograph is admitted as evidence, the court must decide if the defendant and the driver of the vehicle are one and the same person.

4.2.2 Vicarious Liability

Blackburn et al. (3) reported on three Highway Safety Research Institute (HSRI) reports (25, 26, 27) that discussed legal issues associated with speed detection systems. In one report, an assessment of the legal feasibility of vicarious liability speed-law statues was made. It concerned the legal issues that might be encountered with states that impose criminal or civil liabilities on the owners of vehicles observed in violation of speed laws, in the absence of the identity of the actual drivers.

Liability for speeding may be criminal, quasi-criminal (where a city traffic violation is not actually a "crime"), and/or civil. Criminal liability requires in most cases formal charges, a jury trial (if desired), benefit of counsel, and the right to confront opposing witnesses. Civil actions are generally viewed as being less serious than criminal actions because penalties do not include incarceration. Civil sanctions ordinarily involve monetary penalties, forfeitures, and liens. (Liens may be monetary or may prohibit re-registration of a car.) Ruschmann et al. (26) stated that legally, the jeopardy of the defendant is viewed by the courts as less in civil cases and vicarious liability is, therefore, more likely to be constitutionally (due process) permissible. So far the most popular vicarious-liability vehicle offense is a parking violation.

Ruschmann et al. (27) concluded that civil statutes designed to impose vicarious liability on the owners of vehicles observed in violation of speed laws are legally feasible. On the other hand, criminal statutes directed at a vehicle owner that provide for any form of incarceration would probably not be legal under either a vicarious liability or a presumptive basis. However, criminal statutes providing only for fines might be legal under a vicarious liability basis in some states provided it can be postulated that an owner can have considerable control over the actions of other drivers of the vehicle. If this relationship between owner and driver cannot be postulated, then it is unlikely that vicarious liability could be imposed.

4.2.3 Texas Issues

In 1970, the Attorney General of Texas wrote an opinion on whether the operation of a system consisting of a sensing device, a computer, and a camera which photographs the front view of the vehicle, the driver, its registration plate, and showing the date, time, location, and posted speed limit is legal. The complete opinion is reproduced in Appendix A. In summary, the Attorney General of Texas found:

> "There is no actionable invasion of the right of privacy of a person whose photograph is taken on a public highway by a traffic surveillance system when such photo is used solely for speed enforcement or traffic surveying purposes. Such photographs would be admissible in evidence as proof of identification of defendants and their speed of driving, provided they comply with the rules of evidence applicable thereto."

In 1987, Traffic Monitoring Technologies contracted with the Andrews and Kurth Law Firm to identify legal issues associated with prosecuting speeding violations documented with a TMT photo traffic radar system (28). They identified four issues for considerations. A summary of the firm's comments follow:

1. Identification and compulsion of court appearances of the driver. The driver of the automobile shown in the photographs may be identified and prosecuted in a number of different ways under current Texas law and procedural rules.

Notice of Violation. The registered owner of the automobile as reflected in the Department of Public Safety Records can be mailed a Notice of Violation requesting identification of the driver. If the owner responds and identifies the driver, then another Notice of Violation can be mailed to the operator. If the registered owner, or the person identified as the driver by the owner, ignores a notice, there are two options available for identifying and ultimately prosecuting the driver of the vehicle in question: examining trial (or in a court of inquiry) or further investigation by police.

Ordinance or Statue Creating Presumption that Registered Owner Responsible for Unlawful Operation. Some municipalities (including Houston) have ordinances creating a *prima facie* case against the registered owner of a vehicle for parking violations. Such an ordinance allows the immediate filing of a complaint against the registered owner of an illegally parked vehicle and places the burden on the owner to produce evidence of who is responsible for the illegal parking. In order to facilitate the collection of fines relating to speeding violations documented with the TMT System, a similar ordinance could be adopted by municipalities or states which accomplishes the same result with regard to operation of the vehicle in a manner contrary to law. Although the driver can be identified and prosecuted under current law and procedures, such an ordinance would facilitate the prosecution of moving traffic violations documented with photographic evidence. A proposed ordinance is provided in Appendix B. Appendix C is a copy of the Town of Paradise Valley Ordinance.

2. Admission of the photographs and radar readings as evidence. The photographs will be admissible as evidence subject to compliance with certain procedures.

3. Illegal searches and seizures and claims of invasion of privacy. The photographs of the automobile and its driver which are in plain view of the public will not constitute an illegal search or invasion of privacy under the Fourth Amendment.

4. State certification or restrictions on use. The State of Texas has no statute or regulation regarding the certification of radar units or the posting of signs warning of the use of police radar.

In August 1990, portions of this report in the form of a technical memorandum were submitted to the Texas SDHPT General Council. Robert E. Shaddock reviewed the material and provided a brief discussion on some legal concerns regarding automated enforcement of speed laws. In summary, the following should be considered in using automated enforcement:

- A statutory change should be sought to allow for admissibility of the photographs into evidence.

- Contempt of court may be the only alternative for forcing the owner of the car to divulge the identity of the driver when the photograph itself proves that the owner was not the driver.

- The due process clause of the fifth amendment may preclude vicarious liability.

- The availability of the husband-wife privilege may limit the effectiveness of the program.

4.3 LEGAL ISSUES FOR HOV ENFORCEMENT

Enforcement of high-occupancy vehicle lane restrictions is an integral element of a HOV project. In the Miller and Deuser (14) review of enforcement on HOV facilities, they conducted a legal review of six prominent legal issues posed by innovative techniques such as photographic instrumentation, mailing of citations, tandem (team) patrol, and para-professional officers. The

six legal issues concerning innovative enforcement techniques for HOV lanes identified by Miller and Deuser are:

- Can photographic evidence be made to be admissible in traffic court through legislative action?
- If instrumentation is used to the enforcement operations, what type and amount of instrument certification would be required?
- Can the minimum number of occupants required for the utilization of an HOV lane be related to their visibility without being successfully challenged on the basis of age discrimination (i.e. small children) or other grounds?
- Can citations be mailed out to the owner of a vehicle for a moving violation without the driver's identification being confirmed?
- Can a non-witnessing officer cite a violator of an HOV facility?
- Do the legislative requirements for effective HOV lane enforcement require the allocation of powers to the enforcement agency which can then be abused? What can be done to minimize this possibility?

4.4 LEGAL ISSUES FOR RED-LIGHT ENFORCEMENT

Blackburn et al. (1) discussed legislation that was passed in New York and Victoria, Australia, concerning red-light traffic signal enforcement. 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 will remain in full force for three years. At that time the amendments and provisions made by the act shall be repealed unless extended by another act of the legislature.

In March 1986, legislation was passed in Victoria, Australia, that was intended to improve police operations in relation to the use of red-light cameras, and subsequently, 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. The results of this legislation have had beneficial effects on police costs and efficiency.

CHAPTER 5
PUBLIC ACCEPTANCE

The Insurance Institute for Highway Safety (IIHS) sponsored a telephone survey (29) among residents of two communities (Paradise Valley, Arizona, and Pasadena, California) where photo radar is currently being used. IIHS also contacted residents of communities near to Paradise Valley and Pasadena. Interviews for this survey were conducted by telephone August 18 through September 5, 1989. Random digit dialing methods were employed to select households. In each household, one interview of a licensed driver was conducted. The interview required about 10 minutes to complete; respondents were asked questions in three areas: awareness of photo radar, attitudes toward its use, and reported behavior in response to photo radar.

Considerable awareness that photo radar was being used was found, especially in Paradise Valley where 72 percent mentioned it spontaneously. In all areas combined, 58 percent either approved or strongly approved its use; residents of Paradise Valley and Pasadena were more likely to approve than residents of nearby communities. Two-thirds of those who approved of photo radar thought its use should be increased. Almost half of the respondents who knew about photo radar being used said it had made them drive slower. Those who live in or near Paradise Valley were more likely to report driving slower than those who live in or near Pasadena. Interviewees were more likely to say that photo radar has made them drive slower if they had mentioned photo radar use spontaneously when asked about speed enforcement techniques being used; if they had seen photo radar in use; and if they had received a speeding ticket -- especially a photo radar ticket -- in the last three years. Less than 5 percent of those interviewed said they had received a speeding ticket based on photo radar.

Possibility of errors and the wrong person getting a ticket was the most popular reason for disapproval. However, the authors observed that virtually the only source of this error occurs when the owner of the vehicle was not the driver. The owner still receives the ticket, but the photographic evidence allows the owner to show that he or she was not the driver. The second most popular reason for disapproval was that it is "sneaky" and gives police an "unfair

advantage," but the authors observed that signs are used widely in both cities to warn drivers that photo radar is in use. The authors also noted that photo radar does eliminate interaction at the scene between police and driver that would allow the driver to explain mitigating circumstances, but concluded that it is objective, accurate, and nondiscriminatory.

CHAPTER 6
SUMMARY AND CONCLUSIONS

Enforcement is considered an important contributor for maintaining safety. However, limited resources, such as staff and funds, constrain the efforts of police in traffic law enforcement. New technologies such as automated enforcement may offer a partial solution to this problem. Areas where the use of automated enforcement has been used include:

- speed limit enforcement,
- red-light traffic signal violation enforcement, and
- high-occupancy vehicle lane enforcement.

6.1 TECHNOLOGY

The National Highway Traffic Safety Administration has sponsored several studies to identify technologies that may be applicable to speed enforcement and to evaluate their possible utility in the United States. Tables 1, 2, and 3 describe speed enforcement devices reviewed for a NHTSA study for down-the-road doppler radar, cross-the-road doppler radar, and time/distance measuring concepts, respectively. Down-the-road radar is commonly used in the United States. It emits a microwave beam that is directed down the road (see Figure 1). Cross-the-road radar systems use a very narrow, low-power beam directed at an angle on the order of 20° from the direction of traffic (see Figure 1). Time/distance measuring devices uses sensors near, on, or in the pavement to determine the time interval taken by a vehicle to pass a specific distance. Manufacturers and equipment for red-light violation detection systems were also identified during the NHTSA study. Table 4 describes the systems marketed by six manufacturers.

Several techniques have been identified to aid in the enforcement of high-occupancy lanes. These techniques include mailing traffic citations and warning letters to the registered owner of a vehicle violating the HOV facility, remote apprehension of the HOV violator on an exit ramp or other downstream location by an enforcement officer working in tandem with

another officer detecting the HOV violation, and use of photographic systems to detect HOV violations.

6.2 EXPERIENCES IN USING AUTOMATED ENFORCEMENT DEVICES

6.2.1 Speed Limit Enforcement

Innovative speed enforcement strategies used over the last several years in the United States include portable billboard speed display and automated speed enforcement. Portable billboard speed displays have been used in Richardson, Texas, and Glendale, Arizona. The Speeding Monitoring Awareness Radar Tool (SMART) Trailer used in Richardson shows an approaching motorist's speed for direct comparison with the posted speed limit, which is also displayed on the trailer. Richardson and Glendale have had many positive experiences and citizen comments concerning the use of the displays.

The initial use of automated speed enforcement occurred in Arlington, Texas, with the Orbis III device. Orbis III was used on four roadway segments from mid-January to mid-April in 1976. Speed distribution profile data showed a small decrease in mean speeds at three of the four sites, with the impact of the unit lasting for some time after the equipment was removed from operation (9). Orbis III was discontinued partially because of the court's requirement that an expert witness testify at each case concerning the unit's technical operation (4).

A Multanova 6F device was used in Galveston County from July 1986 to July 1987 and in LaMarque, Texas, for 90 days in 1987. Traffic Monitoring Technologies (TMT) provided the equipment and vehicle, the film, film processing, film review for identification of the license plate number, and the printing and mailing of the citations for $20 for each fine collected. Public opinion against the use of the equipment was strong; for example, some irate motorists were detected throwing rocks at the device to knock out the flash, which was claimed to be blinding the motorists.

In October 1987, Paradise Valley, Arizona, began using Traffic Monitoring Technologies services. A diamond-shaped warning sign with the message "Photo Radar in Use" was deployed upstream of the enforcement vehicle to notify motorists of the operation. During 1990, about 10,000 speeding citation were issued. Approximately 68 percent of the owners sent the speeding citations either paid the fine or agreed to attend defensive driving school (10).

Pasadena, California, begin using the equipment in a pilot study in December 1987. Because of the success of the pilot study, a decision was made to begin speed enforcement with the device on roads other than freeways on June 1, 1988. Pasadena police like the equipment and claim very few problems with the equipment, the courts, or adverse public opinion. Informational signs as well as signs used downstream of the enforcement vehicle notify motorists of the photo radar operation.

In March 1990, the Peoria, Arizona, police began using photo radar. A petition drive was initiated by Peoria citizens soon after the device began operating. In the March 1991 election, voters approved 5,014 to 2,200 the proposition which gave the city manager the authority to terminate the city's three-year contract with Traffic Monitoring Technologies. The contract carried a penalty for cancellation, $50,000 for the first year, $35,000 for the second year, and $20,000 for the third year.

6.2.2 High-Occupancy Vehicle Lane Enforcement

The use of videotape equipment for surveillance and enforcement on California HOV lanes was investigated in 1990. The tests showed that is technologically possible to record several accurate views of vehicles traveling in mainline HOV lanes. However, no combination of recorded views currently provides enough information to support prosecution for occupancy violations on that evidence alone, although, the authors concluded, the technique can support on-line enforcement and lane performance monitoring.

In February 1984, the Washington State DOT implemented a public telephone hotline, called HERO, for reporting HOV facility violators and to discourage the illegal use of the HOV

lanes. Signs provided a phone number that other drivers use to provide the descriptions of violating vehicles. Studies done before and immediately after the HERO's implementation showed that the HERO hotline reduced violation rates by 33 percent. A study in 1990 reported that although the project could not demonstrate that the HERO program has kept the violation rate lower than it might otherwise have been, the violation rate was below pre-HERO levels despite a substantial increase in traffic demand (13).

Virginia Department of State Police mails citations to register owners of vehicles that law-enforcement officers have observed violating HOV restrictions. The ability to mail citations frees officers from the task of pursuing and apprehending violators on the spot, which can slow traffic in both the HOV lanes and adjoining lanes. Legislation was passed to allow this type of ticketing process. It also made the violation a traffic infraction, therefore no points are assigned toward revoking the driver license. Approximately 80 percent of all observed violators are mailed tickets. In 1989, Northern Virginia implemented a HERO program modeled after the program in Seattle.

Observers were stationed in the priority lanes at toll booths on the San Francisco-Oakland Bay Bridge Priority Lane to record license plate numbers of all lane violators. After the same license plate was observed more than once, the plate number was sent to the Department of Motor Vehicles for identification and a letter mailed to the vehicle's owner. Observations indicated that the response to the letter was very good. Only about one violator in ten was observed in the lane after receiving the letter. However, the overall violation rate did not change, apparently new violators moved into the HOV lane to replace the removed violators and more direct means of enforcement were considered necessary.

6.2.3 Red-Light Violations Enforcement

Pasadena, California, in early 1989 participated in two trials of the Multafot automated red-light surveillance system. Two intersections were selected based on the high incidence of right-angle collisions and high traffic volumes. About 95 percent of the photographs taken were of nonviolating vehicles, partly because of the locations 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 were conducted in New York City in 1985 to 1986 and 1988. During the 44 days of the first demonstration, approximately 4,000 red-light offenses were clearly detected and recorded on film. During the second demonstration, 40 to 56 percent of the photographs taken recorded a readable red-light violation.

Casings to hold a signal-activated camera were installed in December 1987 at two Nottinghamshire County sites (United Kingdom) selected based on reported accidents which involved signal violations. The proportion of drivers committing red-light violations, of those who had the opportunity to do so, was similar both before and three months after the introduction of the camera. However, the number of violations 0.8 seconds or more after the onset of the red sequence of the traffic signal was reduced.

Cameras were to be installed at 120 locations over a five-year period in Singapore beginning in 1986. A before-and-after study investigated the change in red-running violation rates at 16 locations selected for the second phase of the project. The results of the study showed that generally the violation rates have been reduced, especially among heavier vehicles.

6.3 LEGAL ISSUES

The use of automated enforcement devices has resulted in several questions, debates, and court cases over legal issues. Early court cases sustained a speeding conviction based on photographic evidence and established the need to photograph the operator of the vehicle in order to prosecute for speeding. Other cases and debates have involved issues such as identifying the driver of a vehicle, notifying the owner of the vehicle by mail, and vicarious liability.

Ruschmann et al. (27) concluded that civil statutes designed to impose vicarious liability on the owners of vehicles observed in violation of speed laws are legally feasible. However,

criminal statutes directed at a vehicle owner that provide for any form of incarceration would probably not be legal under either a vicarious liability or a presumptive basis.

In 1970, the Attorney General of Texas wrote an opinion on whether the operation of a system consisting of a sensing device, a computer, and a camera which photographs the front view of the vehicle, the driver, its registration plate, and showing the date, time, location, and posted speed limit is legal. In summary, the Attorney General of Texas found:

> "There is no actionable invasion of the right of privacy of a person whose photograph is taken on a public highway by a traffic surveillance system when such photo is used solely for speed enforcement or traffic surveying purposes. Such photographs would be admissible in evidence as proof of identification of defendants and their speed of driving, provided they comply with the rules of evidence applicable thereto."

The General Counsel for the TxDOT (then State Department of Highways and Public Transportation) reviewed and commented on a preliminary draft of the legal section of this report. He summarized the following as items that should be considered for using automated enforcement in Texas:

- A statutory change should be sought to allow for admissibility of the photographs into evidence.
- Contempt of court may be the only alternative for forcing the owner of the car to divulge the identity of the driver when the photograph itself proved that the owner was not the driver.
- The due process clause of the fifth amendment may preclude vicarious liability.
- The availability of the husband-wife privilege may limit the effectiveness of the program.

6.4 PUBLIC ACCEPTANCE

In an Insurance Institute for Highway Safety (29) sponsored telephone survey on automated speed enforcement devices (photo radar), 58 percent of the surveyed residents of Paradise Valley, Arizona, and Pasadena, California, stated they either approved or strongly approved of the use of photo radar. Almost half of the respondents who knew about photo radar said it had made them drive slower. Possibility of errors and the wrong person getting a ticket was the most popular reason for disapproval. The second most popular reason for disapproval was that it is "sneaky" and gives police an "unfair advantage."

6.5 CONCLUSIONS

The information in this report will be of use to agencies considering the use of automated enforcement. The Technology section of the report provides an overview of what is currently available. Agencies' experiences in using automated enforcement can provide needed advice on the potential problems that may be encountered when implementing an automated enforcement program. For example, Paradise Valley and Peoria, Arizona experiences illustrate the need, both positively and negatively, for a public relation campaign to educate the residents of the advantages of using photo radar. The Legal Issue section provides an introduction to legal issues associated with the use of automated enforcement devices by providing information on existing and potential legal challenges to the use of these devices.

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THE ATTORNEY GENERAL OF TEXAS
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CRAWFORD C. MARTIN
ATTORNEY GENERAL

September 14, 1970

Honorable A. Ross Rommel
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Austin, Texas 78711

Opinion No. M-692

Re: Several questions relative to whether a particular traffic surveillance system is legal.

Dear Mr. Rommel:

Your request for an opinion as to whether the operation of the described traffic surveillance system is legal, presents the following questions:

1. Is there an actionable invasion of the right of privacy of a person whose photograph is taken on a public highway by the described traffic surveillance system when the photo is used solely for speed enforcement purposes?

2. Is there an actionable invasion of the right of privacy of a person whose photo is taken on a public highway by the above system when used for traffic surveying purposes?

Your third question has been withdrawn and is therefore omitted.

4. Assuming that the chain of possession of the film is unbroken from the time it is placed in the camera until the time of trial of a defendant to a speeding violation, would the photograph be admissible in evidence as proof of identification of the defendant and of the speed at which he was driving when the traffic surveillance unit is left unattended during its operation?

5. With the same assumption as stated in Question 4, would the photograph be admissible in evidence as proof of identification of the driver and of the speed at which he was traveling when the

> traffic surveillance unit is attended by a police officer who does not apprehend the defendant at the time of violation?

According to your letter, this system consists of a sensing device, a computer, and a camera with illuminating attachment to measure the speed of a motor vehicle, photograph the front view of the vehicle, the driver, its registration plate, and showing the date, time, location and posted speed limit. The only service requirement is the occasional change of film cassettes, and no attendant is required for the operation of the system. Its primary in tended uses are for traffic speed control and traffic engineering survey purposes. Your questions raise issues of first impressions in Texas, as there are no court decisions which have decided these issues.

With reference to your first two questions, it is well settled that the individual's right to preserve his personal seclusion must give way to the state's reasonable exercise of the police power. Consequently, for example, statutes making reasonable provision for taking and keeping fingerprints and photographs of persons accused of crime have been sustained. 14 A.L.R. 2d 761, Right of Privacy, Sec. 9, Police Power.

In the case of Voelker v. Tyndall, 75 N. E. 2d 548 (Ind. Sup. 1957 app. denied 33 U.S. 834 reh. denied 333 U.S. 858) appellant was arrested on a misdemeanor charge and claimed an invasion of his right of privacy. The Court, in upholding the right to take his fingerprints and photograph, said:

> "The purpose is single, clear and quite salutary to promote the public safety, by achieving greater success in preventing and detecting crimes and apprehending criminals. The accomplishment of this object has been an important duty of government in all times. Not infrequently a lack of accurate identification has been a serious handicap in clearing up a crime. It is probable that an accurate identification system, faithfully administered, may be an assistance not only in finding the guilty criminal, but in clearing an innocent suspect."

The rule generally is also stated in 41 Am. Jur. 945, Privacy, Sec. 27:

> "It is generally held that the customary photographing and measuring of a prisoner for the purpose of police records do not amount to an invasion of the prisoner's right of privacy."

It is our opinion that a person driving on a public highway in an automobile, is subject to public view and to the state's reasonable exercise of the police power to promote the public safety. Accordingly, we answer your questions 1 and 2 that there is not an actionable invasion of the right of privacy. We find no case authorities recognizing such a right of privacy. Our Courts have so far confined their decisions in upholding a right of privacy to matters relating to marriage, family and sex. 56 American Bar Assn. Journal 673-677, and see California v. Belous, 80 Cal. Reptr. 354, 458 P2d 194 (1969); Griswald v. Connecticut, 381 U.S. 479 (1965). The Courts have refused to extend a right of privacy where public health or safety or

other police powers of the state are a competing interest. Public Utilities Commission v. Pollak, 343 U.S. 451 (1952); Frank v. Maryland, 359 U.S. 360 (1959).

Your letter expresses concern as to whether the described system can become accepted as a scientifically reliable speed testing device.

The evidentiary proof required in Court for the reception of evidence in this system would be the same as for any other photographic system in a criminal case.

The rule stated in Wigmore, The Science of Judicial Proof, p. 450, as quoted in Wilson v. State, 168 Tex. Cr. 439, 328 S.W.2d 311 (1959), applies to your questions 4 and 5:

> "... since the additions made possible to our unaided senses are due to the use of instruments constructed on knowledge of scientific laws, it is plain that the correctness of the data thus obtainable must depend upon the correctness of the instrument in construction and the ability of the technical witness to use it. Hence, the following three fundamental propositions apply to testimony based on the use of all such instruments:
>
> "'A. The type of apparatus purporting to be constructed on scientific principles must be accepted as dependable for the proposed purpose by the profession concerned in that branch of science or its related art. This can be evidenced by qualified expert testimony; or, if notorious, it will be judicially noticed by the judge without evidence.'
>
> "'B. The particular apparatus used by the witness must be constructed according to an accepted type and must be in good condition for accurate work. This may be evidenced by a qualified expert.'
>
> "'C. The witness using the apparatus as the source of his testimony must be one qualified for its use by training and experience.'

As stated in Wilson v. State, supra, "... There must be proof that the machine has been properly set up and recently tested for accuracy."

As to your questions 4 and 5 regarding the admissibility in evidence of photographs from the traffic surveillance system as proof of identification of defendants and speed of driving as proof of identification of defendants and apply and the burden is upon the prosecution to qualify the evidence for submission and to connect up and prove the identity of the defendant committing the offense. This would probably be more difficult when the system's units are left unattended and the defendant is not apprehended at the time and at the scene of the speeding violation. The Court would have to be satisfied that the photographs comply with the usual rules of evidence and accurately depict what they purport to represent. However, admissibility of the

photos does not necessarily require identification by an attendant or an eye witness. See Scott, Photographic Evidence, 2nd Ed., Sec. 1026; Vardilos v. Reed, 320 S.W.2d 419 (Tex. Civ.App. 1959, no writ.)

The speed of motor vehicles may be measured by use of a "phototraffic camera", and the "Foto-Patrol" which operates on an electronic impulse which activates a strobe light camera. "It has been held that expert testimony as to the scientific principles underlying it and as to its accuracy at the time of an alleged speeding offense is necessary in order to base a conviction thereon." 7 Am.Jr.2d 871, 872, Sec. 328, Automobiles and Highway Traffic, which cites People v. Pett, 13 Misc.2d, 975, 178 N.Y.S.2d 550.

In People v. Hildebrant, 308 N.Y. 397, 126 N.E.2d 377, N.Y.Ct.App. (1955), the offense was speeding. Police officers, to measure the speed, had used a "phototraffic camera." The Court said, "there should be applicable the criminal-law rules of presumption of innocence and necessity of proof of guilt beyond a reasonable doubt." The Court, holding that the identity of the driver must be proven, and that proof of vehicle ownership alone will not give rise to a presumption that the owner was the driver, said:

> "... Apparently, the question is a new one, but that is because speeders are usually pursued and arrested after pursuit, whereas this identity question arises because of the use of a photographic speed recorded, without pursuit or arrest. The device used may be efficient and scientifically trustworthy, its use may make pursuit and immediate arrest inconvenient or unnecessary, and highway safety may be promoted by eliminating such pursuits. But it takes more than necessity to validate a presumption in a criminal case. Tot v. United States, 319 U.S. 463, 467, 63 S.Ct. 1241, 87 L.Ed. 1519, and here we do not even have a presumption."

However, positive identification of the defendant is not required if a witness can testify that the photo is a fair and accurate representation of the scene. U.S. v. Hobbs, 403 F.2d 977 (6th Cir., 1968).

In Commonwealth v. Buxton, 205 Mass, 49, 91 N.E. 128 (1910), a speed violation case, the question was the competency of an instrument known as a "photo-speed recorder." The Court said:

> "As a rule the question whether evidence of experiments shall be admitted depends largely upon the discretion of the trial judge; and his action in the exercise of this discretion will not be reversed unless plainly wrong. In this case the result of the experiments did not depend upon the fluctuations of human agencies, nor on conditions whose relations to the result were uncertain, but upon the immutable working of natural laws; and upon the evidence the presiding judge may well have found that such experiments were likely to be more reliable as to the speed of the automobile than the conjectural statement of an eye witness or the interested

> statement of a chauffeur. We cannot say as a matter of law that the evidence would not justify the judge in coming to the conclusion that the experiments would be useful in determining the speed of the car. Indeed, it would seem desirable to have some machine whose action being dependent upon the uniform working of the laws of nature would record the speed of a moving object."

It is, therefore, our opinion in answer to your questions 4 and 5 that the traffic surveillance photographs would be admissible in evidence as proof of identification of defendants and their speed of driving, subject to the requirements and rules of evidence hereinabove stated.

S U M M A R Y

There is no actionable invasion of the right of privacy of a person whose photograph is taken on public highway by a traffic surveillance system when such photo is used solely for speed enforcement or traffic surveying purposes. Such photographs would be admissible in evidence as proof of identification of defendants and their speed of driving, provided they comply with the rules of evidence applicable thereto.

Yours very truly,

CRAWFORD C. MARTIN
Attorney General of Texas

Prepared by Ben M. Harrison
Assistant Attorney General

APPROVED:

OPINION COMMITTEE

KERNS TAYLOR, Chairman
W.E. ALLEN, Co-Chairman
Houghton Brownlee
Jim Broadhurst
Howard Fender
John Banks
Tom Bullington

MEADE F. GRIFFIN, Staff Legal Assistant

NOLA WHITE, First Assistant

PROPOSED ORDINANCE

Section _____. It shall be unlawful for any person, having registered in his name or owning or operating or having in charge any motor vehicle, knowingly to allow or suffer or permit the same to be operated on any street or highway within the (*insert name of the municipality or county*) in any manner contrary to law or the ordinances of this (*municipality/county*).

Section _____. When any motor vehicle is operated in any manner contrary to law or the ordinances of this (*municipality/county*), proof that the vehicle was, at the date of the offense alleged, owned by the person charged with the offense shall constitute prima facie evidence that the vehicle was being operated at the time of the alleged offense by the owner and/or that the owner knowingly permitted the operation of such vehicle in the alleged manner, but the owner shall have the right to introduce evidence to show that such vehicle was not being operated by him and that he did not knowingly permit the operation of such vehicle in the alleged manner as charged in the complaint.

When recorded, return to:

Paradise Valley Town Attorney
6401 East Lincoln Drive
Paradise Valley, Arizona 85253

ORDINANCE NUMBER 297

AN ORDINANCE OF THE TOWN OF PARADISE VALLEY, MARICOPA COUNTY, ARIZONA, AMENDING ARTICLE 11-2 OF THE TOWN CODE BY REVISING SECTION 11-2-18 PRESUMPTIVE OPERATOR.

BE IT ORDAINED:

Section 1: That present Section 11-2-18 of the Paradise Valley Town code, Registered Owner of Vehicle Presumed Responsible for Certain Violations is revoked.

Section 2: That new Section 11-2-18 of the Paradise Valley Town Code, Presumptive Operator is adopted, reading:

A. If any vehicle unoccupied by a licensed driver is found upon a street or roadway in violation of any provision of this Article Title 28, Chapter 6, Article 14 of the Arizona Revised Statutes.

or if any vehicle has been driven in violation of the speed restrictions of this Article or Title 28, Chapter 6, Article 6 of the Arizona Revised Statutes or A.R.S. 28-797, then

proof of the identity of the person in whose name such vehicle is registered pursuant to Title 28, Chapter 3 of that Arizona Revised Statutes may be sufficient evidence that such person was responsible for such violation, in the absence of probative contrary evidence and if the magistrate is so persuaded.

B. Nothing in this Section shall limit the defenses to or evidence otherwise probative and admissible concerning such violation or responsibility therefor.

C. The registered owner of such vehicle, if not the person responsible for such violation, shall upon request inform the magistrate or town attorney of the identity of the person responsible for such violation, if known.

PASSED AND ADOPTED by the Mayor and Council of the Town of Paradise Valley, Arizona, this 23rd day of March, 1989.

Robert W. Plenge, Mayor

ATTEST:

Mary Ann Brines, Town Clerk

APPROVED AS TO FORM:

Charles G. Ollinger, Town Attorney

ORD297/ORS