Investigation of Automated Photo Enforcement for Red Light Running

prepared by

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Executive Summary

Deliberate running of red lights at intersections is a significant factor contributing to nearly one million motor vehicle crashes at traffic signals each year.⁠¹ In Florida alone, red light running caused more than 11,600 crashes, 121 deaths and 16,000 injuries in 1996.⁠² Employing traditional engineering and enforcement methods such as ensuring proper signal timing, removing unwarranted signals and police enforcement can reduce red light running. However, financial constraints and logistical problems make it difficult and dangerous to enforce the law at the hundreds of intersections in urban areas.

Automated photo enforcement, using red light cameras, provides an innovative approach for compliance with traffic control devices. Red light cameras connected to the traffic signal system and the loop detectors buried in the pavement continuously monitor the intersection and produce photographic evidence of vehicles whose drivers run red lights. Red light cameras generally take two pictures of each violation, one just as the vehicle enters the intersection and the second when the vehicle is in the middle of the intersection.

Across the U.S., and in Florida, new state laws and subsequent amendments to local ordinances are required to implement automated photo enforcement projects. These legal issues are complex and need to address liability aspects, citation fines, and equitable distribution of revenues to various agencies involved. People may also have concerns over a loss in privacy, especially if frontal photography is needed.

Significant investments are necessary to implement this technology. They include acquiring cameras, installation of new loops, and public awareness campaigns. A well planned and focussed public awareness and information campaign is essential for the success of photo enforcement projects. Involvement of various community, traffic safety, and automobile agencies such as Community Traffic Safety Teams, Senior Citizen Groups, and AAA would help in convincing the community. Additionally, these projects can be cost neutral as the fines can pay for the program.

Interest on red light camera systems is growing rapidly among state agencies and local governments. A number of automated photo enforcement projects are being implemented in various states/cities including Arizona, Virginia, Maryland, North Carolina, New York, Los Angeles, and San Francisco. The results from various evaluation studies are promising, indicating significant reductions in red light violation rates as well as considerably improved awareness of the problem, after the implementation of photo enforcement programs.

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¹ Richard Retting et al., Evaluation of red light camera enforcement in Oxnard, California, Insurance Institute for Highway Safety.
² Tallahassee Democrat, 01/07/98.
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1.0 Introduction

Running red lights is one of the leading causes of accidents in urban areas. Nationwide, 22 percent of all collisions in 1996 were due to the driver's disregard for the traffic control devices. In Florida alone, red light running caused more than 11,600 accidents, 121 deaths, and 16,000 injuries in 1996. This problem goes largely unchecked due to the inability of law enforcement to adequately patrol hundreds or even thousands of intersections in an urban area. A new method, the use of red light photo enforcement cameras, is being implemented to enforce traffic laws by automatically photographing vehicles whose drivers run red lights.

The objective of this study is to examine various issues concerning the usage of red light photo enforcement cameras and their use in several cities in the U.S. and to examine their potential use in Florida. This study explores various legislative issues concerned with automated photo enforcement; technical details of red light cameras; advantages; disadvantages, and issues of the use of this technology; and different application methods.

1.1 Red Light Running and its Impact

Throughout the U.S., red light running has been increasingly recognized as a serious safety concern. The Insurance Institute for Highway Safety reports that running traffic control devices like red lights is one of the most frequent causes of crashes in urban areas. Generally, red light offense occurs when a motorist illegally enters an intersection after the light has turned red (there are exceptions, such as turning right, see Section 1.3). However, motorists inadvertently caught in the intersection when waiting to turn are not red light runners. It is the responsibility of motorists to adjust their driving behavior to suit the weather and road conditions. As stated earlier, 121 fatalities in Florida resulted from drivers running red lights in 1996, and drivers running red lights in Tallahassee caused two deaths and 246 injuries in 1997. It was estimated

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3 Gerald Ensley, Tallahassee Democrat, 1/7/98; and Personal communication with George Ferris, Former Chief-Polk County Community Traffic Safety Team.
4 Gerald Ensley, Tallahassee Democrat, 1/7/98.
that the annual number of red light violations on the streets of San Francisco was approximately 3.5 million.\textsuperscript{6} A study conducted at a busy intersection in Arlington County, Virginia, found that a motorist ran a red light every 12 minutes.\textsuperscript{7} The situation was found to be even worse during peak commuting hours. It has been estimated that the accidents due to red light running cost about $7 billion a year in the U.S.\textsuperscript{8}

1.2 Counter Measures for Reducing Red Light Running

Various countermeasures are available to solve the red light running problem. Some can be categorized as engineering measures that provide operational solutions, such as ensuring proper signal timing or removing an unwarranted signal, and as enforcement techniques that are aimed at changing the behavior of the drivers such as traditional police enforcement. This section describes some of the countermeasures that could be used to curb red light running.

1.2.1 Adjusting the Signal Timing

Substantial portions of motor vehicle crashes in the U.S. occur at intersections controlled by traffic signals. This phenomenon has been found to be more prevalent in urban areas, as the National Highway Traffic Safety Administration showed that 39 percent of fatal crashes at urban intersections occurred at traffic signals in 1991.\textsuperscript{9} The length of the change interval or clearance interval at the intersections has been found to be one of the factors influencing red light violations.

The change interval consists of a steady yellow signal indicating an imminent change in the signal, and this may be followed by an all-red phase during which the traffic approaching the intersection in all directions is required to stop. Past research has found that indecision of the drivers in predicting the phasing of the yellow interval and their inability to come to full stop

\textsuperscript{6} Bond M. Yee and Jack L. Fleck, San Francisco Red Light Camera Enforcement Program.
\textsuperscript{7} Insurance Institute for Highway Safety.
\textsuperscript{8} The Orlando Sentinel, 12/28/97.
when the signal changes to red, results in crashes. Generally, the type and duration of change intervals is selected by following standards specified by The Manual on Uniform Control Devices (MUTCD), which indicates that a yellow interval in the range of 3 to 6 seconds is sufficient for normal speeds. In a study conducted by the Insurance Institute for Highway Safety, researchers concluded that increasing yellow signal length may decrease late exits and reduce potential vehicle conflicts and, hence, might reduce motor vehicle crash rates.

1.2.2 Removal of Unwarranted Traffic Signals

The researchers at the Insurance Institute for Highway Safety found that red light running and intersection crashes might occur due to the traffic signals maintained at intersections with very low volumes. A study done on low volume intersections by Kay et al. in 1980 reports reductions in crashes and injuries after conversion from signal controls to stop sign control. Another crash analysis (Persaud et al.) done in 1996 reported an overall crash reduction of 24 percent at low volume intersections after the removal of signals.

1.2.3 Traditional Enforcement

Enforcing various traffic laws, such as signal violation, in accordance with the respective laws can also reduce red light violations. Traditional enforcement requires a law enforcement officer to observe a red light violation and then chase, stop, and cite the violator. This process can be very difficult, because the police officer must see the same signal phase that the violator sees in order to cite the violator. It can also endanger motorists, pedestrians, and officers, because the officers would also have to run the red light to catch the violators. Apart from safety issues, the financial and manpower resources required to enforce traffic laws at multiple intersections by traditional methods are enormous.

Safety consequences and the large volume of signalized intersection red light violations mean police may not be able to enforce the law; therefore, the automation of this enforcement activity may prove particularly attractive to many cities. Red light camera enforcement is being used in several sites in the United States, and it can change driver behavior towards red light running if
conducted in conjunction with a widespread public awareness campaign, as reported in several studies.  

1.3 Legal Issues Associated with Red Light Running and Red Light Cameras

Running red lights is against the law and can be extremely dangerous. In Florida, this offense is treated as a moving violation, and offenders are issued traffic citations accordingly. Florida Statutes 316.075(3) and 316.076(1), and the Florida Driver's Handbook specifically outline the requirements of drivers as they encounter a red light situation. Some of the enabling state legislation aspects will be discussed in the later part of this section. However, special laws are necessary to allow the use of cameras to catch red light runners. Several states have amended their laws accordingly, and, as of today, Florida does not allow the use of cameras.

1.3.1 Florida Statutes 316.075 (3)

This statute stipulates the required obedience by vehicular traffic whenever a steady red light is used in a traffic sign or signal

Steady red indication

(a) Vehicular traffic facing a steady red signal shall stop before entering the crosswalk on the near side of the intersection or, if none, then before entering the intersection and shall remain standing until a green indication is shown; however:

1. The driver of a vehicle which is stopped at a clearly marked stop line, but if none, before entering the crosswalk on the near side of the intersection, or, if none then at the point nearest the intersecting roadway where the driver has a view of approaching traffic on the intersecting roadway before entering the intersection in obedience to a steady red signal may make a right turn, but shall yield the right-of-way to pedestrians and other traffic proceeding as directed by the signal at the intersection, except that municipal and county authorities may prohibit any such right turn against a steady red signal at any

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10 Retting et al., "Evaluation of Red Light Camera Enforcement in Oxnard, California" and "Follow-up Surveys done on Tempe & Mesa residents", Summit Group.
intersection, which prohibition shall be effective when a sign giving notice thereof is erected in a location visible to traffic approaching the intersection.

2. The driver of a vehicle on a one-way street that intersects another one-way street on which traffic moves to the left shall stop in obedience to a steady red signal, but may then make a left turn into the one-way street, but shall yield the right-of-way to pedestrians and other traffic proceeding as directed by the signal at the intersection, except that municipal and county authorities may prohibit any such left turn as described, which prohibition shall be effective when a sign giving notice thereof is attached to the traffic control signal device at the intersection.

(b) Unless otherwise directed by a pedestrian control signal as provided in s. 316.0755, pedestrians facing a steady red signal shall not enter the roadway.

1.3.2 Florida Statutes 316.076 (1)

This statute stipulates the required obedience by vehicular traffic whenever an illuminated flashing red or yellow light is used in a traffic sign or signal

FLASHING RED (STOP SIGNAL). --When a red lens is illuminated with rapid intermittent flashes, drivers of vehicles shall stop at a clearly marked stop line, but if none, before entering the crosswalk on the near side of the intersection, or if none, then at the point nearest the intersecting roadway where the driver has a view of approaching traffic on the intersecting roadway before entering the intersection, and the right to proceed shall be subject to the rules applicable after making a stop at a stop sign.

Chapter 4 ( Signals, Signs, and Pavement Markings) in Florida Driver’s Handbook says drivers must

Come to a complete stop at the marked stop line or before moving into the crosswalk or intersection. After stopping, you may turn right on red at most intersections if the way is clear. Some intersections display a NO TURN ON RED sign, which you must obey. Left turns on red from a one-way street into a one-way street are also allowed.
Currently, drivers committing red light violations are issued citations for the offense of Florida statute 316.074(1). This offense is treated as a moving violation, and the State has assessed a fine of $60 for each of these moving violations. Furthermore, counties may also include some administrative fees. For example, Hillsborough County imposes an administrative fine of $30, bringing the total fine to $90. Additionally, the State assesses three points to the license status of every driver convicted of a moving violation.

The traditional method of police enforcement of traffic laws in urban areas has not been entirely effective, as evidenced by the increasing magnitude of the problem. Large amounts of resources are necessary to deploy patrolling officers at all the intersections. Apart from funding problems, enforcement of red light running may also create some safety problems. These violations may also require chasing a red light runner through a red light, thereby endangering the lives of officers, motorists, and the pedestrians.

Technology now exists to automatically identify red light runners. Special high speed and high-resolution cameras receive vehicle location information from loops embedded in the pavement and the signal timing box. When a vehicle passes over the loops and into the intersection after the light has turned red, pictures (usually two) are taken of the vehicle and its license plate. The time of day, length of the time after the light has turned red, and the vehicle speed are all imprinted on the photographs. Based on these photographs, citations can be mailed to the motorists.

Several cities and states in U.S. have been involved in implementation of red light camera programs. New York and Los Angeles were the first two cities to implement red light programs. As the knowledge and awareness on the technology grow, several states such as California, Virginia, Maryland, Arizona, and North Carolina, are in the process of implementing such

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11 Florida Statute 316.074 (1) Obedience to and required traffic control devices: The driver of any vehicle shall obey the instructions of any official traffic control device applicable thereto, placed in accordance with the provisions of this chapter, unless otherwise directed by a police officer, subject to the exceptions granted the driver of an authorized emergency vehicle in this chapter.

12 Conversations with Hillsborough County Sheriff's Office and the University of South Florida Police.
programs. A few other places like Ft. Meade in Florida and Arlington in Virginia carried out experiments with the concept by issuing warning letters to violators.

Existing Florida laws\(^\text{13}\) do not permit the use of red light enforcement cameras, and new laws would be required to allow the local authorities to use red light cameras for law enforcement purposes. The laws are necessary to cite the red light runners by mail and to issue a ticket without a law enforcement officer witnessing the infraction. The legislation would make the registered owner/operator of the vehicle responsible for the violation, establishing a presumption that the owner is the vehicle driver at the time of offense. The legislation should also provide a procedure under which the registered owner/operator of a vehicle may establish that the vehicle was under the control of another person at the time of offense, and this other person would be fined.

In this direction, Florida Legislature will be discussing a bill (hb1479 cl) introduced in March 1997 by State Rep. John Cosgrove, during the 1998 legislative session. This bill, if passed, would allow police officers to ticket red light runners through the mail based on the evidence produced by automated enforcement. It also authorizes county or municipality to enact an ordinance that provides for use of detector to enforce steady red light traffic signal and requires public notice prior to use of said detector.

Depending upon the respective state laws, red light running violations photographed by cameras can be handled in one of the three ways described below:

1. The registered owner is charged with a traffic violation, but he/she can contest the citation by filing an affidavit swearing that he/she was not driving at the time of violation.
2. The registered owner is issued a parking citation and is responsible for the violation without regard to who is driving at the time offense.
3. The driver is charged with a moving violation, if sufficiently identified. Drivers are identified by obtaining clear photographs of both the driver and license plate. If the vehicle's driver cannot be identified, then the registered owner is charged, and his/her

\(^{13}\) Some states amended their old laws in order to permit the use of red light cameras
failure to pay the fine or identify the driver (if the registered owner was not the driving the vehicle at the time of violation) will hold up registration of the vehicle. (This method is used in California and Arizona).

In the first and second cases, the need for frontal photography (to identify the drivers) would not be necessary, removing the potential concern over driver's right to privacy. Virginia, Maryland, and North Carolina do not require frontal photography as the citations are issued to the registered owners and the owners have the right to challenge citations. In New York City, red light violations are treated like parking violations in which the registered owner is responsible for the violation without any regard to who is driving the vehicle at the time of violation, and, hence, frontal photography is not needed.

California and Arizona passed legislation requiring that photo enforcement of red light violations fully identify the driver of the car. These laws mandated that the automated photo enforcement system must obtain clear photograph of the vehicle's license plate as well as the driver. In such a case, frontal photography becomes essential, making automated photo enforcement more complex.

1.4 North Carolina's State Law on Red Light Cameras

The General Assembly of North Carolina passed an act (S.L.1997-216 and Senate Bill 741) in its 1997 session to authorize local governments to use photographic evidence images as prima facie evidence of a traffic violation. It defined a traffic control photographic system as an electronic system consisting of a photographic, video, or electronic camera and a vehicle sensor installed to work in conjunction with an official traffic control device to automatically produce photographs, video, or digital images of each vehicle violating a standard traffic control statute or ordinance.

This act also made the owner of the vehicle responsible for a violation unless the owner can furnish evidence the vehicle was, at the time of the violation, in the care, custody, or control of another person. This statute states that a violation detected by a traffic control photographic system shall be deemed as a non-criminal violation for which a civil penalty of $50 shall be
assessed. Subsequently, an ordinance has been made amending the Charlotte City Code allowing the use of cameras at the intersections to catch red light runners. (See Appendix B for a complete text of the legislation.)

1.5 California’s State Law on Red Light Cameras

Following the success of photo enforcement at railroad crossings in Los Angeles County, California enacted a law in 1996 authorizing red light photo enforcement. This law stipulated that a clear photograph of the driver and license plate are needed to issue a violation. Once the camera captures the driver’s image, and if the driver of the vehicle is sufficiently identified, drivers are charged with the violation. Otherwise, a citation is sent to the registered vehicle owner under the presumption that the driver is generally the owner. Failure to pay the fine or identify the driver (if the registered owner was not the driving the vehicle at the time of violation) will hold up registration of the vehicle. During the initial study period, the violators were penalized with a standard fine of $104 and, subsequently, the state assembly increased the fine for motorists who run red lights to $270 and allocated half of the increase to city or county where the violation occurs. (See Appendix B for a complete text of the legislation.)

2.0 Red Light Camera Technology

This section describes red light camera technology, including its components, functionality, outputs, manufacturers, installation and maintenance issues; reliability and accuracy aspects, and costs associated with the cameras. Red light cameras (see Figures 1 & 2) generally take two pictures of each violation, one just as the vehicle enters the intersection and another when the vehicle is in the middle of the intersection. On both photographs, violation data such as date, time, seconds into the red phase, lane number, and the location of the violation are imprinted. These cameras are capable of operating on a 24-hour basis and under adverse weather conditions without any interruption. A light flash (of about 150-200W) allows the cameras to operate at night without blinding drivers with a flash.
Figure 2 shows the red light camera at two different positions on the supporting pole or bar. These systems are equipped with mechanical gears or bearings so the cameras can be lowered or raised to different locations on the bar. This arrangement is useful for maintenance and repair.
purposes. As the loading and unloading of the film has to done manually, this saves a lot of time and also resources. Figure 3 shows some more examples of pole mounted cameras.

![Figure 3. Examples of Pole Applications with Red Light Cameras.](image)

Cameras often are installed at multiple locations at each intersection, as shown in Figure 4, to photograph the violating vehicles and, if required by the state laws, the vehicle drivers (as in the
case of California and Arizona). Red light cameras installed and connected to traffic signal systems (loops and signal boxes) monitor the traffic in each lane approaching the intersection. Often, the cameras will not have any power except during the red phase for the direction being monitored. Red light cameras generally take two pictures (Photo ‘A’ and Photo ‘B’ - see Figures 4 & 5) of each violation. The camera is triggered and first photograph (Photo ‘A’) will be taken when any vehicle passes over the sensors at a specified elapsed time and at a certain speed after the signal has turned red. Another photograph (Photo ‘B’) shows the vehicle in the middle of the intersection.

Figure 4. Location of Red Light Cameras at an Intersection.
Upon the review of the photographic evidence and depending upon the state law requirements, citations (see Figure 6) are issued by mail to either vehicle owners or to drivers at the time of the offense. (Note: Pictures of red light cameras presented in this section have been based or sourced from the web pages/brochures of American Traffic Systems, USPTI and MultaStar.)

Various manufacturers are involved in the development of red light camera technology. They include American Traffic Systems based in Arizona, U.S. Public Technologies from California, Digital Red Light Camera System from Israel, REDFLEX Traffic Systems based in California, and AVL4R Inc from Texas.

The majority of these systems use conventional wet film photography, although there is one experimental site (Howard County, Maryland) using digital images. Wet film technology has been the preferred method since any tampering with the film is easily detected and these cameras offer higher resolution. However, using digital cameras are improving in resolution and vendors are developing methods to ensure there is no opportunity to tamper with the digital image. (See Appendix A for brochures from different vendors.)
NOTICE OF LIABILITY

Please take notice as the Registrant of the vehicle described below which was operated in violation of section 1290(a) of the Vehicle Traffic Law at the place, date and time below in that the driver violated the traffic law stipulated below, that you are liable to pay a fine within thirty (30) days after the date of this notice in the amount shown below pursuant to section 1290(a) of the Vehicle Traffic Law, section 378-54 of the Administrative Code and Rules of the Traffic Bureau. Two photographs evidencing the violation are shown below. If you fail to either remit payment or contest your liability within thirty (30) days after the date of this notice, then you shall be deemed to have admitted liability and be subject to an additional monetary penalty and a default judgment may be entered against you.

* This fine is payable in person or by mail.
* Checks and money orders are payable to the "Newtown Department of Transportation".
* Cash payments are to be sent by registered mail.

Details of Violation

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<tr>
<td>Date: 21/01/99</td>
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<tr>
<td>Time: 8:35 AM</td>
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<td>License Plate #: 26-466-07</td>
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<tr>
<td>Place: Intersection of Main and Pine Streets, Newtown</td>
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<td>Offense: Entering the intersection and Disregarding Red Traffic Light Signal</td>
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Details of Vehicle Owner

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<tr>
<td>Given Name: John</td>
</tr>
<tr>
<td>Address: 12 Lincoln Street, Newtown, NT</td>
</tr>
<tr>
<td>Driver's Licence No.: #769926509</td>
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<td>Fine Amount: $200.00</td>
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Figure 6. An Example of Citation Issued using Automated Photo Enforcement.
3.0 Red Light Camera Usage in the U.S.

Red light cameras are being proposed or are now used for law enforcement purposes at several places in the United States, including New York City; Los Angeles, San Francisco, Oxnard, Poway, El Cajon, and Beverly Hills, California; Scottsdale, Tuscon, and Mesa, Arizona; Charlotte, North Carolina; and Fairfax, Virginia. Several other communities, including Arlington, Virginia; Jackson, Michigan; City of North Miami, Florida; and Polk County, Florida, are experimenting with the cameras to issue warning notices to vehicle owners. This section briefly describes the San Francisco red light enforcement project and Polk County’s red light photo enforcement pilot project.

3.1 San Francisco’s Red Light Camera Enforcement Program

3.1.1 Legal Aspects

Following a tragic and a highly publicized accident caused by someone running a red light at an intersection close to San Francisco State University in October 1994, City officials in San Francisco initialized a pilot project to study the use of red light cameras. In June 1995, the County Transportation Authority approved funding for a pilot project using three vendors to install cameras at two intersections each.

As the pilot project began, the State Legislature amended the California Vehicle Code in 1996 (SB833) to allow the use of red light cameras to identify red light runners. The State law requires full identification of the driver of the car. Once the camera captures a red light violator’s image, the vendor mails the citations (carrying a fine of $104 and one point against the driver’s license) signed by the police department to the registered owners under the presumption that the registered owners are typically the drivers. If the accused desires to contest the ticket, they can schedule a court hearing. The accused also can view the photographs by scheduling a time with the Municipal Court.

14 This project did not go beyond the concept stage.
15 This pilot project ended in 1996.
3.1.2 Financial Aspects

The San Francisco Transportation Authority appropriated $250,000 from sales tax collections to cover start-up costs (installation of loops, conduits, etc.), project management and oversight, and interim studies throughout the project. Each vendor was provided with $30,000 per intersection to cover the installation of cameras. For each $104 fine levied, San Francisco County receives $46.50. From these funds, the vendors receive $17.50 per paid citation to cover the cost of cameras, film developing and citation processing costs, statistical and data analysis, and follow-up court liaison and support as necessary. However, the Pilot Program has found that the $17.50 is inadequate to fund a full-scale program. In October 1997, the Governor signed into law AB 1191, which increased the fine for red light violation to $270. Table 1 shows the distribution of fine and assessment amounts mandated by AB 1191.

<table>
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<th>Violations in incorporated areas</th>
<th>Distribution of Fine</th>
<th>Amount ($)</th>
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<td></td>
<td>State Trial Court Implementation Fund</td>
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<td></td>
<td>City general fund</td>
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<td></td>
<td>State penalty assessment</td>
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<td>County penalty assessment</td>
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<td></td>
<td>City and County shares</td>
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<td><strong>Total</strong></td>
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<table>
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<td>State Trial Court Implementation Fund</td>
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<td></td>
<td>County penalty assessment</td>
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<td></td>
<td>County share of base fine</td>
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</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>270.00</strong></td>
</tr>
</tbody>
</table>

The City of San Francisco recently awarded a new, expanded red light photo enforcement project to US Public Technologies Inc (USPTI). This project will include 34 intersections outfitted with all the hardware and will integrate portable equipment units to be rotated from one intersection to another. The details of this agreement are still under negotiation, but the vendor will be paid a
flat monthly fee plus a per citation fee. The violator’s fines are now such that they will fully fund this project.

3.1.3 Vendor Aspects

In June 1995, the County Transportation Authority selected three vendors to install cameras at two intersections each. Two vendors Electronic Data Systems (EDS) and USPTI installed cameras at four intersections. A third vendor, also assigned two locations, dropped out of the program. Eventually, EDS also pulled out of the project, and USPTI completed the installation of cameras at all the four intersections in January 1997. The following section describes the USPTI technology used in the pilot project.

3.1.4 Technological Aspects

The red light camera system\(^\text{16}\) (see Figure 7) consists of two parts. Its core is the integrated portable enforcement unit that can be moved from one intersection to another. This unit consists of a computer, a high-speed camera, a flash, a digital loop signal processor, and an optional memory card system. The fixed part of the system, dedicated to a single intersection, has wiring and detection loops installed in the roadway and a bullet-resistant cabinet mounted on a hinged pole. Approximately 80 percent of the system’s cost is in the portable enforcement unit, which can be effectively rotated among as many as 10 traffic intersections.

These cameras are activated only when a vehicle is detected entering the intersection after the traffic signal has turned red. Cameras are capable of taking two photographs: first when the vehicle enters the intersection, and again approximately 1.5 seconds later. These pictures show the vehicle’s illegal progression through the intersection. Each photograph includes a data box containing the date and location of the violation, the speed of the vehicle, the length of the yellow phase of the signal preceding the violation, and the precise number of seconds the signal was red prior to the vehicle entering the intersection. The driver’s face, the vehicle and the license plate, and other visible environmental conditions are shown in each photograph.

\(^{16}\) The information on USPTI Red Light Cameras discussed in this report is based on the brochures provided by USPTI and conversations with USPTI personnel.
3.1.5 Political and Public Support/Awareness Aspects

The key political decision-makers associated with the pilot project, such as the Mayor and the Board of Supervisors, were very supportive and provided coordinated efforts to make the project successful. The project received widespread community support from groups such as the Senior Action Network and the San Francisco Pedestrian Safety Coalition who have worked with Department of Parking and Traffic in support of automated photograph enforcement. The media also played a major role in disseminating the information on new technologies to the public.

Though it is too early to determine the effectiveness of the red light camera technology in terms of a reduction in the number of accidents, the red light enforcement program statistics (see Table 2) provided by the City of San Francisco show that red light running was reduced by more than 40 percent at the four intersections in the first six months of the automated photo enforcement program (November 1996 to April 1997). According to a recently released press release from the City of San Francisco on collision data, collisions resulting from infractions related to traffic control devices dropped by about 10 percent in 1997, the year after the installation of red light
cameras. This encouraged the City to expand the project to another 34 intersections. However, no information is available on the attitudinal survey that was supposed to be conducted to ascertain the public perceptions towards the pilot project.

Table 2. Red Light Enforcement Program Statistics

<table>
<thead>
<tr>
<th>Month/Year</th>
<th># of vehicles counted</th>
<th># of violations photographed</th>
<th>Ratio of violations to total vehicles detected (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov '96</td>
<td>2,698,241</td>
<td>2,986</td>
<td>0.11</td>
</tr>
<tr>
<td>Dec '96</td>
<td>3,214,898</td>
<td>3,087</td>
<td>0.10</td>
</tr>
<tr>
<td>Jan '97</td>
<td>3,842,595</td>
<td>3,493</td>
<td>0.09</td>
</tr>
<tr>
<td>Feb '97</td>
<td>3,662,034</td>
<td>2,669</td>
<td>0.07</td>
</tr>
<tr>
<td>Mar '97</td>
<td>3,748,881</td>
<td>2,535</td>
<td>0.07</td>
</tr>
<tr>
<td>Apr '97</td>
<td>2,111,905</td>
<td>1,362</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Source: Red light cameras fact sheet, Department of Parking & Traffic, Traffic Engineering Division, City and County of San Francisco.

3.2 Polk County's Red Light Pilot Project

Polk County, Fl, conducted one of the first demonstration projects showcasing automated photo enforcement technology. The project consisted of installation of red light cameras at an intersection in Lakeland, Haines City, Fort Meade, and Bartow. Apart from the installation of these four red light cameras, the project also included continuous video monitoring of some intersections. Conceived in the year 1993, and implemented in September 1994, this pilot project was one of the earliest experiments conducted on red light cameras in the United States. The main goals of the project were to test the various camera technologies developed by vendors, and to ascertain the impacts of automated photo enforcement on red light running, if any. The following sub-sections describe some issues associated with this project.

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17 Conversation with Bridget Smith, Red Light Photo Enforcement Project Manager, City of San Francisco.
18 The section on Fort Meade's pilot project is based mostly on the information provided by George Ferris, who was the project leader and also the Chief of Polk County Community Traffic Safety Team.
3.2.1 Legal Aspects

In the absence of any state law allowing the use of cameras to cite red light violators in Florida, no citations were issued, but warning letters were sent. This did not evoke much interest or response from the community as there are no provisions for fines. However, some commercial corporations responded, saying that they appreciated the information and that their drivers would be reprimanded.

3.2.2 Financial Aspects

The pilot project was federally funded, with more than $150,000 of support from Federal Highway Administration (FHWA). The County rented the camera equipment from different vendors (see section 4.2.3) and also paid them to install the cameras. However, one vendor (Aviar Inc.,) installed equipment at its own expense.

The Polk County Community Traffic Safety Team (CTST) was the lead agency the project. CTSTs involve a comprehensive, multi-disciplinary, and multi-jurisdictional approach to solving safety problems within a community such as a county, a portion of a county, multiple counties, or any other jurisdictional arrangement. Formed with representatives from the disciplines of engineering, enforcement, education, emergency services, these community traffic safety teams perform various activities concerned enforcement and public education. These teams are developed to solve local problems by involving the public, with assistance from the state.

3.2.3 Technological and Vendor Aspects

Since one of the goals of the demonstration project was to test various red light camera technologies available, cameras developed by different vendors were used. Three vendors USPTI, American Traffic Systems Inc., and Aviar Inc.-were involved in the project. Two intersections in Lakeland and Bartow were equipped with cameras from two different vendors, while two intersections in Haines City and Fort Meade were given to a single vendor, and the same camera was used on a rotation basis. Some intersections were monitored on a continuous basis by using video cameras. These cameras, controlled and viewed from nearby police stations, recorded several traffic crashes.
3.2.4 Public Awareness/Community Support Aspects

A public awareness campaign was conducted by posting signs at each of the intersections to increase awareness among the people on various aspects of red light running. However, it was determined that other special public awareness measures are needed to inform the vast number of visitors who rarely drive through these intersections.

3.2.5 Results and the Effectiveness of the Project

The following were the results from the pilot project:

- The reduction in red light violations and accidents is unknown because the duration of the project was short and cameras were used only periodically, not on a continuous basis. Also, most data that were collected have not yet been analyzed.
- A total of 15 violations/day were observed in Haines City and Lakeland, and 10 violations/day were observed in Fort Meade.
- The cameras worked very accurately during both day and night.
- No problems were faced in getting photographs of license plates, except with tractor-trailers with front license plates on power units.
- Two key issues in gaining public support were identified. One issue relates to the reluctance of the people to disclose the names and addresses of their friends to whom they loan their cars. The other is the delay in receiving a citation.

4.0 Project Costs

The cost of the photo enforcement projects varies depending upon the magnitude of the program, that is, the number of intersections to be equipped with red light cameras. The project costs include start up items such as cameras, housing (it protects equipment from environmental conditions and eliminates the problems of vandalism) and infrastructure such as installation of new loops and signal boxes at intersections. According to information provided by vendors, the cameras cost approximately $50,000 each, housing costs around $6,000; and installation of new loops requires another $10,000.
However, it is to be noted that the costs described here do not represent the costs on a whole project basis, but these are individual component costs.

5.0 Evaluation of the Red Light Camera Enforcement Projects

During the initial use of automated photo enforcement, it is important to evaluate the project and determine the device's effectiveness in reducing red light accidents caused by running red lights. These projects can be evaluated to determine reductions in actual red light violations after the installation of cameras; increased driver compliance to traffic control devices; and community, media, and political support to the use of technology. A number of such studies were done in California, Arizona, and New York. The Insurance Institute for Highway Safety evaluated red light camera enforcement project in Oxnard, while the Summit Group conducted an attitude and opinion survey concerning red light photo safety in Mesa and Tempe. This section summarizes results from these studies.

In a study conducted on police-reported crashes, the Insurance Institute for Highway Safety concluded that the likelihood of vehicle occupants sustaining injuries is increased in red light running crashes (45%) than the other types of crashes (30%). However, it may be too soon to conclude that accidents due to red light running will drop, as many of the photo enforcement projects in U.S are in their initial stages of development and implementation.

The City of San Francisco reported a 10 percent drop in collisions related to traffic control infractions after the implementation of automated photo enforcement. An Australian study reported a 32 percent drop in right-angle collisions at the intersection with red light cameras in Victoria. Some earlier studies done in the U.S. reported a decline in the number of tickets/violations issued after the installation of red light cameras.

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19 Personal communication, San Francisco Department of Parking and Traffic.
Figure 8 shows the percentage of reductions in red light violations after the implementation of automated photo enforcement. Results from San Francisco show that the rate of vehicles running red lights has dropped from approximately 5 violations per 5,000 vehicles to 3 vehicles per 5,000 vehicles. The City reported more than a 40 percent drop in red light running at four test intersections in the first six months of the program.

**Figure 8. Percentage Reduction in Red Light Violation Rates**

<table>
<thead>
<tr>
<th>Location</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>40%</td>
</tr>
<tr>
<td>Oxnard</td>
<td>62%</td>
</tr>
<tr>
<td>New York</td>
<td>32%</td>
</tr>
<tr>
<td>Alondra Blvd, LA</td>
<td>60%</td>
</tr>
<tr>
<td>Victoria, Australia</td>
<td>92%</td>
</tr>
</tbody>
</table>

Notes: 1. Red Light Cameras Fact Sheet, Department of Parking and Traffic, City and County of San Francisco  
2. Retting et al, Evaluation of red light camera enforcement in Oxnard, California, Insurance Institute for Highway Safety  
3, 4, and 6. Bond M. Yee et al., San Francisco red light camera enforcement program  
5. Joseph Genovese, Oxnard's experience with run red photo enforcement.

New York City reported that New Yorkers have altered their driving habits significantly after the installation of red light cameras, and the city experienced a 62 percent decrease in the average number of violations photographed per location since the program inception. Los Angeles, the first city in the United States to issue tickets based on automated photo enforcement, also showed promising results. The four-month pilot project on Compton Boulevard produced a 92 percent reduction in the number of violations; the three-month project at Alondra Boulevard reduced violations by 60 percent.

A study conducted by Insurance Institute for Highway Safety in the City of Oxnard, California, found a large and highly significant reduction in red light violations after the implementation of
photo enforcement program. It has been observed that the violation rates at the test sites reduced by about 42 percent. This study also found that the amount of citation fines would significantly influence the long-term effects of red light camera enforcement in Oxnard. The study believes that the implications in Oxnard will be influenced by the substantial increase (from $104 to $270) in red light violation fines in California.

The Summit Group conducted surveys two surveys for two cities in Arizona (Mesa in 1996 and 1997; Tempe in 1997 and 1998) to ascertain the attitudes and opinions concerning the use of photo radar and red light photo safety. The results from these surveys and other studies have been shown in Figure 9.

Figure 9. Percentage In Favor of Automated Photo Enforcement

The Summit Group conducted first survey immediately after the implementation of the red light camera projects, while the second survey was conducted one year after the implementation. Several questions were added to the second survey to see who might have received citations and its impact on their behavior towards the programs. The results from these surveys indicated significant improvement in public awareness of the enforcement projects (72 percent in 1997 from 28 percent in 1996 for Mesa; 61 percent in 1998 from 34 percent in 1997 for Tempe).
Survey results also show that the respondents continue to strongly support the safety programs (82 percent in 1997 and 76 percent in 1996 for Mesa). However, the biggest block of opposition came from the respondents who admitted they had been ticketed in the past for red light running. In a nationwide survey conducted by the Insurance Institute for Highway Safety in 1995, 61 percent of about 1,000 people surveyed favored the use of automated photo enforcement. According to another national survey sponsored by the Insurance Research Council, 61 percent of the respondents favored the use of cameras and it was also found that greatest support came from large cities. 20

6.0 Issues, Advantages, and Disadvantages of Automated Photo Enforcement

As the use of red light photo enforcement grows, a number of key issues, advantages, and disadvantages of these systems are being discovered and documented. Automated photo enforcement faces several challenges prior to implementation including legislative, legal, financial, technical, and awareness issues. This section describes some issues, advantages, and disadvantages associated with automated photo enforcement.

6.1 Legislative Issues

In most jurisdictions, it is necessary for an officer of the law to witness a traffic infraction before a ticket can be issued. Therefore, to implement photo enforcement projects, laws allowing governments to make use of cameras to identify red light runners are necessary. As discussed earlier, several states, including California, Maryland, and North Carolina, have amended their existing enforcement laws, while some local governments like Arlington, Virginia, Polk County, Florida; and Jackson, Michigan have been encouraging testing the technology by holding pilot projects.

However, passing the required legislative measures has, in some states, been difficult, with stiff resistance coming from several associations and politicians. Some of the issues that the required legislation should include are:

- How should a red light violation be handled—as a moving violation or as a violation similar to parking violation? This provides the answer to the question as of who will be liable for the violation—either the driver of the vehicle or the registered owner of the vehicle.
- Is it necessary to identify the drivers? Or should the tickets be issued to the owner/operator of vehicles. A procedure should be provided to establish if the vehicle was under the care of somebody else.
- Can images produced by red light cameras be used as a prima facie evidence to issue citations and also to convince the judiciary?
- What is the appropriate amount of citation fees and their distribution to vendors/operators and various other departments involved? This proved to be a difficult task in California. The State Assembly of California increased the citation fees from $104 to $270 because it was found that the fines and their distribution in the pilot project were inadequate to fund a full scale program.

6.2 Technical Issues

Today, various manufacturers are developing red light camera systems in the U.S. They not only supply and install the equipment, but they are also involved in the operation and maintenance of entire projects. By and large, the technological aspects of the cameras developed by different manufacturers are the same; however, differences might exist in their service standards. This section describes some of the technical aspects that should be considered in developing a red light camera project.

- Is the project a pilot project or a full-scale project? Conducting a pilot project (similar to the one in Polk County) along with an appropriate publicity campaign may help convince the legislature and gain the public and community support on the usefulness of red light cameras in reducing traffic accidents. This might eventually lead to a full-scale project if the results from pilot project prove to be positive.
• How do existing loops and signal system work with the new technology? This is an important concern because the installation of new loops and traffic signal equipment involves considerable costs. However, it has been found that most of these technologies work very well with the existing traffic signal equipment, but they do require the installation of new loops, and this costs approximately $10,000 per intersection.²¹

• What sort of cameras should be used—wet film or digital? As discussed earlier, most of the existing photo enforcement systems use wet film cameras because they provide greater resolution photographs. However, they involve more maintenance work since periodic loading and unloading of the film is required. Though digital cameras offer a high level of flexibility in storing and transmitting the photographs, it is possible to tamper the evidence using computer technologies.

• Should photos showing the violations be printed on the citations? The results from San Francisco project found that appeals to the courts that dispute the citations could be reduced by as much as 80 percent if the photographs are printed on the citations. This technique is useful in avoiding court battles, and thereby collecting the fines more rapidly. However, this would increase the cost of preparing the citation.

• Should police officers be trained, thus eliminating the need for vendor representatives in courts in case of disputes, and thus reducing costs?

• How should missing license plates and environmental factors like glare and obscurity be handled? These are found to reduce approximately 25 percent of the readable license plates.

6.3 Administrative/Inter-Departmental Issues

Implementation of red light camera projects requires coordinated and cohesive efforts among various governmental departments in the study area. These projects demand coordination among various agencies such as county/city transportation authorities, law enforcement agencies including police, judicial councils, and municipal courts; and elected officials. Another vital administrative issue regards the organizing agency that would be in charge of maintenance,

²¹ Conversation with Lauri S. Keller, Regional Marketing Manager, USPTI.
gathering and developing film, issuing citations, and providing expertise and evidence in the courts. Often these responsibilities are part of the vendor contract.

6.4 Public Awareness/Community Support Issues

The success of red light camera projects depends upon the understanding of the public on the use of the technology and the public support for the project. As automated photo enforcement is relatively a new and emerging technology, an aggressive public information and awareness campaign is essential to ensure driver compliance to traffic rules and fines imposed by new statutes. The target audience consists of many communities, including political decision makers, automobile associations, senior citizen groups (particularly for states like Florida), Traffic Safety Coalitions and Community Traffic Safety Teams, and various media including print, TV, and radio. Some of the issues associated with public awareness campaign include:

- developing partnerships and building coalitions with various agencies
- enlisting the support of law enforcement agencies
- gathering pre-campaign crash data related to red light running and explaining the advantage of using cameras to reduce those crashes, with proven results from other projects
- conducting media campaigns and developing customized media materials
- conducting and analyzing post-campaign surveys
- fully explaining the technology

6.5 Financial/Funding Issues

The financial aspect is one of the key issues in the implementation of red light camera projects. Because of the severe financial constraints, and in the absence of any proven record on the success of these projects, funding from local governments for these projects has been limited. City and County authorities are implementing automated photo enforcement projects with assistance from various state and federal agencies; however, most of the funding for pilot projects has come from vendors developing these technologies. These vendors have supplied, installed, operated, and maintained the technology; issued the citations; and collected revenues.
In turn, governments pay the vendors either a fee per paid citation or a fixed monthly/yearly fee. Some important financial issues associated with automated photo enforcement are:

- Identifying the funding source. This includes examining and evaluating various funding sources available such as federal/state/local/governments, and the vendors who may be willing to bear some of the expenses.
- Determining citation fees, and their distribution among various departments and agencies to ensure a justifiable compensation. This task has to be done by considering overall objectives and goals of the project. For example, if the vendors are paid a fee per paid citation, then there is a disadvantage of appearing to encourage a profit motive into vendors to issue more citations and hence more revenue. Conversely, if vendors are paid based on a flat monthly rate, the governing agencies should be willing to take some risks due to losses. It requires a reasonable estimation of the number of violations expected and the amount of revenue that would be generated; otherwise, the local agencies might incur losses.

6.6 Privacy Issues

The privacy issue has often been used as an argument against the use of red light cameras. Proponents of this argument claim that photographing vehicles whose drivers run red lights violates their privacy rights. The use of frontal photography (as used in states like California and Arizona) to identify drivers and take their photographs has been a major concern for this group of people. In this aspect, the use of cameras to record only the license plates in the rear of the vehicles, but not the vehicle occupants, will greatly reduce the problem. Furthermore, a well-planned public awareness campaign that explains the advantages of cameras to the community in containing the violations, could also help in solving the privacy issue.

6.7 Advantages

Automated photo enforcement using red light cameras helps to:

- reduce the problem of limited enforcement resources and logistical difficulties of conducting traditional methods of traffic signal violation enforcement.
- reduce red light running, and hence the number of crashes
• modify driver behavior, particularly if used in conjunction with public awareness campaign
• provide evidence that can be used in the court both for red light violations and accidents
• captures more violators, and increased revenue can be used for various developmental purposes or to expand the violation program to additional intersections
• reduce insurance rates and health care costs for drivers
• increase the safety of drivers and law enforcement officers

6.8 Disadvantages

Automated photo enforcement may also result in some disadvantages, including:
• dealing with legislative issues, which can be very time consuming and may take many years and much effort before adoption
• selecting intersections and vendors can be complex and time consuming once the legislation is in place for the development of a photo enforcement program
• dealing with the large time lag between when an infraction occurs and when the violator receives a ticket. This is confusing and requires violators to try to remember if they were the driver and the circumstances surrounding the infraction. Using traditional methods, the violator is identified almost immediately and can prepare a possible defense of their actions.
• dealing with the vehicle owners who were not driving the vehicle at the time of the infraction it puts the owner of the vehicle in an awkward situation. The owner might have to confront the driver and get that person (likely a friend or a relative) to get to court and pay the fine.
• high start up and infrastructure costs involved with the project
• the potential loss of privacy
• public perceptions--If the goal of the governments and vendors is to increase revenue by fixing high citation/ticket fee, it may result in public opposition. The program should be oriented to improve the quality of life by reducing safety concerns.
7.0 Conclusions

Based on interviews with red light photo enforcement vendors and project managers, literature, and personal site visits, the following conclusions can be drawn:

Traffic infractions due to red light running pose severe and growing concerns, and the safety consequences are enormous. Red light running can be reduced by using various engineering measures like adjusting signal timing and removing unwarranted signals, and also by traditional enforcement. However, limited enforcement resources and logistical problems make it difficult to adequately enforce the law at hundreds (even thousands) of intersections in urban areas.

Automated photo enforcement provides an approach for better compliance with traffic control devices and improves safety at the intersections, and, in some cases, it will have a greater impact on violators as the cameras provide undeniable photographic proof of the violation.

Interest in red light camera systems is growing rapidly among state agencies and local governments. The results from various evaluation studies are promising, which indicate significant reductions in red light violation rates as well as considerably improved awareness, after the implementation of photo enforcement programs. In San Francisco, red light running was reduced by more than 40 percent at four intersections in the first six months of the program, and this encouraged the City to expand the project. The New York City experienced a 62 percent decrease in the average number of violations photographed per location, and it has been observed that the violation rates at the test sites reduced by about 42 percent in the City of Oxnard.

A state law and subsequent amendments to the local ordinances are essential to implement automated photo enforcement projects. These legal issues are complex and need to address several issues, including liability aspects, citation fines, and equitable distribution of fines to various agencies involved. Adopting the required legislation to allow photo enforcement and developing liability standards are time consuming and require support from several communities.
People may also have concerns over a loss in privacy, especially if frontal photography is needed.

A well planned and focused public awareness and information campaign is essential for the success of photo enforcement projects. Involvement of various community, traffic safety, and automobile agencies such as Community Traffic Safety Teams, Senior Citizen Groups, and AAA would help in convincing the community. Law enforcement officers need to be trained to effectively deal with the new technology.

Though significant initial investments are necessary to acquire camera technology, install new loops and for conducting public awareness campaigns, automated photo enforcement projects can be cost neutral because the fines can pay for the program. However, a number of vendors are showing keen interest in participating in photo enforcement pilot projects at their own expense, by associating with various state and local agencies. Such pilot projects can be converted into long-term and meaningful safety projects by offering incentives such as, a fixed monthly/annual fee or a fee per paid citation, to vendors.

Finally, automated photo enforcement is important and holds promise to the future of law enforcement by reducing red light crashes and enhancing safety at intersections.
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Appendix

Appendix A: Information from Red light Camera Vendors

Appendix B: Legislation from North Carolina and California

Appendix C: Contacts
Appendix A

Information from Red Light Camera Vendors
The Red Light Camera, an Automated Traffic Intersection Enforcement System from U.S. Public Technologies Inc. (USPT), produces photographic evidence of vehicles illegally running red lights. The Red Light Camera combines a computer with a high-speed industrial camera and sub-surface detection loops to provide around-the-clock intersection enforcement.

In use around the world (Europe, Asia and the U.S.), the Red Light Camera has proven to be extremely effective in preventing accidents and reducing the number of traffic intersection violations. In Jackson, Michigan, violations at intersections monitored by USPT Red Light Cameras have declined by 67%. And in Compton, California, violations have been reduced by 84% at monitored intersections.

The Red Light Camera System

The Red Light Camera system consists of two parts. At its core is the integrated portable Enforcement Unit that can be moved easily from one intersection to another. This portable unit consists of a computer, high-speed camera, flash, digital loop signal processor and an optional memory card system. The fixed part of the system, dedicated to a single intersection,
has wiring and detection loops installed in the roadway, and a bullet-resistant cabinet (which houses the portable Enforcement Unit) mounted on a hinged pole. Approximately 80% of the system's cost is in the portable Enforcement Unit, which can be effectively rotated among as many as ten traffic intersections. In addition to being cost-effective, this type of installation serves as an effective deterrent because potential violators are unable to tell the difference between an "active" and an "inactive" system and are unwilling to take the chance of being cited.

Upon detection of a traffic intersection violation, two photographs are taken—first, when the vehicle enters the intersection and again approximately 1.5 seconds later. These pictures show the vehicle’s illegal progression through the intersection. Superimposed on each photograph is a data box containing the time, date and location of the violation; the speed of the vehicle; the length of the yellow phase of the signal preceding the violation; and the precise number of seconds the signal was red prior to the vehicle entering the intersection. The driver's face, the vehicle and license plate, and other visible environmental conditions are clearly visible in each photograph.

How the Red Light Camera Works
Activation of the Red Light Camera occurs only when a vehicle is detected entering the intersection after the traffic signal has turned red. The system remains dormant at all other times, unless the optional component allowing the system to record green-light speeding violations is installed.
USPT provides a complete line of traffic enforcement and survey systems and services. Our line of Automated Traffic Enforcement products includes TRA Guard for railroad grade crossing enforcement, Red Light Cameras for intersection enforcement, and PhotoRadar for speed enforcement. We also provide these systems as part of a complete Turnkey Processing Service which includes all of the backshop processing services, such as developing the film, viewing the images, running the plates through the motor vehicle registry and printing and mailing the citations on a fee per transaction basis.
Permanent Camera Recording Systems for Speed and/or Red-Light

Permanent camera recording systems for speed, speed and red-light or dedicated red-light are successful in reducing road traffic accidents on a permanent basis at the exact location of occurrence. The system can easily be moved from one to another permanent housing. With our patented piezo electric "T" sub-surface profiles speed law enforcement can be undertaken with proven reliability on bridges, in tunnels, on curves and corners and in dense road traffic situations, thus making the system extremely versatile. Using the same system, simultaneous Red-light violations can also be recorded, making the TRUVELO system unique. The dedicated red-light violation recording system makes use of scanning inductive loops (one or two per traffic lane, up to 4 lanes) to prevent loop crosstalk together with unique algorithms to avoid false camera triggers produced by "creeping" vehicles. Combining various sub-systems battery or 220V mains powered sites can be accommodated for. Please contact your local agent for assistance in optimising a system for your specific requirements.

### Camera Recorder

- **Camera:** Robot Motorrecorder 36DCE
- **Shutterspeed:** 1/1000s fully flash synchronised.
- **Lens:** Schneider Kreuznach 45mm, 75mm, 90mm or 150mm
- **Filter:** Rg 610-665, magenta or orange
- **Optional Automatic aperture adjuster.**
- **Film material:** Std. 35mm by 36 exposures.

### Optional Remote Control Unit

With this optional remote control unit the operator can monitor and control the M4 MPC speed measuring instrument. It can also be connected to a paper printer for print out of speed violations and statistical data.

### Specifications:

<table>
<thead>
<tr>
<th>Camera Recorder</th>
<th>M4\textsuperscript{2} Speed Measuring Instrument</th>
<th>Optional Remote Control Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Camera:</strong></td>
<td>Permanent Camera Recorder</td>
<td>With this optional remote control unit the operator can monitor and control the M4 MPC speed measuring instrument. It can also be connected to a paper printer for print out of speed violations and statistical data.</td>
</tr>
<tr>
<td><strong>Shutterspeed:</strong></td>
<td>1/1000s fully flash synchronised.</td>
<td></td>
</tr>
<tr>
<td><strong>Lens:</strong></td>
<td>Schneider Kreuznach 45mm, 75mm, 90mm or 150mm</td>
<td></td>
</tr>
<tr>
<td><strong>Filter:</strong></td>
<td>Rg 610-665, magenta or orange</td>
<td></td>
</tr>
<tr>
<td><strong>Optional Automatic aperture adjuster.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Film material:</strong></td>
<td>Std. 35mm by 36 exposures.</td>
<td></td>
</tr>
</tbody>
</table>

### M4\textsuperscript{2} Speed Measuring Instrument

This German PTB and British home office approved speed measuring instrument performs two independent time measurements making use of 4 detector cables/profiles and converts these into speed using the formula distance divided by time.

- **Detection system:** Flush mounted Piezo electric "T" profiles
- **Measuring distance:** 1.5m
- **Time measurement resolution:** ±0.1 milli seconds
- **System accuracy:** ±2km/h or ±2%, whichever higher

| Speed range: 10km/h to 300km/h  |
| Standard features: Manual or automatic operation | Test push button for instrument calibration check | Faulty accessory indication | Speed limit selection with overspeed alarm | Time of violation indication |

- **Power supply:** 12V, 18W
- **Operating temperature range:** -5°C to +65°C (optional -20°C to 70°C)
- **Humidity:** 98% non condensing
- **Dimensions:** 435mmx110mmx340mm
- **Weight:** 6kg

### M4 MPC Speed Measuring Instrument

This instrument makes use of multi processor control technology to take two independent time measurements from 3 or 4 detector cables/profiles. These times are converted into speed using the formula distance divided by time. Additional control measurements are taken for reliable speed results. The same specifications as per M4\textsuperscript{2} apply expect for the following:

| Time measurement resolution: ± 4 micro seconds |
| Standard features: Normal or low speed limit selection with overspeed alarm | Time of violation indication | Alpha-numeric liquid crystal display with automatic backlighting |

<table>
<thead>
<tr>
<th>Integral traffic statistical data: lowest/highest speed</th>
<th>-average speed and 65%</th>
<th>-peak and average traffic flow</th>
<th>-total and violating vehicle count</th>
<th>-vehicle speed distribution</th>
</tr>
</thead>
</table>

### Optional Remote Control Unit

With this optional remote control unit the operator can monitor and control the M4 MPC speed measuring instrument. It can also be connected to a paper printer for print out of speed violations and statistical data.

### 12V Battery Power Interface for Speed

Permanent speed violation recording systems can be powered by 12V, 200 Ahr rechargeable batteries for a period of 3-7 days.

### 220V Mains Power Interface for Speed

This interface unit is transportable from one to another permanent housing. It provides power for the flash (300 Joules at a repetition rate of 0.5s) as well as a battery back-up for 20 hours to the system in case of mains power failure.

### 220V Mains Power Interface for Red Light

The same as above with the addition of the inductive loop control- and red-phase interface circuitry for traffic intersection violation recording systems.

### Permanent Housing

Tamper proof, powder coated stainless steel housings with mounting pole and optional bullet proofing. The power interface units can optionally be permanently fixed into the permanent outer housing for ease of operation.

For more details contact:

AVIAR inc
P.O. Box 162184
Austin, Texas 78716 USA
TRUVELO COMBI

SPEED VIOLATION

TRAFFIC LIGHT VIOLATIONS

WITH REMOTE UNIT AND PAPER PRINTER
**Truvelo "Combi" System Specification**

Our latest development - the TRUVELO "COMBI" - is a combination of two well-known products, the M4-MPC speed measuring instrument and the TRUVELO camera recording system. It uses modern microprocessor technology and is supplied in one, robust housing for ease of installation.

- Operation on all roads and in all traffic conditions.
- Simple, rapid installation.
- Manual or automatic operation for portable or permanent installations.
- Successive photographic evidence with driver identification with 0,5 second intervals.
- Guarantee: 12 months
- Full support with maintenance, service and spares.
- Fault finding indication.

### Camera Specification

<table>
<thead>
<tr>
<th>Camera</th>
<th>Robot Motorrecorder 56DCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutter Speed</td>
<td>1/1000s fully flash synchronised.</td>
</tr>
<tr>
<td>Lens</td>
<td>Schneider Kreuznach 45mm, 75mm, 90mm or 150mm</td>
</tr>
<tr>
<td>Filter</td>
<td>Kg 610-665, magenta or orange</td>
</tr>
<tr>
<td>Film Material</td>
<td>Std. 35mm by 36 exposures</td>
</tr>
<tr>
<td>Optional Bulk Film Magazine</td>
<td>17m (400 exp.) or 30m (800 exp.)</td>
</tr>
<tr>
<td>Displays</td>
<td>7 Segment L.E.D.</td>
</tr>
<tr>
<td>Clock Accuracy</td>
<td>±2 min. per month</td>
</tr>
</tbody>
</table>
| Auxiliary Shutter for Recording | - time (h.m.s.0.1s)  
- date (y.m.d)  
- Edgit code (or 3 digit code + 3 digit photo count) |
| For Speed or Speed with Red-light Violation Systems | - red-phase timer (0.1s)  
- 2x3 digits speed |
| Additional Displays | - Photo counter  
- Traffic counter (red-light violation) |
| Flash | Integral 140 Joules (ept. 280 J) with flash repetition time of 0.7s for 12V battery applications |
| Adjustable Delays for System Activation after Red Phase Detection and 2nd Photograph | |
| Camera Motor Overload Protection | 12V 2.4W standby  
Camera only 24W (0.5s)  
12V Flash 500W (6.7s) |
| Operating Temperature | -5°C to +55°C  
(-20°C to +70°C optional) |
| Humidity | 98% non condensing |
| Dimensions | 425mm x 305mm x 410mm |
| Weight | 17kg |

### M4-MPC Specification

This instrument makes use of multi processor control technology and performs two independent time measurements from 3 or 4 detector cables/profiles. These times are converted into speed using the formula distance divided by time. Additional control measurements are taken for reliable speed results.

| Detectors | Piezo electric co-axle cables |
| Measuring Distance | 1.5m |
| Calculator | 5 400/t (fully electronic, 2 independent systems) |
| Automatic Reset | Speed difference of more than 2km/h |
| Systems Accuracy | ±2km/h up to 100km/h  
±2% over 100km/h |
| Speed Range | 10km/h to 300km/h |
| Time Measurement Resolution | ± 4 micro seconds |
| Standard Features | - Normal or low speed limit selection with overspeed alarm  
- Time of violation indication  
- Alpha-numeric liquid crystal display with automatic backlighting |
| Integral Traffic Statistical Data | - lowest/highest speed  
- average speed and 85%  
- peak and average traffic flow  
- total and violating vehicle count  
- vehicle speed distribution |
| Power Supply | 12V, 0.5W, 20hours from internal battery |

### Remote Control Unit Specification

- Portable hand-held remote unit with:
  - Micro processor technology
  - Intelligent 4 rows x 16 character dot matrix display giving:
    - Both speeds measured
    - Average speed
    - Standard deviation
    - 85 percentile
    - Highest/lowest speed recorded
    - Peak and average traffic flow
- Audible buzzer for violator
- Keypad to control combi:
  - Reset
  - Test function
  - Clear violation counter
  - Clear traffic counter/statistics
  - Speed limit low select (for trucks)
- Printer connection for print out of:
  - Statistical data
  - Control sheet of violators

Extension cable up to 100m.

For more details contact:

**AVIAR inc**  
**P.O. Box 162184**  
**Austin, Texas 78716**  
**USA**
Appendix B

Legislation from North Carolina and California
SYNOPSIS OF STATE LAWS ON PHOTOGRAPHIC ENFORCEMENT OF TRAFFIC LAWS

CALIFORNIA

Secs. 21362.5 and 21455.5. Automated enforcement systems.

The California Vehicle Code authorizes governmental and law enforcement agencies to operate "automated enforcement systems" at railroad grade crossings (sec. 21362.5) and traffic light intersections (sec. 21455.5). Cal. Veh. Code secs. 21362.5 & 21455.5 (West 1994).

Sec. 210 of the Vehicle Code defines an "automated enforcement system" as "...any system...that photographically records a driver's responses to a rail or rail transit signal or crossing gate, or both, or to an official traffic control device...and is designed to obtain a clear photograph of a vehicle's license plate and the driver of the vehicle." Automated enforcement systems are authorized for permanent use at railroad crossings. However, under sec. 21455.5, the devices may only be used at traffic light intersections until 1/1/99.

Both sec. 21362.5 and sec. 21455.5 require that signs be posted giving notice to drivers of the presence of automated enforcement systems. Both statutes also provide that photographic records made by automated enforcement systems are confidential. These records may only be accessed by relevant governmental and law enforcement agencies, the registered owner of the violating vehicle, and any individual identified by the violating vehicle's owner as the driver at the time of the alleged violation. If signs are posted to notify drivers of the system's presence.

Sec. 22451 states that violations detected by an automated enforcement system are subject to the procedures established by sec. 40518. Under sec. 40518, a written notice to appear, issued by a peace officer or a qualified employee of a law enforcement agency and mailed within fifteen days of the alleged violation to the current address of the registered owner of the violating vehicle, constitutes a complaint against the vehicle owner.

DELWARRE

COMMENT: 1995 House Bill 194, which was introduced on SL195, authorizes photo-traffic monitoring at red lights. The bill failed to pass the Delaware House on 6/29/95, but is currently being reconsidered by the House.

FLORIDA

COMMENT: 1995 House Bill 247 authorizes counties and municipalities to use "traffic infraction detectors," and to contract with private providers for traffic infraction detectors. An amended version of this bill passed the Florida House on 4/26/95. (The amended version is not yet available on-line.)

The original version of 1995 House Bill 247 defines a traffic infraction detector as "a traffic control device used to detect traffic infractions through photographic means, which when used in cooperation with a speed calculating device, compiles with sec. 316.1905(1). Sec. 316.1905(1)m mandates that speed enforcement devices used by police must be of a type approved by the Department of Highway Safety and Motor Vehicles, and must be tested at least every six months by the Department. If a signed and witnessed certificate shows that the device was tested within the specified period and that the device was working properly, the device is presumed to be accurate and reliable.

All deployed traffic infraction detectors must also meet various requirements to be established by the Florida Department of Transportation. Operators of the devices must qualify as traffic infraction officers under sec. 318.141.

As originally drafted, the bill authorizes county and municipality to adopt an ordinance providing for the imposition of monetary liability on the owner of the violating vehicle detected by a traffic infraction detector. Owner liability is imposed in the same fashion as parking owner liability under sec. 316.1962. Tickets are mailed first class to owners of violating vehicles. The tickets may be processed by the county or municipality with jurisdiction over the street or highway where the violation occurred, or by any other entity authorized by said county or municipality. A ticketed owner may avoid liability by furnishing evidence that at the time of the violation the vehicle was in the care, custody, or control of another person. Counties are authorized to use at least 50% of the net ticket proceeds to create additional law enforcement positions and to raise salaries of law enforcement officers. Drivers with outstanding fines are placed on a list which bars the driver from obtaining a license plate or re-validation license plate sticker.

ILLINOIS

COMMENT: 1995 Senate Bill 1154, introduced S4/195, authorizes the Regional Transportation Authority, together with the Illinois Commerce Commission and local law enforcement agencies, to establish a two-year automated railroad crossing enforcement pilot program in DuPage County.

The bill defines an automated railroad crossing system as, "a system operated by a law enforcement agency that records a driver's response to a railroad crossing signal or mechanical signal device and provides a clear photograph or other recorded image of the vehicle, vehicle operator and the vehicle registration plate of a violating vehicle...[while also] display[ing] the time, date and location of the violation."

Beginning 11/1/96, the Illinois Commerce Commission is to identify the three most dangerous railroad crossings in DuPage County, and, with the approval of local law enforcement, is to equip those crossings with photo-enforcement systems. Signs giving fair notice of the system's use must be posted at the three crossings.

Under the plan, local law enforcement agencies send a Uniform Traffic Citation to the registered owner of a violating vehicle within 30 days of the violation. A written explanation of the violation's rights and obligations must accompany the mailed citation. Photographs or recorded images made by an automated enforcement system are admissible as evidence in any proceeding related to an automated enforcement system.

1995 Senate Bill 1154 was passed by the Illinois Senate on 4/24/95, and the bill was referred to the House Committee on Transportation and Motor Vehicles on 5/17/95. The bill was reported by the House Committee on Transportation and Motor Vehicles on 10/30/95, no further action on this bill was reported.

MASSACHUSETTS

COMMENT: 1995 House Bill 2433, introduced 2/3/95, permits the use of photo monitoring devices as a means of promoting traffic safety. On 9/18/95, the bill was moved from the Joint Committee on Public Safety without comment.

NEW JERSEY

Sec. 39:4-103.1. Prohibition of photo radar.
To: County Auditors  
From: Assemblyman Kevin Shelley and CSAC  
Date: January 6, 1998  
Re: AB 1191 – allocation of fines for red light violations

On October 10, 1997, Governor Wilson signed into law AB 1191, which increases the fine for motorists who run red lights and allocates half of the increase to the city or county where the violation occurred. This memo is meant to clarify how the base fine and penalty assessment monies for red light violations should be distributed under AB 1191, both before and after the effective date of the trial court funding legislation. This supercedes the memo of November 14, 1997.

1. As of January 1, 1998, the base fine for running a red light is $100. This applies to all violations of Vehicle Code Sections 21453(a), 21453(c), 21454(c), and 21457(a). There is no increase in the base fine for subsequent violations.

2. The mandatory state penalty assessment of $100 (PC Section 1464) and a local penalty assessment of $70 (GC Section 76000) are added to make the total fine $270.

3. Pursuant to Government Code 68090.8, two percent of the total penalty amount shall be distributed to the State Trial Court Improvement Fund. This works out to be $5.40.

4. As a result of AB 1191, thirty percent (30%) of the remaining total shall be allocated to the general fund of the city or county where the violation occurred. This works out to $79.38.
5. The percentages subtracted in steps 3 and 4 are taken out of the base fine and assessments in equal proportions. As a result, the remaining base fine equals $68.60. The remaining state penalty assessment is also $68.60. The remaining local penalty assessment is $48.02.

6. For red light violations committed in incorporated areas between January 1, 1998 and June 30, 1998, the $68.60 in base fine monies shall be distributed as follows: 1) The county receives its corresponding share pursuant to Penal Code 1463.002. This amount will vary according to county. 2) What is left after subtracting the county’s 1463.002 share is then split 50%-50% between the city and the county.

7. For red light violations committed in incorporated areas on or after July 1, 1998, the $68.60 in base fine monies shall be distributed as follows: 1) The county receives its corresponding share pursuant to Penal Code 1463.002. This amount will vary according to county. 2) The city receives all of base fine money left after the county’s 1463.002 share is subtracted.

8. For all red light violations committed in unincorporated areas on or after January 1, 1998, the entire $68.60 of base fine money shall be distributed to the county.

The following table breaks down the distribution of fine and assessment monies required by AB 1191:

<table>
<thead>
<tr>
<th>Violations in incorporated areas</th>
<th>January 1, 1998 - June 30, 1998</th>
<th>On or after July 1, 1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Trial Court Imp. Fund</td>
<td>$5.40</td>
<td>$5.40</td>
</tr>
<tr>
<td>City General Fund</td>
<td>$79.38</td>
<td>$79.38</td>
</tr>
<tr>
<td>State Penalty Assmt</td>
<td>$68.60</td>
<td>State Penalty Assmt</td>
</tr>
<tr>
<td>County Penalty Assmt</td>
<td>$48.02</td>
<td>County Penalty Assmt</td>
</tr>
<tr>
<td>City and County Shares*</td>
<td>$68.60</td>
<td>City and County Shares**</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$270.00</td>
<td>Total $270.00</td>
</tr>
<tr>
<td>Violations in unincorporated areas</td>
<td>State Trial Court Imp. Fund $5.40</td>
<td>State Trial Court Imp. Fund $5.40</td>
</tr>
<tr>
<td>County General Fund</td>
<td>$79.38</td>
<td>County General Fund</td>
</tr>
<tr>
<td>State Penalty Assmt</td>
<td>$68.60</td>
<td>State Penalty Assmt</td>
</tr>
<tr>
<td>County Penalty Assmt</td>
<td>$48.02</td>
<td>County Penalty Assmt</td>
</tr>
<tr>
<td>County Share of Base Fine</td>
<td>$68.60</td>
<td>County Share of Base Fine $68.60</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$270.00</td>
<td>Total $270.00</td>
</tr>
</tbody>
</table>

*County share calculated pursuant to Penal Code Section 1463.002. Remainder split 50%-50% between the city and the county.

**County share calculated pursuant to Penal Code Section 1463.002. Remainder distributed to the city.

If you have any questions regarding this memo, please feel free to contact Mark Stivers in Assemblyman Shelley’s office (916-445-8253), Rubin Lopez at CSAC (916-327-7500) or Michael Corbett (916-442-0412).
6.2 N.C.G.S. 160A-300.1

GENERAL ASSEMBLY OF NORTH CAROLINA
1997 SESSION
S.L. 1997-216

SENATE BILL 741

AN ACT TO AUTHORIZE LOCAL GOVERNMENTS TO USE PHOTOGRAPHIC IMAGES AS PRIMA FACIE EVIDENCE OF A TRAFFIC VIOLATION.

The General Assembly of North Carolina enacts:

Section 1. Chapter 160A of the General Statutes is amended by adding a new section to read:

"160A-300.1. Use of traffic control photographic systems.

(a) A traffic control photographic system is an electronic system consisting of a photographic, video, or electronic camera and a vehicle sensor installed to work in conjunction with an official traffic control device to automatically produce photographs, video, or digital images of each vehicle violating a standard traffic control statute or ordinance.

(b) Any traffic control photographic system or any device which is a part of that system, as described in subdivision (a) of this section, installed on a street or highway which is a part of the State highway system shall meet requirements established by the North Carolina Department of Transportation. Any traffic control system installed on a municipal street shall meet standards established by the municipality and shall be consistent with any standards set by the Department of Transportation.

(c) Municipalities may adopt ordinances for the civil enforcement of G.S. 20-158 by means of a
traffic control photographic system, as described in subsection (a) of this section. Notwithstanding
the provisions of G.S. 20-176, in the event that a municipality adopts an ordinance pursuant to this
section, a violation of G.S. 20-158 at a location at which a traffic control photographic system is in
operation shall not be an infraction. An ordinance authorized by this subsection shall provide that:

(1) The owner of a vehicle shall be responsible for a violation unless the owner can
furnish evidence that the vehicle was, at the time of the violation, in the care, custody, or
control of another person. The owner of the vehicle shall not be responsible for the violation if the
owner of the vehicle, within 21 days after notification of the violation, furnishes the officials or agents
of the municipality which issued the citation:

a. The name and address of the person or company who leased, rented, or
otherwise had the care, custody, and control of the vehicle; or

b. An affidavit stating that the vehicle involved was, at the time, stolen or in the
care, custody, or control of some person who did not have permission of the owner to use the
vehicle.

(2) A violation detected by a traffic control photographic system shall be deemed a
noncriminal violation for which a civil penalty of fifty dollars ($50.00) shall be assessed, and for
which no points authorized by G.S. 20-160 shall be assigned to the owner or driver of the vehicle.

(3) The owner of the vehicle shall be issued a citation which shall clearly state the
manner in which the violation may be challenged, and the owner shall comply with the directions on
the citation. The citation shall be processed by officials or agents of the municipality and shall be
forwarded by personal service or first-class mail to the address given on the motor vehicle
registration. If the owner fails to pay the civil penalty or to respond to the citation within the time
period specified on the citation, the owner shall have waived the right to contest responsibility for the
violation, and shall be subject to a civil penalty not to exceed one hundred dollars ($100.00). The
municipality may establish procedures for the collection of these penalties and may enforce the
penalties by civil action in the nature of debt.

(4) The municipality shall institute a nonjudicial administrative hearing to review
objections to citations or penalties issued or assessed under this section."

The Photo Citation Program
Charlotte Department of Transportation
Section 2. This act applies to the City of Charlotte only.

Section 3. This act is effective when it becomes law.

In the General Assembly read three times and ratified this the 23rd day of June, 1997.

s/ Dennis A. Wicker

President of the Senate

s/ Harold J. Brubaker

Speaker of the House of Representatives
The TRUVELO camera system for recording of speed, speed and traffic light, or dedicated traffic light violations is of modular, compact, and lightweight design. The system is robust, with a proven track record of more than 15 years. It records the violating vehicle, road sensors, driver identity, and all relevant data about the violation onto film, under all light conditions. This is achieved by using an automatic aperture adjuster, a powerful electronic flash with fast recharge time and optical filters.

The TRUVELO Camera Recording System uses 35mm film as the data and image storage medium, which is extremely safe and reliable. All the required violation data is on the negative and form part of the photo image and therefore cannot be altered, accidentally erased, or manipulated. The TRUVELO Photographic Image Processing hardware and software package applies image processing to the negative, automatically extracts data, and issues intent of prosecution notices.

The road sensors used for speed violation recordings are piezo-electric detectors. Three or four of these sensors, spaced a fixed distance apart, are used to obtain two independent time measurements. These are converted into speed using the formula distance divided by time. Two independent measurements again provide for additional system reliability for Court purposes. Although these detector cables/profiles have to be placed across the road to detect axles passing over them, they allow for accurate speed measurements not possible with conventional detection methods. Even in dense traffic situations, under bridges, in tunnels, and around bends the TRUVELO system detects axles accurately. The violating vehicle is always clearly visible and positioned on the road detectors.

TRUVELO uses a unique secondary speed-checking method by which the violation vehicle's front wheels must be on a predetermined marked position on the photograph. Any deviation from this shows a possible system malfunction. This means that instruments can be installed with confidence, in portable and/or permanent sites, producing watertight evidence to reduce the accidents and fatalities in such identified areas drastically. This was proven by many users of TRUVELO Camera Recording Systems.

The road sensors used for traffic intersection violation recordings are inductive loop detectors. One or two of these loops are installed per lane, to cover a maximum of 4 traffic lanes. Voltage or current interface sensors detect the "red" and "amber" phases of the traffic light. The TRUVELO loop detection system uses a special "in-house" algorithm to exclude triggers from vehicles "creeping" over the stop line. Once the traffic light turns red, the amber phase was present for a minimum time, the operator-set delay time has passed, and a vehicle crosses the detectors, two photographs are taken a selectable time delay apart.

The TRUVELO systems, combining speed and traffic light violation recordings, also use piezo detectors. Other systems, that use loop detectors, ONLY obtain a NON-ENFORCEABLE SPEED indication for red light violations, whereas TRUVELO produces an enforceable speed measurement.
During the green phase, the system will record enforceable speed violations. During the red phase, the system will photograph speed and/or red light violators. This application is another "first" from TRUVELO.

The TRUVELO Camera Recording System is equally at home in portable or permanent installations and operates under extremes of temperature. Portable installations allow for freedom of movement to sites with reported violation problems. The system is tripod-mounted and powered by a 12-volt automotive (car) battery. The same system can also be inserted into a stainless-steel permanent outerhousing, which protects it against vandalism and is 2.5 meters above the ground. In this instance, it is powered by 220-volt mains supply. Many users have proved that permanent violation recording systems installed at accident-prone sites reduce the accidents and/or fatalities drastically. One system can be moved to different outerhousings, thus covering a large area and making the system very cost-effective.

Depending upon the application, installation, and the size of the license plate, 2 to 3 traffic lanes can be covered by the system. Adding optical filters to the powerful electronic flash with a fast repetition time, frontal vehicle photography is possible under all lighting conditions. This enables positive driver identification. With a 30-meter film magazine attached to the camera, 800 photographs can be taken.

For combined speed and traffic light violation recording systems, the data block appearing in the top right-hand corner of the photograph shows the time, date, site or location code, two speed readings, and the duration of the red phase. In dedicated traffic light violation recording systems, the speed readings are exchanged for a violation counter and lane of violation indications. The TRUVELO Camera Recording System simultaneously photographs this data block from a display panel, via a secondary shutter assembly, and the violating vehicle through the main shutter. This data is not "written" onto the picture AFTER the main picture has been taken, thus eliminating another source of possible errors.

Much thought, experience, and technology went into the design of these systems. They can be used with confidence to reduce unnecessary road accidents and fatalities. They are backed up by a team of dedicated engineers. Please contact one of our representatives for further information about the TRUVELO Camera Recording Systems.

Truvelo Distributor——
AVIAR inc P.O. Box 162184 Austin, TX 78716 Tel: (512) 295-5285 Fax: (512) 295-2603
SPECIFICATIONS FOR TRUVELO “COMBI S” SYSTEM FOR PERMANENT SPEED INSTALLATIONS

TRUVELO “COMBI S” SPEED CAMERA SYSTEM

Camera: ROBOT Motor recorder 36DCE
Shutter speed: 1/1000s fully flash synchronised
Lens: Schneider Kreuznach, 45mm, 75mm, 90mm or 150mm with Automatic aperture adjuster
Lens filter: RG610-665, magenta or orange
Film material: Std. 35mm by 36 exposures
Bulk film magazine: up to 30m (800 exp.)
Displays: 7 Segment L.E.D.
Auxiliary shutter, for recording onto film negative of:
- time (h,m,s,0.1s)
- date (d,m,y) or (y,m,d)
- 6 digit site code
- violation counter
- speed (km/h)
- secondary speed verification time (for vehicle to travel 1.8m)

Additional displays:
- Photo counter
- Traffic counter
Flash: Integral 360 Joules with flash repetition time of 0.5s
Electronic camera motor overload protection.
Power supply: 220Vac, Mains
Battery backup power: 8 hours
Operating Temperature:
-20°C to 70°C
Humidity: 98% non condensing
Dimensions: 425mm x 276mm x 315mm
Weight: 13 kg

Speed measuring instrument:
Three or four independent time measurements are taken, using three micro-processors, with three or four piezo detectors and converting these into speed using the formula distance divided by time. Two primary speed results have to be within ±2km/h to be accepted. Truvelo only uses one picture to independently verify the speed by means of a secondary method. All this information is contained on the photograph.

Detection system:
Flush mounted TRUVELO Piezo-electric "T" profiles
or
Sub-surface mounted piezo cables

Measurement distance:
1.50m
Time measurement resolution:
±5 micro seconds
System accuracy:
±2km/h or ±2%, whichever higher
Speed range:
10km/h to 300km/h

Standard features:
- Alpha-numeric liquid crystal display with automatic backlighting
- Manual or automatic operation
- Automatic or manual test push button instrument calibration check
- Faulty accessory indication
- Speed limit selection with over speed alarm
- Time of violation indication

Integral traffic statistical data:
- Lowest/highest speed
- Average speed and 85%
- Peak and average traffic flow
- Total and violating vehicle count
- Vehicle speed distribution

MEMORY CARD
This optional device will store and record all violation information, as well as statistical data. Truvelo supplies software for "Windows 95" or "Windows NT" to read, analyse, print and archive the data.

REMOTE CONTROL UNIT
With this optional remote control unit the operator can monitor and control the M4MPC speed measuring instrument. It can also be connected to a paper printer for print out speed violations and statistical data.

PERMANENT HOUSING
Bullet- and Tamper proof, powder coated stainless steel housing with optional mounting pole. The COMBI S is housed within this enclosure and can easily be moved to other sites.
BRIEF DESCRIPTION OF RED LIGHT AND SPEED ENFORCEMENT CAMERAS SYSTEMS

The TRUVELO Red-Light Violation Camera System is a dedicated Red-Light System only.

At Railway level crossings or road intersections this system will react and take two photographs of vehicles violating the red-light signals by crossing an inductive loop installed behind the stop line.

Easily portable and operator friendly, this instrument weighs 13 kgs. only and is placed into a pole mounted, permanent outer housing by the operator.

The 4 lane loop controller and mains flash unit is also incorporated into the above unit.

A. CAMERA UNIT

The camera unit consists of the following functional blocks:

The base-plate with microprocessor-controlled electronics and data-readout. The data read-out has the following information, which is transferred onto the film negative:

1. Date, in year:month:day
2. Time, in hours:minutes:seconds and 1/10th seconds
3. Location code, 6 digits, operator programmable
4. Red-light timer, 4 digit seconds and 1/10th seconds
5. 3 digit frame counter (not visible on photographs)
6. Amber light information is fixed programmed for 3 seconds and may be changed according to requirements.
7. A 6 digit total traffic volume counter is also integrated (not placed on photograph)
8. Adjustable red-time delay, operator adjustable, 0 - 5 seconds in steps of 0.25 seconds.
9. Second photograph delay time 0.5 - 2 seconds, in steps of 0.25 seconds.
10. Two 3 digit speed indications (km/h).

B. CAMERA MOTOR-RECORDER

A well known Motor-recorder 36DCE is utilised in the system, which allows for a picture rate of 3/second, 1/1000 second exposure time, with full flash-synchronisation.

Optic lenses of 45mm, 75mm and 90mm are available. (Only one lens delivered per system, normally a 45mm lens).

A 30 metre film magazine allows the handling of 17 metre or 30 metre bulk film material resulting in 350 or 800 film exposures of either 35mm black and white or colour film.

Automatic aperture controller is also provided to change the lens settings for different ambient light conditions.

For front photography, with driver identification, it has been found from years of experience, that only black and white film should be utilised, to avoid "blinding" the drivers, but still have maximum illumination of the car interior, by the use of red-filters on the camera as well as on the powerful flash.

The filters are in the spectral range 665 to 610 nm. This allows for continual operation day and night with only one f-stop setting, hence avoiding any adjustment by operators.

Colour film should only be used for rear photography with unfiltered flash and automatic aperture control.
C. 4 LANE LOOP CONTROLLER/MAINS FLASH UNIT (220 VAC)

This unit forms part of the camera system.

Loop circuits are our own Truvelo designed microprocessor-controlled systems which are self-tuning and cross-talk free.

The unit has a built-in algorithm which avoids false or unnecessary triggering of the system by vehicles “creeping” over the stop line.

A sensitivity adjustment forms part of the unit and allows the operator to set the different loop sizes.

Red-light simulation and vehicle simulation, with test facilities, are built-in functions and are simply push-button operated.

MAINS FLASH

This powerful mains flash unit forms part of the portable 4-lane loop controller. Flash power of 350 joules allows illumination of vehicles and surroundings, with driver identification. Flash repetition of 500 ms allows full illumination in the second photograph of the violation.

D. MOUNTING POLE, OUTERHOUSING & STREET FURNITURE

The following describes a mounting pole which is most widely used, which is cost effective and most vandal resistant:

A zinc-plated pipe welded onto a mounting plate with a height of 2.2m. The lowest section has a diameter of 160mm, the second section - 110mm, with a flange on which to fit the housing.

A concrete foundation needs to be constructed for the mounting cage, with bolts onto which the pole and base are bolted.

The Outer housings are weather and vandal resistant with special security locking systems.

They are manufactured from stainless-steel and are powder-coated. Ventilation is provided for excessive climatic conditions.

Additional bullet-proofing can be supplied and fitted, on request and at an additional charge.

The outer housings are equipped with all necessary circuit breakers and earth leakage switches and wire looms, with connectors, for the systems.

The flash reflector is also an integral part of the outer housing.

Connections to Amber and Red-Lights:

The information from these signals is accomplished via our Truvelo pick-up sensors, which are galvanically de-coupled from the light controllers and are based on current sensing from the physical wires leading to the amber and red light globes. No power is consumed from the controllers.

The signal from the current sensors are routed via single-core, screened wire to the outer housings.

E. TRUVELO COMBINED SYSTEM

The instrument is a combination of two well-known, approved systems, for speed law enforcement and red-light violation recordings. It may be utilised for either/or application or together at intersections where not only red-light violations occur on red-light but also speed violations are an accident cause at green lights.
The speed measuring system forms part of the camera recording unit and is an integral part of the unit described under section A.

Additional speed sensor profiles are added to the inductive loops mounted behind the stop-line, 1.5m apart before the stop line at the intersection.

With this sensor arrangement, the speed of each vehicle is monitored and irrespective of the condition of the red light, speeds are monitored and photographs of violators are taken when a pre-set speed limit is exceeded.

On amber and red-phase, this operation has pre-dominance and two photographs are taken with the speed of the violator included in the first photograph.

This type of operation offers the ultimate in law-enforcement, as both systems carry Approval.
TRUVELO has developed a new and user-friendly speed verification method, which has been implemented in all of their new speed camera systems. The first speed verification takes place automatically within the system. Two speed measuring instruments are combined into one housing and one speed measurement result is compared with the other one. The speed results are displayed only if both readings fall within ±2km/h of one another.

It is now possible to independently verify the speed measurement from the photographic evidence. The method uses the position of the vehicle's front wheels in relation to the last detector cable/profile in direction of travel, as well as the time the wheels took to travel that distance. Speed can be calculated from these units. This speed result is known as the secondary speed measurement. This independent speed verification is required in some European countries.

Background: The TRUVELO M4² or M4²-MPC speed calculating instruments use pressure-sensitive piezo detector cables/profiles for reliable axle detection. Three or four detector cables are placed on top of the road pavement for portable installations. Permanent sites use flush-mounted detector "I" profiles. These sensors are numbered in vehicle travel direction as 'Start 1', 'Start 2', 'Stop 1', and 'Stop 2'. In a three cable layout method, cables two and three are common ('Stop 1' and 'Start 2'). The distance between 'Start' and 'Stop' is 1.5 meters. Time measurement 1 is taken from Start 1 to Stop 1 and time measurement 2 from Start 2 to Stop 2. The speed is then calculated by each of the two instruments, using the formula (1)—speed is equal to distance divided by time. Both speed results are displayed only if both readings fall within ±2km/h of one another.

\[
(1) \quad v = \frac{d}{t}
\]

\(v\) = speed; \(d\) = distance; \(t\) = time

In the above formula, distance is known and time measured. The formula can also be rewritten to express time as a function of speed and distance or distance as a function of speed and time.

\[
(2) \quad t = \frac{d}{v} \quad \text{or} \quad (3) \quad d = v \times t
\]

Various methods of secondary speed measurements or calculations are described below. They all make use of formulas (1) to (3) above to independently verify the speed measured by the instrument. This method is implemented on all M4²-MPC speed measuring systems coupled to a 'ROBOT 36-DCE' camera.
**Method A. Two Photographs Taken a Fixed Time Interval Apart.**

The violating vehicle's speed will be measured by the instrument at point X1 and photographed. A fixed time interval of 0.5 seconds later, another photograph will be taken showing the same vehicle in position X2. Depending upon the speed of the vehicle, the position of X2 will vary. The speed can then be verified using formula (1) and dividing the fixed delay time (e.g., 0.5 seconds) into the distance the vehicle travelled during that time (X1 to X2).

The distance travelled can be seen in the two photographs but is, however, only an approximation unless markers are painted on the road surface. The time between the two photographs can be calculated to 1/1000 of a second by subtracting the time in the first photograph from time in the second photograph.

With this verification method, only rear vehicle photography can be used as position X2 varies. The violating vehicle, together with the detector cables and all other relevant information, is photographed from behind at position X1. The photograph at position X2 is used only for speed validation purposes.

\[
\text{Formula: } v = \frac{d}{\text{time}} \text{ (approximation)}
\]

**Method B. Two Photographs Taken a Fixed Distance Apart.**

The violating vehicle's speed is measured at position Y1, and a photograph is taken. A line is painted onto the road surface a fixed distance away from the last detector cable/profile, in travel direction, together with the 10 percent distance tolerance limits (e.g., 20, 18, and 22 meters). Using formula (2) and the speed result at position Y1, a delay time can be calculated at which the camera will have to be triggered to ensure the vehicle's front wheels to be on the painted 20-meter line. The time difference to 1/1000 of a second can be accurately obtained by subtracting the times on the first and second photographs from one another. The speed can, in this example, be verified accurately using formula (1). Even a lay person can do first-order verification by analyzing the second photograph and ensuring that the front wheel position is between the tolerance markers painted on the road surface.

The advantage of this method of speed verification is that the second photograph position is fixed. The camera lens can be focused on that position and frontal vehicle photography is possible. This allows for driver identification. The first photograph will show the violating vehicle, the detector cables, and all other relevant information pertaining to the offense. The second photograph will show the driver and is also used for speed verification.
showing the accurate position and time. Rear vehicle photography can also be used in the same manner described in (A) above.

\[
\begin{align*}
Y_1 & \quad \text{Fixed distance} & \quad Y_2 \\
\text{\hspace{1em}} & \quad \text{Variable time interval (use formula (2) for calculations)} & \quad \text{\hspace{1em}}
\end{align*}
\]

\begin{align*}
\text{Photo position 1} & \quad \text{Photo position 1}
\end{align*}

\[v = \frac{d \text{ (known)}}{\text{time (measurable)}}\]

**Method C. One photograph a Fixed Time from Last Detector Cable in Vehicle Travel Direction.**

Similar to (A) above but only one photograph is taken a known time after the vehicle has crossed the last detector cable in travel direction (Stop 2). This particular method of secondary speed verification was used mainly with the older TRUVELO M4\(^2\) speed calculating instruments. The calculation time of this model was fixed and only started once all time measurements were complete. Total time from vehicle crossing sensor 'Stop 2' to issuing of camera trigger command was 1.5ms. On the 'Robot 36CE' camera recorders, the time from receiving the camera trigger command to the actual shutter opening is a fixed 32ms. This is mainly due to mechanical delays and lever travel times. This gives a total delay time of 47 milli seconds (47/1000 second) from when the vehicle crosses the last detector cable (Stop 2) to when the photograph is taken.

As the wheel base (distance from front to rear wheels) of the violating vehicle is visible and has a known distance and can be measured on the photograph, a scale factor can be obtained for a particular picture. A certain number of millimeters on the photograph correspond to an actual distance. By measuring the distance the front wheels of the vehicle are away from the last detector cable (Stop 2) on the picture and multiplying this with the scale factor, the actual distance can be obtained. Alternatively, distance markers can be painted onto the road surface. To validate the precise system delay time several photographs before and after the one of interest have to be analyzed. From this an average actual camera trigger time delay is obtained. Using formula (1) above, speed can now be calculated.

This method is rather cumbersome and usually gives better results on frontal vehicle photography and on pictures with a good quality and clarity.

\[
\begin{align*}
\text{Stop 2} & \quad \text{variable distance (use formula (3) for calculations)} & \quad \text{Photo} \\
\text{\hspace{1em}} & \quad \text{fixed time (47ms)} & \quad \text{\hspace{1em}}
\end{align*}
\]

\[v = \frac{d \text{ (approximation)}}{\text{time (known)}}\]
**Method D. One Photograph a Fixed Distance Away from Last Detector Cable in Travel Direction.**

This particular speed verification method is a simplified version of (B) above. The TRUVELO M4\textsuperscript{2}-MPC speed calculating instrument can detect and time axles of vehicles accurately. It times a violating vehicle’s front wheels crossing the last detector cable (Stop 2) to when the camera shutter opens. The newer ‘Robot 36-DCE’ camera recorder has a faster mechanism, and a fixed distance of 1.8 meters was selected to allow the front wheels of a vehicle to move from the Stop 2 detector cable to the photograph position. This distance, together with the 10 percent distance tolerance, is painted on the road surface (e.g., 1.8m, 1.62m, and 1.98m). Using formula (2) above, the instrument calculates a delay time before giving the camera trigger command to ensure the front wheels of the violating vehicle are positioned on this 1.8m line in the photograph. As everything is fixed or measurable, accurate speed verification can be obtained. A lay person can easily verify the speed on the photograph by visually confirming that the violating vehicle’s front wheels are between the distance tolerance markings on the road or by performing the calculation as per formula (1).

Again, the lens focus distance is constant for vehicle frontal photography enabling driver identification. In addition, it SAVES 50 percent of photographic material costs compared to method (B).

\[
\begin{align*}
\text{Stop 2} & \quad \text{fixed distance (1.8m)} & \quad \text{Photo} \\
& \quad \text{variable time (use formula (2) for calculations)} & \\
\text{Vehicle front wheels} & \quad \text{Vehicle front wheel position}
\end{align*}
\]

\[v = \frac{d \text{ (fixed)}}{t \text{ (measurable)}}\]

The above-mentioned methods illustrate all possible secondary speed verification methods. TRUVELO recommends method (B) or (D) above. The minimum information required on the photograph is the road surface, the violating vehicle, and the last detector cable. For obvious reasons, the more detailed the picture information is the better and easier calculations can be undertaken.

RHG/secdspd.wpd/07/7/95
**N.B.** Unless otherwise specified please contact the Chief Traffic Officer or Chief of Police, Traffic Department, Camera Section, at each of the Town Councils/Municipalities/Police Departments.

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<td><strong>BOTSWWANA POLICE</strong></td>
<td>Mr Karate, Private Bag 0012, Gabarone, Botswana Tel: 09287 351161. Fax: 09287 373723</td>
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<td>P O Box 7064, Roodebaai, Cape, 8012 Tel: 021 419 2200. Fax: 021 216607</td>
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<td>P O Box 2803, Cape Town, 8000 Tel: 021 4109111. Fax: 021 410 2261</td>
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<td>P O Box 19, George, 6530 Tel: 0441 878 2400. Fax: 0441 73 3662</td>
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<td>Private Bag 1010, Gingindhluvu, 3800 Tel: 0353 30 1217. Fax: 0353 30 1210</td>
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<td>P O Box 7776, Johannesburg, 2000 Tel: 011 490 1614 or 490 1500. Fax: 011 838 6813</td>
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</table>

**GERMANY**

- **City of Bonn**
  - Der Oberkreisdirektor, Tiefbauamt, Berliner Platz 2, 5311 Bonn. Tel: 0228 774173
  - 3 camera systems
  - 23 permanent speed sites

- **County of Borken**
  - Der Oberkreisdirektor, Straßenverkehrsamt, Burloer Straße 93, 48325 Borken. Tel: 02862 822040
  - 2 camera systems for permanent & portable use.

- **City of Dortmund**
  - Der Oberstadtkdirektor, Straßenverkehrsamt, Ostwall 60, 44135 Dortmund. Tel: 0231 5025829
  - 1 camera system
  - 6 permanent speed sites

- **County of Heinsberg**
  - Der Oberkreisdirektor, Straßenverkehrsamt, Valkenburger Straße 45, 52525 Heinsberg. Tel: 02552 13308
  - 1 camera system
  - 9 permanent speed sites

- **County of Kleve**
  - Der Oberkreisdirektor, Fleischauer Straße 10, 57533 Kleve. Tel: 02821 85370
  - 2 camera systems
  - 17 permanent speed sites

- **City of Cologne**
  - Der Oberstadtdirektor, Amt für öffentliche Ordnung, Verkehrüberwachung, Lindenstraße 14, 50674 Köln. Tel: 0221 2217774
  - 5 camera systems
  - 26 permanent speed sites
  - 9 red light sites

- **County of Mettmann**
  - Oder Oberkreisdirektor, Straßenverkehrsamt, Düsseldorfer Straße 26, 40822 Mettmann. Tel: 02104 991741
  - 3 camera systems, 28 permanent sites, 1 speed & red light combination, 3 permanent red light sites.

- **County of Siegburg**
  - Der Oberkreisdirektor, Straßenverkehrsamt, Kaiser-Wilhelm-Platz 1, 53721 Siegburg. Tel: 02241 132002
  - 3 camera systems
  - 28 permanent speed sites
<table>
<thead>
<tr>
<th>County of Bergisch-Gladbach</th>
<th>Der Oberkreisdirektor, Straßenverkehrsamt, Am Rübezahlwald 7, 51469 Bergisch Gladbach. Tel: 02202 132255</th>
<th>2 camera systems 18 permanent speed sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>County of Steinfurt</td>
<td>Der Oberkreisdirektor, Straßenverkehrsamt, Tecklenburger Straße 10, 48565 Steinfurt. Tel: 02551 692028</td>
<td>2 camera systems 13 permanent speed sites</td>
</tr>
<tr>
<td>County of Wesel</td>
<td>Der Oberkreisdirektor, Straßenverkehrsamt, Reeser Landstraße 31, 46843 Wesel. Tel: 0281 2072165</td>
<td>1 camera system 14 permanent speed sites</td>
</tr>
<tr>
<td>City of Bruchköbel</td>
<td>Der Magistrat, Ordnungsamt, Hauptstraße 32, 63486 Burchköbel. Tel: 06181 701219</td>
<td>1 camera system 4 permanent sites, plus portable use.</td>
</tr>
<tr>
<td>Commune of Erlensee</td>
<td>Der Gemeindevorstand, Ordnungsamt, Rathausplatz, 63526 Erlensee. Tel: 06183 8141</td>
<td>1 camera system, portable</td>
</tr>
<tr>
<td>City of Fulda</td>
<td>Der Magistrat, Rechts- und Ordnungsamt, Unterm Heilig Kreuz 1, 36037 Fulda. Tel: 0661 102334</td>
<td>3 camera systems 10 permanent sites &amp; portable use.</td>
</tr>
<tr>
<td>City of Gross-Gerau</td>
<td>Der Magistrat, Ordnungsamt, Am Marktplatz 1, 64521 Groß-Gerau. Tel: 06152 716220</td>
<td>1 camera system, portable</td>
</tr>
<tr>
<td>City of Bad Homburg</td>
<td>Der Magistrat, Ordnungsamt, Marienbader Platz 1, 61348 Bad Homburg von der Höhe. Tel: 06172 100293</td>
<td>1 camera system, portable</td>
</tr>
<tr>
<td>City of Hanau</td>
<td>Der Magistrat, Ordnungsamt, Krämerstraße 22, 63450 Hanau. Tel: 06181 295451</td>
<td>1 camera system, portable</td>
</tr>
<tr>
<td>City of Kassel</td>
<td>Der Magistrat, Verkehrüberwachung, Kurt-Schumacher-Straße 29, 34117 Kassel. Tel: 0561 7873061</td>
<td>2 camera systems, portable</td>
</tr>
<tr>
<td>City of Kronberg</td>
<td>Der Magistrat, Ordnungsamt, Katharinenstraße 12, 61476 Kronberg im Taunus. Tel: 06173 703250</td>
<td>2 camera systems, portable &amp; 1 permanent speed site</td>
</tr>
<tr>
<td>City of Maintal</td>
<td>Der Magistrat, Ordnungsamt, Alt Bischofsheim 28, 63477 Maintal. Tel: 06181 400262</td>
<td>1 camera system, portable &amp; 3 permanent speed sites</td>
</tr>
<tr>
<td>City of Morfelden-Walldorf</td>
<td>Der Magistrat, Ordnungsamt, Flughafenstraße 37, 64546 Morfelden-Walldorf. Tel: 06105 72252</td>
<td>1 camera system, portable</td>
</tr>
<tr>
<td>City of Oberursel</td>
<td>Der Magistrat, Ordnungsamt, Rathausplatz 1, 61440 Oberursel. Tel: 06171 502277</td>
<td>1 camera system, portable</td>
</tr>
<tr>
<td>City of Rödermark</td>
<td>Der Magistrat, Ordnungsamt, Dieburger Straße 13-17, 63322 Rödermark. Tel: 06074 911248</td>
<td>1 camera system 14 permanent speed sites</td>
</tr>
<tr>
<td>City of Seligenstadt</td>
<td>Der Magistrat, Ordnungsamt, Marktplatz 1, 63500 Seligenstadt. Tel: 06182 87132</td>
<td>1 camera system, portable</td>
</tr>
<tr>
<td>City of Boblingen</td>
<td>Ordnungsamt, Marktplatz 16, 71032 Boblingen Tel: 07031 6695581</td>
<td>1 camera system 3 permanent speed sites.</td>
</tr>
<tr>
<td>City of Esslingen</td>
<td>Landratsamt, Pulverwiesen 11, 73728 Esslingen am Neckar. Tel: 0711 39022721</td>
<td>3 camera systems 39 permanent speed sites</td>
</tr>
<tr>
<td>City of Heilbronn</td>
<td>Ordnungsamt, Weststraße 51/1, 74072 Heilbronn. Tel: 07131 562096</td>
<td>3 camera systems 15 permanent speed sites</td>
</tr>
<tr>
<td>City of Hockenheim</td>
<td>Ordnungsamt, Obere Hapistraße 11, 68766 Hockenheim. Tel: 06205 21228</td>
<td>1 camera system 1 permanent speed site</td>
</tr>
<tr>
<td>City of Leinfelden-Echterdingen</td>
<td>Ordnungsamt, Marktplatz 1, 70771 Leinfelden-Echterdingen. Tel: 0711 7986211</td>
<td>1 camera system, portable</td>
</tr>
<tr>
<td>City of Ostfildern</td>
<td>Ordnungsamt, Wilhelmstraße, 73760 Ostfildern. Tel: 0711 3404250</td>
<td>1 camera system 8 permanent speed sites</td>
</tr>
<tr>
<td>Location</td>
<td>Address</td>
<td>Camera Systems</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>City of Radolfzell</td>
<td>Ordnungsamt, Marktplatz 2, 78315 Radolfzell. Tel: 07732 61260</td>
<td>1 camera system</td>
</tr>
<tr>
<td>City of Ravensburg</td>
<td>Landratsamt, Friedenstraße 6, 88212 Ravensburg. Tel: 0751 85311</td>
<td>1 camera system</td>
</tr>
<tr>
<td>City of Reutlingen</td>
<td>Ordnungsamt, Marktplatz 22, 72764 Reutlingen. Tel: 07121 3032893</td>
<td>1 camera system</td>
</tr>
<tr>
<td>City of Cottbus</td>
<td>Straßenverkehrs - und Zulassungsamt, Madlower Hauptsstraße 13, 03050 Cottbus. Tel: 0355 6120</td>
<td>3 camera systems</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td>City of Dresden</td>
<td></td>
<td>2 camera systems</td>
</tr>
<tr>
<td>City of Rathenow</td>
<td>Kreisverwaltung, Ordnungsamt, Wilhelm-Pieck-Straße 47, 14712 Rathenow. Tel: 03385 5510</td>
<td>1 camera system</td>
</tr>
<tr>
<td>Highway Police -</td>
<td>Polizeiautobahnstation Montabaur, Am Rasthaus, 56412 Heiligenroth. Tel: 02602 3050</td>
<td>2 camera systems</td>
</tr>
<tr>
<td>Heiligenroth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Police Headquarters</td>
<td>Polizeipräsidium Kaiserslautern, Verkehrsinspektion, Barbarossastraße 60, 67655 Kaiserslautern. Tel: 0631 61255</td>
<td>1 camera system, portable</td>
</tr>
<tr>
<td>Highway Police - Ludwigshafen</td>
<td>Autobahnpolizei, Ludwigshafen-Ruchheim, Maxdorfer Straße 85, 67071 Ludwigshafen. Tel: 06237 7062</td>
<td>2 camera systems, portable</td>
</tr>
<tr>
<td>Highway Police -</td>
<td>Autobahnpolizei Schweich, Am Leinenhof, 54338 Schweich. Tel: 06502 307172</td>
<td>2 camera systems, portable</td>
</tr>
<tr>
<td>Schweich</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highway Police - Wittlich</td>
<td>Autobahnpolizei Wittlich, An der B50, 54516 Wittlich. Tel: 06571 8087</td>
<td>2 camera systems, portable &amp; 1 permanent site</td>
</tr>
<tr>
<td>OTHER USERS</td>
<td></td>
<td>50 SYSTEMS</td>
</tr>
<tr>
<td>Bedfordshire Police</td>
<td>1992</td>
<td>6 permanent red light sites</td>
</tr>
<tr>
<td>England</td>
<td></td>
<td>3 permanent speed sites</td>
</tr>
<tr>
<td>London Metropolitan</td>
<td>1995</td>
<td>1 speed &amp; red light site</td>
</tr>
<tr>
<td>Police, England</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Royal Hong Kong Police</td>
<td>1989</td>
<td>5 camera systems</td>
</tr>
<tr>
<td>Taipei, Taiwan</td>
<td>1989</td>
<td>3 speed &amp; red light systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 red light systems</td>
</tr>
<tr>
<td>Abu Dhabi</td>
<td>1990</td>
<td>2 combi systems</td>
</tr>
<tr>
<td>Dubai</td>
<td>1986</td>
<td>16 combi systems</td>
</tr>
<tr>
<td>Korea</td>
<td>1995</td>
<td>2 combi speed &amp; red light systems</td>
</tr>
<tr>
<td>Bartow, Florida, USA</td>
<td>1996 Police Chief Tony Sparks, Tel: (941) 534 5304</td>
<td>2 permanent red light systems</td>
</tr>
<tr>
<td></td>
<td>Police Chief George Ferris, Tel: (941) 285 8191 or Sgt. David Brooks, Tel: (941) 534 5304.</td>
<td></td>
</tr>
<tr>
<td>23 May 1996</td>
<td>TRUVELO MANUFACTURERS (PTY) LTD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P O BOX 14183, CENTURION, 0140, SOUTH AFRICA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tel: +27 (0) 11 314 1405-8. Fax: +27 (0) 11 314 1409</td>
<td></td>
</tr>
</tbody>
</table>
Appendix C

Contacts
Contacts

<table>
<thead>
<tr>
<th>Name</th>
<th>Address/Phone</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>George Ferris</td>
<td>708-503-8892</td>
<td>• Former chief of Polk County Community Traffic Safety Team and project lead for the red light camera pilot project in Polk County in Florida</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provided information on Polk County project</td>
</tr>
<tr>
<td>Amy L. Gambill</td>
<td>704-336-4125</td>
<td>• Public Service Officer with the Charlotte DOT, Charlotte, NC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Source for information on proposed red light project in Charlotte</td>
</tr>
<tr>
<td>Dana King, Zev Fogel, James Maguire, Lauri S. Keller</td>
<td>619-558-8778</td>
<td>• Contacts at U.S. Public Technologies Inc., provided information brochures and catalogues on various technologies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provided on-site interview in San Francisco</td>
</tr>
<tr>
<td>James Kelly</td>
<td>512-295-5285</td>
<td>• President, Aviar Inc.</td>
</tr>
<tr>
<td>Adam E. Tuton</td>
<td>602-922-2100</td>
<td>• Source from the American Traffic Systems Inc.</td>
</tr>
<tr>
<td>Richard A. Retting²²</td>
<td>703-247-1500</td>
<td>• Researcher with the Insurance Institute for Highway Safety</td>
</tr>
<tr>
<td>Bridget Smith, Jack Fleck</td>
<td>415-554-2346</td>
<td>• With the City and County of San Francisco</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provided information on red light cameras in San Francisco</td>
</tr>
<tr>
<td>Elizabeth Sheetz</td>
<td></td>
<td>• With the Central Florida Regional Planning Council, Bartow, Fl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In charge of compiling the final report for Polk County project</td>
</tr>
<tr>
<td>Hiep Huynh</td>
<td>305-948-2903</td>
<td>• City Traffic Engineer, City of North Miami</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Provided information on the proposed red light camera project in the city</td>
</tr>
</tbody>
</table>

Internet Sites with Red Light Photo Enforcement Information

U.S. Public Technologies Inc., www.uspti.com
Driver Safety Systems, www.dss.co.il
Insurance Institute for Highway Safety, www.highwaysafety.org
Winnipeg Police Force, www.winnipeg.freenet.mb.ca
Victoria Traffic Camera Office, Australia, www.home.vicnet.net.au
Online Sunshine, the official guide to the state of Florida Legislature, www.leg.state.fl.us

²² The authors are grateful for the information provided by Mr. Retting and the Insurance for Institute for Highway Safety.