Technical Evaluation of Photo Speed Enforcement for Freeways

Final Report 596

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16. Abstract

Extreme speeding on urban-area freeways contributes to increased crashes resulting in fatalities, property damage, and increased maintenance and public safety costs. Photo speed enforcement systems (speed cameras) that automatically sense a speeding vehicle and photograph it and its driver have proven effective at reducing speeding violations, primarily on city streets and arterials. The use of this technology on high-volume, high-speed, multi-lane freeways is technically much more challenging, and largely untested. This research investigates if the current offerings of vendors can provide a viable technical solution in this freeway environment.

Twelve ideal characteristics were established that are needed for a speed camera system to operate on Phoenix, Arizona, metro-area freeways. Six vendors were interviewed. Thirteen agencies that use speed camera systems were interviewed, although none were found with sufficient freeway operating experience to provide definitive information to design a field trial. Therefore, only a conceptual field trial and accompanying test plan were developed to explore the technical aspects of potential systems. Public opinion and countermeasures on speed camera systems were researched and reported.

No current vendor offering meets all of the twelve ideal characteristics that were established. Advancements in speed camera systems continue, and it is logical to predict that they can be met in the future. One new technology that shows promise is “point-to-point,” which tracks average speed between two points on a roadway. This research did not address the violation processing and management activities, but noted that these must be addressed before a field trial can proceed.

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Photo Radar, Speed Enforcement, Speed Cameras, Freeways, Countermeasures, Traffic Safety

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SI (MODERN METRIC) CONVERSION FACTORS*

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol	Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH					**LENGTH**		
in	inches	25.4	millimeters	mm	mm	millimeters	0.039	inches	in
ft	feet	0.305	meters	m	m	meters	3.28	feet	ft
yd	yards	0.914	meters	m	m	meters	1.09	yards	yd
mi	miles	1.61	kilometers	km	km	kilometers	0.621	miles	mi
		AREA					**AREA**		
in^2	square inches	645.2	square millimeters	mm^2	mm^2	square millimeters	0.0016	square inches	in^2
ft^2	square feet	0.093	square meters	m^2	m^2	square meters	10.764	square feet	ft^2
yd^2	square yards	0.836	square meters	m^2	m^2	square meters	1.195	square yards	yd^2
ac	acres	0.405	hectares	ha	ha	hectares	2.47	acres	ac
mi^2	square miles	2.59	square kilometers	km^2	km^2	square kilometers	0.386	square miles	mi^2
		VOLUME					**VOLUME**		
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.034	fluid ounces	fl oz
gal	gallons	3.785	liters	L	L	liters	0.264	gallons	gal
ft^3	cubic feet	0.028	cubic meters	m^3	m^3	cubic meters	35.315	cubic feet	ft^3
yd^3	cubic yards	0.765	cubic meters	m^3	m^3	cubic meters	1.308	cubic yards	yd^3
	NOTE: Volumes greater than 1000L shall be shown in m^3.								
		MASS					**MASS**		
oz	ounces	28.35	grams	g	g	grams	0.035	ounces	oz
lb	pounds	0.454	kilograms	kg	kg	kilograms	2.205	pounds	lb
T	short tons (2000lb)	0.907	megagrams (or “metric ton”)	mg (or “t”)	Mg	megagrams (or “metric ton”)	1.102	short tons (2000lb)	T
		TEMPERATURE (exact)					**TEMPERATURE (exact)**		
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C	°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F
		ILLUMINATION					**ILLUMINATION**		
fc	foot-candles	10.76	lux	lx	lx	lux	0.0929	foot-candles	fc
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2	cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE AND PRESSURE OR STRESS					**FORCE AND PRESSURE OR STRESS**		
lbf	poundforce	4.45	Newtons	N	N	Newtons	0.225	poundforce	lbf
lbf/in^2	poundforce per square inch	6.89	kilopascals	KPa	kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380

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SIGNIFICANT TERMS, ACRONYMS, AND ABBREVIATIONS

ADOT	Arizona Department of Transportation
AZ*Trans*	The Arizona Laboratory of Transportation, the research unit at Northern Arizona University, Department of Civil and Environmental Engineering that conducted this study.
Back Shop	A collective term for the chain of processing and administrative functions of a photo enforcement program which complete the prosecution of the violation, including documentation of speeding events, identification of subjects, mailing of citations, coordination with the court system, etc.
DfT	Department of Transport in the United Kingdom
DPS	Arizona Department of Public Safety (Highway Patrol)
FHWA	Federal Highway Administration
ITS	Intelligent Transportation Systems
LIDAR	**LI**ght **D**etection **A**nd **R**anging: A sensor similar to radar except it uses electromagnetic energy waves in the visible light spectrum. It is an active sensor in that it emits light waves and detects their return.
Metro	A major metropolitan area that includes the central city and the surrounding suburban communities.
MUTCD	Manual on Uniform Traffic Control Devices
Point-To-Point	A speed enforcement technology that identifies a vehicle at two different locations that are a known distance apart along a roadway and the travel time is used to determine its average speed.
Photo Red-Light Running Camera	The generic term widely used for any system that both senses that a moving vehicle has entered the intersection during a red light and takes a photograph(s) of the vehicle's license plate, and if required, the vehicle's driver.
Piezo Sensor	A sensor is mounted in a groove that is cut into the roadway surface within the traffic lane. The sensor gathers data by using the piezoelectric effect to convert mechanical energy (vehicle driving over it) into electrical energy. It operates as a point detector and speed is determined by timing a vehicle traveling between two detectors set at a known distance apart.
POST	The Parliamentary Office of Science and Technology: An office of both Houses of Parliament in the United Kingdom (UK) charged with providing independent and balanced analysis of public policy issues that have a basis in science and technology.

RAC	RAC Foundation (Great Britain) – a motorist safety advocacy and research group (independent of the Royal Automobile Club since 1999).
Radar	**Ra**dio **d**etecting **a**nd **r**anging: A sensor capable of detecting distant objects and determining their position and speed of movement. With vehicle detection, a device directs high frequency radio waves at a vehicle to determine the time delay of the return signal, thereby calculating the distance to the detected vehicle.
RFP	Request for Proposal
Rubber-Necking	The behavior of drivers to slow down when passing an unusual incident on or near the roadway. Examples are roadside crashes and police vehicles, usually with lights flashing, which have pulled a vehicle over to the shoulder of the roadway. During peak traffic periods, this driver behavior can cause congestion that would not otherwise occur.
Slow-Down / Speed-Up	Where a speeding driver of a vehicle slows down to the speed limit just before the location of a known speed camera location and then after passing it, speeds up again.
Speed Camera	The generic term widely used for any system that both senses the speed of a vehicle and, if speeding, takes a photograph(s) of the vehicle's license plate, and if required, the vehicle's driver.
Sweep Operation	An intensive law enforcement operation. A speeding sweep operation is one that concentrates on speeding violations, usually in a targeted area, using several officers.
TAC	Technical Advisory Committee: a group of stakeholders and advisors for the research project.

EXECUTIVE SUMMARY

Motivation for the Research

Extreme speeding on urban-area freeways contributes to public opinions that the freeways are unsafe, as well as increased crashes that result in property damage, injury, and fatalities. For transportation agencies such as the Arizona Department of Transportation (ADOT), this is an area of significant concern that means more crash cleanup, more infrastructure damage, more repairs, more tragedy and loss for all involved, and potential liability exposure. For emergency response agencies it means increased exposure to high-speed traffic when responding to crashes. These areas are also critical to the Arizona Department of Public Safety (DPS), which is responsible for enforcing speed limits, and for working with ADOT to promote safe public travel and to reduce the effects of high-speed crashes on urban freeways.

Intelligent Transportation Systems (ITS) now exist to accurately enforce safe municipal speed limits using camera-based technology. These enforcement technologies are generically called "speed cameras" and have been effective on municipal streets and arterials. As of 2005, at least 75 countries rely on such cameras to enforce speed limits, especially on high-risk roads, including Australia, Austria, Canada, Germany, Greece, Italy, the Netherlands, Norway, South Africa, Spain, Switzerland, and Taiwan. Compared with other countries, municipal police in the U.S. have used speed cameras on a limited basis, but their use is expanding. Cameras currently are in use in municipalities in several states, including Arizona, California, Colorado, North Carolina, Ohio, Oregon, and the District of Columbia.

Whereas speed cameras have been proven on municipal streets, it is technically a much more challenging operating environment to attempt to employ these devices on high-volume, high-speed, multi-lane freeways such as the Phoenix metro (metropolitan) area system managed by ADOT and DPS. The technical problems arising from such a deployment are the focus of this research:

> Research Question: *Can any current offerings of vendors of photo speed enforcement systems provide a viable technical solution that will accurately measure the Phoenix metro regional freeway speeding problems, given the needs and constraints of ADOT and DPS? Additionally, can a conceptual trial deployment and accompanying field test plan be developed to demonstrate the technical aspects of potential systems, should it be desired to conduct one in the future?*

It is important to note this research question is limited to the technical aspects of a photo enforcement system. Whereas a violation management system would also need to be studied in detail to fully examine the viability of photo speed enforcement, these aspects are beyond the scope of this report.

Current State of Technology

The first automatic systems to be widely deployed in the United States were red-light running systems. These programs generally proved successful, which led to the use of speed cameras by some U.S. municipalities. The international success of speed cameras has driven the technology. For example, by 2004, the United Kingdom had successfully deployed 6,000 photo speed cameras, and the number continues to grow.

Photo speed enforcement systems use three subsystems: *Vehicle Speed Subsystem*, *Vehicle/Driver Photo Subsystem*, and *Speeding Violation Subsystem*. The *Vehicle Speed Subsystem* typically relies on a radar or LIDAR (LIght Detection And Ranging) sensor to determine the speed of a vehicle, or, it uses an in-pavement sensor. When a vehicle is speeding, this triggers the *Vehicle/Driver Photo Subsystem*, which takes two photos, one of the driver and one of the rear license plate. This requires two cameras, whereas only one camera is needed if (a) the vehicle has a front license plate or (b) the enabling legislation does not require that the driver's picture be recorded. A data record is formed with the speed information coupled with the photos of the driver and license plate for each violation.

The last subsystem, *Speeding Violation Subsystem,* is not part of this research. Its functions are to use the records created by the first two subsystems to identify the driver of the speeding vehicle, issue that person a speeding violation, and prosecute the person if guilt is not admitted.

The speed cameras can be mounted overhead in gantries or at the side of the road (side-fire). Side-fire cameras have limitations on the total number of lanes over which they can successfully capture data. Overhead mounted cameras eliminate this problem because each camera captures a single lane at a relatively close distance to traffic, but this requires more cameras than do side-fire applications.

In addition to fixed locations, photo radar cameras can be mounted in mobile devices. This technology takes two basic forms: (a) moving a camera/sensor from fixed location to fixed location and (b) mounting a camera/sensor in a van or tethered to a vehicle. The concept behind moving the camera/sensor between various fixed locations is to spread driver behavior changes over a larger area, without requiring complete systems at each fixed location. The concept behind mounting a camera/sensor in a van is somewhat similar to a typical law enforcement officer using a radar gun in his/her patrol vehicle to issue speeding citations. The ability to "automatically" record violations in the mobile photo enforcement van and later issue citations can be said to increase the efficiency of such a unit versus a patrol vehicle. It is important to note that the mobile unit is quite limited in its function, whereas an officer in a radar-equipped patrol vehicle can instantly switch to other safety functions based on observed information or radio calls.

One new concept being tested at some international sites uses "point-to-point" tracking technology. This technology identifies a vehicle at two different locations along a roadway, which are a known distance apart, and the travel time is used to determine its average speed. This technology substitutes a vehicle recognition system for the radar/LIDAR/in-pavement speed sensors. All vehicle license plate numbers are digitally read and recorded when they pass the first instrumented point and as each vehicle passes the second point it is digitally read and recorded again. License plate identification software is used to match the license plates of a vehicle passing both points. If no match is obtained or if a vehicle is not speeding, the data is automatically erased. The benefit of this system is that it avoids the "slow-down/speed-up" driver behavior along a roadway that can occur at camera locations known to drivers. This technology shows great promise for freeway applications.

Ideal System Characteristics

The project's Technical Advisory Committee (TAC) developed the following list of 12 ideal characteristics for a Photo Speed Enforcement system to be effective on the Phoenix metropolitan area freeways. Many complex interactions can occur between a system and the other activities and goals of ADOT and DPS. The TAC witnessed presentations and/or demonstrations by six vendors and solicited their input based on their knowledge and experience.

1. Mobile deployment options to aid in DPS speeding "sweep" operations.
2. Easily relocatable from one site on a freeway to another.
3. Acceptable light flash intensity.
4. Color photography is desirable to enhance driver/license plate recognition.
5. Identify (ID) both driver and rear license plate.
6. Vendor's compensation is not tied to revenue.
7. System costs are definable by vendor.
8. Download data in electronic format without entering freeway.
9. No technical bias in identifying violations.
10. No sensors placed in pavements that require lane closures for maintenance.
11. Maintain federal roadside crash safety standards for all devices.
12. System can cover five lanes of freeway traffic in one direction.

Detailed information was obtained from six vendors (ACS, Peek Traffic Corporation, American Traffic Solutions, LaserCraft, Traffipax. and Redflex) regarding their current technologies in photo speed enforcement. Most vendors can meet a majority of the 12 ideal characteristics, but no vendor can meet all of them at this time.

Acceptance of Photo Speed Enforcement Systems

Thirteen agencies were interviewed via email and phone that have used or are currently using a photo speed enforcement system. Most of the users report strong public support of their enforcement system, with only two out of thirteen stating that there was an even split in public support. Seven of these organizations were either currently implementing or had implemented the enforcement system on major highways. Three of these jurisdictions, one in Madrid, Spain, one in New South Wales, Australia, and the last in the City of Zurich, Switzerland, are implementing their automated systems on highways with three or more lanes of traffic in each direction. But while these conditions are similar to the Phoenix metro freeways, they lack some specific features that complicate the technical aspects of deploying a vendor's system. Four systems are mobile systems and have or are using their systems on multiple lanes of traffic, but these require manual setup and/or manual monitoring. They typically target only one specific lane using manual efforts.

The link between speed and safety is well established by research over the last several decades. What is less well documented is the relationship between photo speed enforcement and safety. The effectiveness of speed cameras in reducing speeds, and the number of road crashes and casualties, is widely debated and depends on several factors: (a) the causes of road crashes and the extent to which speed in excess of the limit is a factor, (b) the potential for offenders to be identified, and (c) public attitudes to speed cameras. It is not straightforward to draw conclusions on the impact of speed camera use from aggregate crash statistics. Trends can arise from many factors (e.g., other road safety measures) in addition to speed enforcement. However, research about deployed systems does generally support a link between improved safety and use of the systems. Specific supporting research is cited in this report from the United Kingdom, Hong Kong, Queensland, Australia, British Columbia, Canada, and Washington D.C.

Public opinion regarding the use of photo speed enforcement systems varies from country to country and from city to city. Generalizations cannot easily be made. Differences in the cultures of countries may have an impact. Opinions supporting the systems center on (a) driver behavior changes that decrease collisions and improve road safety and (b) freeing law enforcement officers to focus on other tasks. Opinions opposing the systems include (a) accusations of fund raising, (b) placing an over-emphasis on speed, (c) privacy issues, and (d) concerns that slow-down/speed-up behavior occurs which negates real speed reduction. Specific opinion surveys are cited from the United Kingdom, Canada, Australia, and Washington D.C.

The City of Scottsdale, Arizona, began operating speed cameras in its municipality approximately seven years ago. The City has found the program to be successful based on its goal of improving safety, as measured through various statistics dealing with reductions in the number of violations, number of collisions, and number of fatalities. It has also sampled public opinion on approximately an annual basis about its combined red light and speed camera program, and has found that a majority of its citizens support the combined program and its expansion. A limited survey of opinion has been conducted on just the speed cameras alone, without the red light cameras, and the majority of this sample also has viewed them favorably.

This research also considers countermeasures, which are devices used to counteract enforcement programs. No independent research was found that documents the effectiveness of countermeasure devices. Most system vendors are familiar with the common types of countermeasures and in general do not regard them as particularly effective. Laws exist in many states, including Arizona, that prohibit some of these countermeasures.

Conceptual Design of a Field Trial and Test Plan

Based on the system characteristics identified as ideal for the Phoenix metro area freeways, no existing system was found that has been deployed long enough to serve as a model for the development of a field trial. Therefore, a conceptual Model RFP was developed, whose purpose is to raise several likely topics that should be considered. It can serve as a guide to prepare an actual RFP, should it be desired to do so at some point in the future. It includes a Conceptual Field Plan to gather the data needed to evaluate the performance and suitability of a vendor's system for meeting ADOT's and DPS's needs.

Conclusions

Advancements are being made in photo enforcement systems and it is logical to predict that the ideal technical attributes identified in this research could be met by one or more vendors in the future. One new technology that shows promise is point-to-point tracking, which determines average speed between two points on a roadway.

At this time, however, gaps exist between the current vendor systems and the ideal system characteristics needed for the Phoenix metro area freeways. Additionally, this research project has focused exclusively on the technical aspects of a photo enforcement system. Whereas the violation processing and management elements will also need to be studied in detail to fully examine the viability of such a photo enforcement system, these aspects are beyond the scope of this project. Until the enforcement management process issues are addressed, no recommendation can be made from this study regarding the usefulness of proceeding with a field trial of photo enforcement for freeways.

1. INTRODUCTION

1.1. MOTIVATION FOR RESEARCH

Extreme speeding on regional freeways in the greater Phoenix metropolitan area appears to have reached a critical level for the Arizona Department of Transportation, for the Arizona Department of Public Safety, and for their emergency services partner agencies. However, it is technically very difficult on a high-speed, high-volume, multi-lane freeway to obtain accurate speed data to document this problem.

A variety of Intelligent Transportation Systems (ITS) now exist that purport to be able to both accurately collect such data and effectively enforce the speed limits using camera-based technology. While these systems have proven effective on municipal streets with fewer lanes traveling at lower speeds, few if any systems are currently operating on the multi-lane, high-speed types of freeways that exist in the Phoenix metro area.

Extreme speeding creates significant safety problems, as well as economic issues, that are difficult to reduce with current enforcement methods for both technical and resource reasons. Technically, methods like intensive "sweep" enforcement are effective in the area of focus, and they do have an impact through publicity to affect other motorists, but the magnitude of the Phoenix regional freeway system makes it difficult to obtain a system-wide impact. Another technical impediment is the high volume of traffic. During several times of the day, on-the-road enforcement can create congestion due to typical "rubber-necking" motorist behavior in the area of a vehicle pulled over by a DPS officer. In other words, enforcement causes congestion and congestion creates its own types of safety problems.

Effective enforcement using current methods requires sufficient manpower and equipment to cope with excessive speeds and extreme speeding – a growing problem on the Phoenix area's expanding freeway system. DPS faces higher average speeds and traffic volumes on more highway miles, with fewer resources and a growing retention problem. The Metro Highway Patrol Division is now (October 2005) under-strength by more than 50 officers, and recruiting falls short due to state budget constraints. Without substantial resource increases, which may be unrealistic given legislative resource pressures in many other areas, a solution using ITS technology could prove highly cost-effective.

The evaluation of the technical aspects of the ITS photo speed enforcement tools and methods is the focus of the research in this project and gives rise to the research question that was investigated. In a before and after study of photo speed enforcement in Norway, a 26 percent reduction in injury crashes was reported at sites that had high accident rates and density. For sites that did not conform to the warrants, the reduction was only five percent, which was not statistically significant. The results of a meta analysis that combined the effects of automated enforcement reported in Australia, England, Germany, Sweden, the Netherlands, and Norway indicated a 17 percent reduction in injury crashes (Stuster et al 1998).

1.2. SCOPE OF THIS RESEARCH

The primary objective of this project was to investigate this research question:

> <u>Research Question</u>: *Can any current offerings of vendors of photo speed enforcement systems provide a viable technical solution that will accurately measure the Phoenix metro regional freeway speeding problems, given the needs and constraints of ADOT and DPS? Additionally, can a conceptual trial deployment and accompanying field test plan be developed to demonstrate the technical aspects of potential systems, should it be desired to conduct one in the future?*

In order to accomplish this, an initial research work plan was developed and approved by the project's Technical Advisory Committee (TAC). The work plan was modified during the progress of the research, as guided by unfolding results and unforeseen problems encountered. The TAC also approved these modifications.

It is important to note that this work plan is limited to the technical aspects of a photo enforcement system. Whereas a violation processing and management system would also need to be studied in detail to fully evaluate the viability of a photo enforcement system, these aspects are beyond the scope of this report.

The final research work plan consisted of the following major tasks:

<u>Phase 1</u>

1. Conduct a literature search and Internet search of speed enforcement on high-speed, high-volume, multi-lane, limited-access urban freeways.
2. Conduct a vendor survey/review of current photo camera and related technologies for freeways. When possible, have vendors give presentations to the TAC.
3. Conduct interviews with selected practioner agencies. This will not include the entire universe of state DOTs and international agencies. Instead, it will include those agencies identified through vendor information as to the systems they have deployed, agency referrals to other agencies they believe have or are considering system deployment, and others identified through the course of the research.
4. Evaluate vendor systems for potential deployment effectiveness regarding possible public perceptions and potential countermeasures by drivers and private entrepreneurs.

<u>Phase 2</u>

5. Develop a conceptual design of a trial deployment and field test in the form of a "Model RFP" that can be used as the conceptual basis to develop an actual RFP, should it be desired to do so in the future.
6. Develop a conceptual field test plan to evaluate the trial deployment and field test, which will be referenced in the Model RFP developed in Task 5.
7. Complete an ADOT-ATRC Final Report and a Research Note.
8. Make a final presentation to ADOT and partner agency senior management. Be available to assist in other presentations to interested parties as requested.

The project was formally initiated in November 2004. The initial meeting with the project sponsors and technical advisors was held on December 7, 2004, at ADOT's Traffic Operations Center in Phoenix. The research was actively guided by a Technical Advisory Committee whose stakeholder / member sections are listed below:

Technical Advisory Committee Membership

ADOT, State Traffic Engineer
ADOT, Transportation Technology Group
ADOT, Traffic Engineering Group
ADOT, Risk Management
ADOT, Communication and Community Partnerships
Arizona Department of Public Safety
Maricopa Association of Governments
City of Scottsdale, Traffic Engineer
Arizona Governor's Office of Highway Safety
Federal Highway Administration
Arizona Attorney General (advisory only)

1.3. ORGANIZATION OF THE REPORT

The report is organized into chapters that address each element of the research work. If additional detail is deemed relevant, it is included in an Appendix. The organization scheme for chapter topics and location focuses on understanding the outcomes rather than the chronological flow of work.

As is typical with most research, unanticipated problems were encountered that were not envisioned in the work plan. However, unless these have a direct bearing on the results, they are not reported here. A detailed Table of Contents is given to assist the reader in finding topics of interest.

2. CURRENT STATE OF TECHNOLOGY

2.1. GENERAL CONCEPTS

The worldwide development of photo speed enforcement systems has been driven by a combination of need and technology availability. The need for an automatic system to enforce speed laws is driven by both the desire to use public safety monies in a cost effective manner, and by the growth of traffic volumes that typically outstrip traffic capacity in most large metropolitan areas worldwide. This outstripping creates greater safety problems for the motoring public.

The first example of automatic traffic control reported in the research literature was the photo-radar installed in May 1973 on Autobahn A3 between Cologne and Frankfurt, Germany. While crude by today's technology, the basic elements of this early system are still what are used today. (Sagberg 2000) As of 2005, at least 75 countries rely on cameras to enforce speed limits, especially on high-risk roads, including Australia, Austria, Canada, Germany, Greece, Italy, the Netherlands, Norway, South Africa, Spain, Switzerland, and Taiwan (IIHS 2005). Compared with other countries, speed cameras have only been used on a limited basis so far by U.S. police. Cameras currently are in use in communities in several states, including Arizona, California, Colorado, North Carolina, Ohio, Oregon, and the District of Columbia (IIHS 2005).

The technology to create a complete system to provide automatic speed enforcement has evolved in response to the need, but relies on technologies largely developed in different fields for different applications.

Conceptually, three basic elements are needed for an automatic speed enforcement system:

1. *Vehicle Speed Subsystem*: senses the speed of a vehicle as it travels within the path of the system.
2. *Vehicle/Driver Photo Subsystem*: photographs the identifying characteristics of the speeding vehicle and, if required, its driver as the vehicle travels within the path of the system.
3. *Speeding Violation Subsystem*: identifies the owner, and if required, the driver of the speeding vehicle, issues a speeding violation, and prosecutes the violation if guilt is not admitted.

This study focuses exclusively on the technology aspects of the first two subsystems.

2.2. RED-LIGHT RUNNING TECHNOLOGY

The first automatic photo systems to be widely deployed in the United States were "red-light running" systems. The most severe consequence of running a red light is a right-angle collision in the intersection. At typical municipal arterial speeds, this type of collision often results in fatalities or severe bodily injuries, accompanied by extensive property damage. During the 1990s, many municipal agencies were seeing an increase in the frequency of these types of collisions and were willing to test automatic systems.

Testing these types of systems requires cooperation between the traffic-engineering agency, the public safety agency, and the traffic courts. All of these groups are within the control of a municipality when dealing with traffic law violations in their city. Typically, local public support was behind “doing something” about red-light running in “our” city. For these reasons, it was relatively easy and quick for a municipality that was experiencing red-light running problems to test these systems. One impediment often was a requirement by the state legislature to provide legislation allowing the city to legally use the system, or at least to verify that it was allowed under home rule statutes.

The Phoenix metropolitan area was an early adopter of red-light running systems, including the cities of Paradise Valley, Scottsdale, Phoenix, and Mesa. The frequency of these types of violations was regarded as being among the highest in the nation, often documented by accident and insurance reports. One contributing factor was the geometric layout of the metropolitan street system. Most cities west of the Mississippi were laid out on a grid system. In addition, the Phoenix metro area made an early commitment to a strong interconnectivity in its grid system, which included multi-lane arterials on a regular basis, typically every quarter mile.

These multi-lane arterials typically have a 35-45 mph speed limit and unrestricted sight distances ahead to the next stop light. These conditions make it easy for a driver to see an “opportunity” to “beat” the red light. Additionally, increasing traffic volumes added two inducements to drivers who were willing to break the law and run the red light rather than stop. First, higher traffic volumes typically lead to longer traffic signal cycle times so drivers know that if they miss the green light, they will have to wait a long time until they get the green light again. Second, higher traffic volumes cause traffic engineers to coordinate their signals along a long stretch of arterial so that a driver going the speed limit can have all green lights as s/he drives through a series of intersections. So a perceived benefit of “running” through the red light (but just at the end of the yellow light) is that the driver can probably catch the green light at the next traffic signal.

Red-light photo enforcement systems were originally deployed in Europe, and most of the original vendors were European companies. Many of these vendors set up operations or partnered with American companies to bring this technology to the United States. The only difference between a speed enforcement system and a red-light running system is that one captures a vehicle speeding and the other captures a vehicle running the red light.

2.3. FIXED SPEED ENFORCEMENT TECHNOLOGY

An automatic speed enforcement system is closely related to an automatic red-light running system, since many technical and management systems overlap. In fact, some vendors’ designs will do both in the same system.

2.3.1. Vehicle Speed Subsystem

2.3.1.1. Sensors

Almost all vendors use a form of radar sensor to instantly sense the speed of a vehicle. Two vendors (one exclusively and another as an option) use a LIDAR sensor, which works in the same fashion as radar, except it emits energy in the visible light portion of the electromagnetic spectrum. Some vendors can use an alternative in-pavement piezo sensor (pressure-sensitive strip), which requires a vehicle to run over it to sense its presence. To capture speed, two piezo sensors are embedded in the roadway at a small distance apart and speed is calculated based on the elapsed time in between. Regardless of the sensor type, the purpose is the same: (1) determine the speed of the vehicle and (2) determine if it is in violation of the speed limit.

Capturing speed is complicated by where the sensor is located relative to the vehicle. A sensor can be located overhead (gantry) or at the side of a road (side-fire) (see Figure 1).

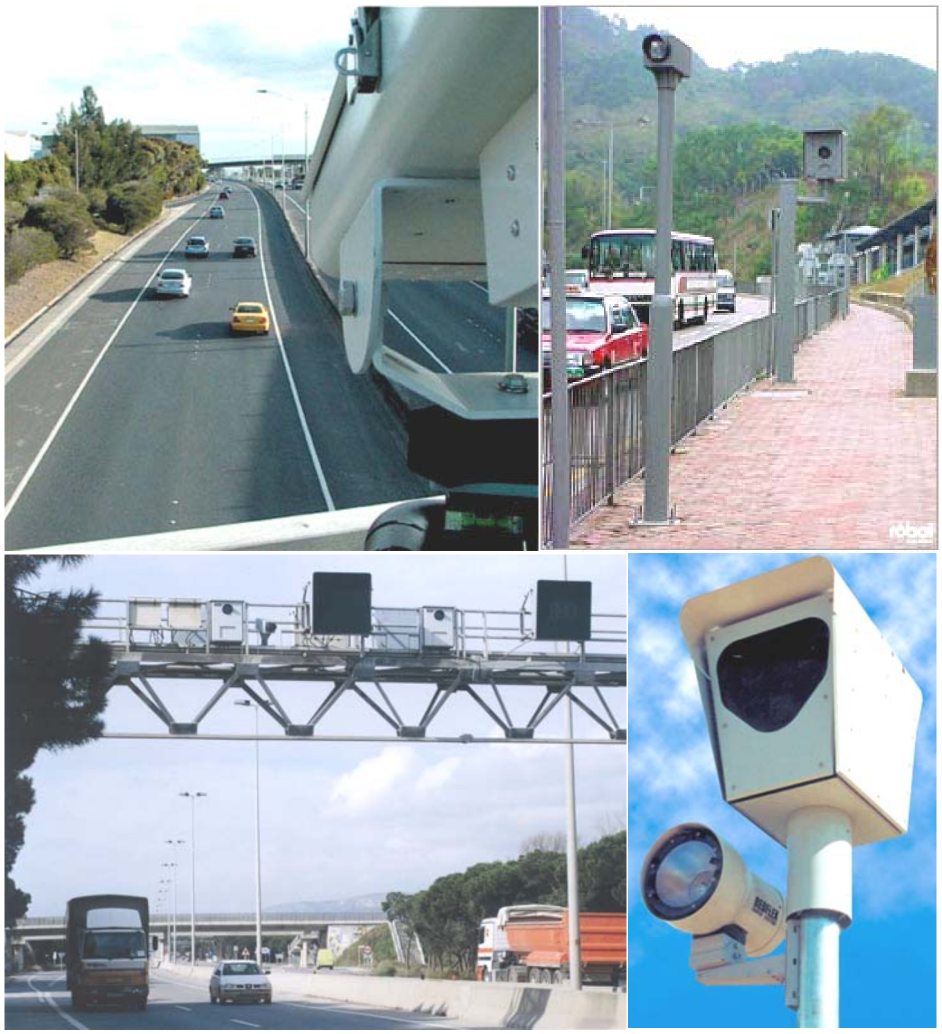

Figure 1: Gantry-Mounted and Pole-Mounted Speed Camera Equipment

Photos on left show gantry-mounted equipment; photos on right show pole-mounted, side-fire equipment.
[Source upper left and lower right: Road Traffic Technology 2005]
[Source upper right: Traffipax 2, 2005]
[Source lower left: LaserCraft 2005]

A gantry-mounted sensor typically only monitors one lane of a roadway--the one directly under it. A side-fire sensor typically is directed across the roadway and senses multiple lanes. A disadvantage of a side-fire sensor is that when a vehicle in a nearby lane blocks a vehicle in a far lane, the vehicle speed in the far lane cannot be sensed. Because the gantry-mounted sensor only looks down at one lane, no vehicle can block it. However, this requires that one sensor be used for every lane monitored, whereas a single side-fire sensor can monitor more than one lane. The same pros and cons apply to a pair of in-pavement piezo sensors, which also can sense only one lane.

Side-fire sensors have technical limits of how many lanes they can capture, which is simply a function of distance from the sensor. The farther lanes are more technically difficult to sense than the nearer lanes. As mentioned earlier, vehicles in lanes near the sensor can block vehicles in far lanes, and the more lanes that are being sensed, the greater the probability that the farthest lane will be blocked by vehicles in one or more of the nearer lanes.

2.3.1.2. Sensed Versus Target Speed

Another function of the subsystem is to compare the sensed speed of a vehicle against the threshold speed. In practice, the threshold speed is a value that is controlled by the agency. If a grace interval is to be used, then the threshold speed is set as the actual speed limit plus the amount of the grace interval. Some systems can also sense the type (classification) of vehicle in some circumstances as a function of length. If there are different speed limits for large trucks and vehicles, then these systems can use a different threshold speed for each.

Once it has been determined that a vehicle is speeding, the *Vehicle/Driver Photo Subsystem* is activated. The information about the vehicle's speed is passed to this subsystem so it can be recorded simultaneously with the photos that will be taken.

2.3.2. Vehicle/Driver Photo Subsystem

2.3.2.1. Film and Digital Photography

Early systems used film cameras, which required retrieval of the film at the camera, and is still available from some vendors. Currently, almost all (if not all) systems now use digital photography to capture photos of the driver and the vehicle. The photos are typically only taken when the vehicle is sensed to be moving above the set target speed. The detailed speed information from the Vehicle Speed Subsystem is merged digitally with the photos to create a record of the speeding violation. Two critical issues with this record are privacy of the driver and post-capture tampering with the record. To help guard against these issues, many vendors encrypt the data as soon as the record is made. Typically a remote speed sensor (radar and LIDAR) is housed with the camera and can be side-fire or gantry mounted. It is important that the speed is sensed and the photo is taken simultaneously.

2.3.2.2. Number of Cameras Required

A critical issue is where the license plate(s) is located. If a vehicle has a front license plate, a single photo may serve to simultaneously capture both the license plate and the driver image. If the vehicle only has a rear license plate, as is the case in Arizona, then two photos have to be taken. When these two photos are taken is a critical issue. If the photos are taken at exactly the same time, then it is perhaps easier to defend that the photo of the front of the vehicle matches the photo of the rear of the vehicle. This requires two cameras, in an arrangement commonly called a master and a slave. This arrangement forces the slave camera to fire at the same time the master camera fires. However, this arrangement requires the two cameras to be located at two different locations, not a trivial issue.

If only one camera location is used, the photos of the driver and the vehicle must be taken at different times, albeit with a very small time interval in between. Two cameras are still required, but the first one faces the oncoming driver and the other faces the opposite direction. So the first camera takes the first photo of the driver and then the second camera waits the required time for the vehicle to pass and then takes the second photo of the rear of the vehicle (license plate) as it is going away from the camera. These two images are merged, with time stamps, along with the speed sensor information into the record of the speeding violation.

2.3.2.3. Illumination Required

Illumination is required to obtain the best photographs, which typically takes the form of a flash tube and optimized lamp reflector. It must be capable of providing adequate illumination under all light and weather conditions, including rainy night-time conditions. The flash system must also be safe for passing motorists. Many citizens are concerned about frontal flash and may claim that it is unsafe to expose a driver to such a bright light. While the flash is intense, it is of very short duration. According to one source (PhotoCop 2005), there are no cases of recorded accidents resulting from flash units used in photo enforcement. In some cases red filters are used over the flash units to reduce the effect, but these are most frequently used with black and white film since they produce poor color images.

Flash intensity is critical. The best quality photographs are obtained with a lower flash position, and relatively close proximity to the vehicle/driver being photographed. More flash intensity is required as the distance to the vehicle/driver increases. Recall that side-fire units must take photos across several lanes. Lighting the interior of a vehicle for purposes of driver identification is equally problematic. Some vendors with extensive experience have faced and conquered most side-fire flash challenges across two lanes of roadway but little, if any, experience exists across four and five lanes, especially at the high speeds typical on the Phoenix metro freeway system.

2.3.2.4. Maintenance

Maintenance is a critical issue on high-speed, multi-lane freeways for safety, cost, and congestion reasons. The location of devices that must be maintained greatly affects their desirability in a freeway application. A lane closure for maintenance is not only an expensive process but always carries a safety risk. A person on an overhead gantry with traffic flowing below typically does not require a lane closure, but does pose a safety risk. Working at the side of a freeway also poses a safety risk and a cost to protect the worker. It is generally easier to work on the right shoulder than the left shoulder. If the space outside the left shoulder is too narrow, it requires a lane closure to work within it. At some locations the space outside the right shoulder can be so narrow that it also requires a lane closure to work in it.

Access to equipment, typically the camera, may be required for reasons other than maintenance. For example, the system deployment plan may include switching a camera among multiple locations in order to minimize the known “single point” enforcement effect. Also, the data from the system must be downloaded on a regular basis. In some systems this downloading can be done remotely through wireless. If it cannot be accessed remotely, then the storage device either will have to be visited on a regular basis, which can be problematic, or a hard wire must be used for downloading, perhaps via a cell phone modem.

2.3.3. Speeding Violation Subsystem

While evaluating this subsystem is beyond the scope of this project, obviously the *Speeding Violation Subsystem* is also required for a complete photo speed system to function. It should be noted that the speeding violation subsystem requires considerable adaptation to the individual requirements of the jurisdiction where the system is deployed.

The conceptual functions of this subsystem are listed below from the perspective of a single violation. These functions depend primarily on management systems rather than technology and are people-intensive functions. These are in simple outline form and were adapted from the actual process currently used by a major city in the Phoenix metro area that has extensive experience in both photo red-light running and photo speed enforcement (City of Scottsdale, Arizona, 2005):

- The record from the *Vehicle/Driver Photo Subsystem* is retrieved for processing.
- The owner of the vehicle is identified through license plate records. If the owner of the vehicle and the person in the photo of the driver do not appear to be of the same gender, then the owner is voluntarily asked to identify the driver.
- The violation citation is issued, typically by mail. Depending on the requirements of the jurisdiction, the citation may include the photo of the driver. The person cited is typically given three choices: (a) plead guilty and pay a fine, (b) plead innocent and ask for a court date, or (c) prove that the photo of the driver is not the person cited, in which case the citation will be voided.
- The violation is transferred to the court.
- If the recipient of the violation proves that it is not his/her photo, the citation is dropped; this information is transferred to the court.
- If a citation is contested, the citation is defended in court.
- If a citation is ignored, provide process service after a set period of time from date of issue; this information is transferred to the court.

Since these functions are manpower intensive, it is often this subsystem that is the most critical in the selection process for an agency. Some vendors supply all of these services on a contract basis or will provide only those elements that an agency may not want to do internally.

2.4. MOBILE SPEED ENFORCEMENT TECHNOLOGY

As contrasted by the fixed speed enforcement technology as previously discussed in Section 2.3, mobile devices are available. This technology takes two basic forms: (a) moving a camera/sensor from fixed location to fixed location and (b) mounting a camera/sensor in a van or tethered to a vehicle.

The concept behind moving the camera/sensor between various fixed locations is to spread driver behavior changes over a larger area, without requiring complete systems at each fixed location. The motivations for this can be economic or managerial. The economics are straightforward--fewer camera/sensor units are required. Management reasons might include reducing the complaint of creating a speed trap and/or a desire to limit the number of citations issued per month, perhaps because of court loads.

The concept behind mounting a camera/sensor in a van is somewhat similar to a typical law enforcement officer using a radar gun in his/her patrol vehicle to issue speeding citations (see Figure 2). The ability to automatically record violations in the mobile photo enforcement van and later issue citations can be said to increase the efficiency of such a unit versus a patrol vehicle. It is important to note that that the mobile unit is quite limited in its function whereas an officer in a radar-equipped patrol vehicle can instantly switch to other safety functions based on observed information or radio calls. These include helping stranded motorists, removing drivers under the influence, and answering radio calls for assistance for a wide variety of needs. Conversely, many municipalities do not use police officers to operate the mobile vans, but use technicians instead.

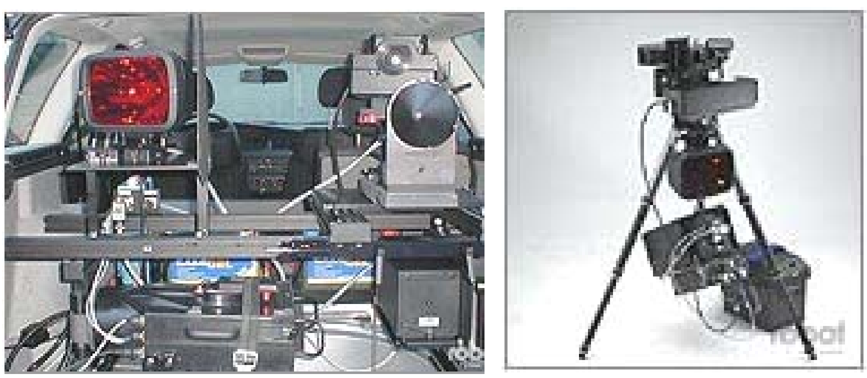

Figure 2: Mobile Speed Camera Equipment

Photo on left shows entire system (except for slave camera) mounted inside a van. Photo on right shows a slave camera (this one also includes a radar sensor) that would be deployed away from the van in order to take two simultaneous photos of the front and the rear of a vehicle.
[Source: Traffipax 2005]

The mobile van includes the record storage equipment as well as the camera/sensor. Because the unit is mobile, it enforces different speed limits depending on location. Therefore, the mobile van must include equipment to make these types of adjustments as well as set-up and configuration adjustments. If a two-camera system is used, then the slave camera must be located some distance from the mobile van and is typically connected to the van via a cable.

A regular law enforcement vehicle can be adapted for use instead of a mobile van. This gives the officer operating the system the ability to provide other functions if the need arises. However, if two cameras are used, an officer must first recover the slave camera/sensor before he/she can move away from the location where the photo speed enforcement was taking place. The slave could be abandoned with hopes of recovering it later.

2.5. NEW TECHNOLOGY: POINT-TO-POINT

One exception to the typical instant sensing of speed by means of a radar or LIDAR sensor is to use two (or more) sensor points along a roadway that yield the average speed of a vehicle between those points. The sensor points can be considerable distances apart. This is currently being tested in some parts of the world (see Figure 3). Since it is not actively deployed yet, it is not part of this study, but it may have future application and is developing rapidly.

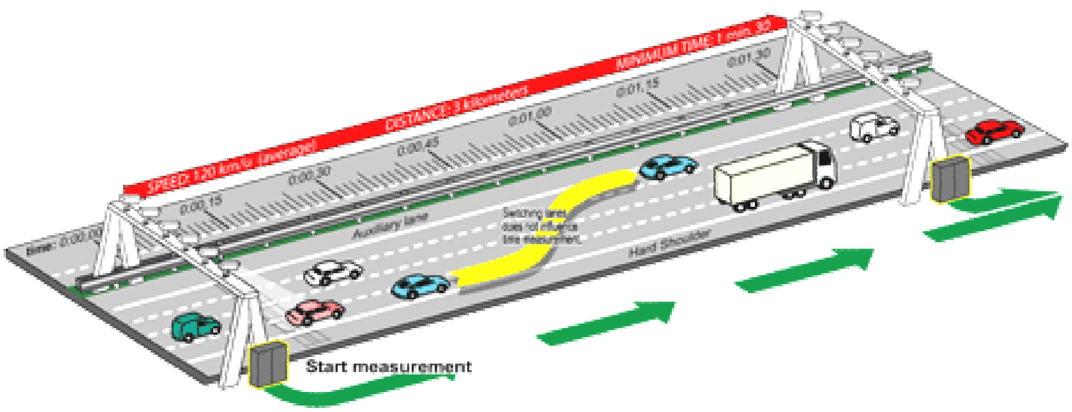

Figure 3: Point-to-Point Photo Speed Enforcement Schematic

[Source: Gatsometer 2005]

The concept of this system is that instead of instantly sensing speed at a single point, the vehicle is identified at two different locations that are a known distance apart along a roadway, and the travel time is used to determine speed. This is called *point-to-point* or *section control* speed enforcement technology and gives the average speed over the distance between the two points. This technology substitutes a *vehicle recognition system* for the instant speed sensor. All vehicles are recorded when they pass the first instrumented point and as each vehicle passes the second point it is recorded again. The recorded information of the individual vehicle at the second point is compared to all the recorded vehicles at the first point to determine a match. When matched, the times that the vehicle passed each point along with the known distance between the two fixed points is used to determine if a violation has occurred. If it has, the rest of the process is essentially identical to that already discussed for the fixed technology. If a violation has not occurred, typically the record is immediately deleted.

The *vehicle recognition system* can rely on different technologies. A technology currently being tested “reads” the photo of a license plate using computer algorithms to yield the license plate number, which is used to make a match. Another technology that is possible, but not known to be in use, is to use an electronic tag that is carried on the vehicle, each having a unique number that can be used to make a match. The use of vehicle electronic tags is increasing for such uses as automatic toll collection and truck port-of-entry clearance. In the future, an electronic tag could be imbedded into the vehicle license plate.

Point-to-point systems are being tested in Scotland (BBC News 2005), Australia (RTA-NSW 2005), the Netherlands (BVOM 2005 and Gatsometer 2005), and Austria (Efkon 2005). While this type of system is potentially more expensive, it eliminates some of the “known point” aspects of speed enforcement wherein a driver slows to obey the speed limit where a camera/sensor location is known to exist and then speeds up again right after it. A potential drawback of the system is that it is ineffective when a driver leaves the roadway between the known points.

3. IDEAL SYSTEM CHARACTERISTICS FOR ADOT AND DPS

Photo speed enforcement is extensive worldwide. However, systems on multi-lane, high-speed freeway applications are not deployed and proven. Some agencies are currently implementing such programs. Madrid, Spain, is an example, but they do not have explicit programs that address all of the issues encountered on Phoenix metro area freeways. Therefore, the TAC extensively discussed the characteristics that an ideal system should have to serve the needs of the Phoenix metro area freeways. These ideal characteristics were formalized into 12 items to serve as the guide in developing a future pilot implementation.

3.1. GENERAL ADOT NEEDS

ADOT has the mission to provide products and services for a safe, efficient, cost-effective transportation system that links Arizona to the global economy, promotes economic prosperity, and demonstrates respect for Arizona's environment and quality of life (ADOT 2005). Within this mission, ADOT is responsible for the design, operation, and maintenance of the state highway system, which includes all traffic control devices. The primary goal of ADOT is safety for the traveling public and its own employees. It constantly strives to improve safety through a variety of traffic control devices as well as design features. Its maintenance and operations functions are always examined in detail so as not to compromise worker or motorist safety, and wherever possible, to improve it.

The increase in traffic volumes has seen the advent of new technologies being deployed to combat congestion. Some examples are HOV lanes, dynamic message signs (DMS), a traffic operations center, real-time camera monitoring of traffic conditions, and web-based motorist advisory information. All of these systems deploy new technologies without degrading safety and often enhance it.

ADOT supports the goal of speed enforcement on the Phoenix metro area freeway system because it is well aware that the current high levels of speeding are known to contribute to higher collision rates and generally compromise public safety. Photo speed enforcement systems appear to be one potential way to accomplish the agency goals, if the technology can be proven to be technically effective in this application. However, the overarching concern for the State is that a photo speed enforcement system must never compromise the safety of the motoring public or ADOT or DPS employees.

3.2. GENERAL DPS NEEDS

DPS has the mission to protect human life and property by enforcing state laws, deterring criminal activity, assuring highway and public safety, and providing vital scientific, technical, and operational support to other criminal justice agencies (DPS 2005). Within this mission, DPS enforces the traffic laws on the state highway system. It too has an overarching goal of protecting the safety of the motoring public and its employees. It constantly seeks ways to deploy its resources in the most cost-effective manner possible to fulfill its overall responsibilities.

Photo speed enforcement systems appear to be one potential way to assist DPS in a cost effective manner, if the technology can be proven to be technically effective in this application. When a DPS officer is actively conducting speed enforcement on the freeways, either individually or as part of a group sweep activity, the officer is enforcing all the traffic laws at the same time, not just speeding laws. The officer can respond to more critical needs, such as a driver under the influence, based on the officer's experience and observations, which are lacking in an automatic system. An ideal system would be able to assist an officer in the field in real time to enforce traffic speed laws.

3.3. LIST OF IDEAL SYSTEM CHARACTERISTICS

The TAC developed the following list of 12 ideal characteristics for a Photo Speed Enforcement system to be effective on the Phoenix metro area freeways. Many complex interactions can occur between a system and the other activities and goals of ADOT and DPS. In addition to factoring in these goals, the TAC viewed presentations and/or demonstrations from six vendors and solicited each vendor's knowledge and experience during question and answer sessions. The goal of the 12 selected attributes is to provide the ideal list of characteristics that are believed to best serve the motoring public and the needs of both ADOT and DPS.

1. <u>Mobile System:</u> The system needs to be a mobile system in order to be used by the DPS in real time, as part of DPS sweep operations. The mobile system need not be in a van, but could be. If a large enough system was acquired, the mobile aspect might be a sub-set of equipment to meet just this need.
2. <u>Easily Relocatable:</u> This system needs to be easily relocatable in order to avoid a "spot" speed enforcement that becomes known to drivers. Such a spot can lead to unsafe driving behavior when motorists quickly slow down just before the camera/sensor and then speed up after passing it. To avoid this, users should be able to pull the system in and out easily ("plug and play") and relocate it.
3. <u>Acceptable Light Flash:</u> The system needs to have an acceptable light flash so that drivers are not blinded as they drive by the operating system; a "no-light flash" such as infrared may be a viable option. This driver-distraction issue is a priority over any color photographic features that the system may offer. Of particular concern will be the competing needs to have a flash intense enough to reach across several lanes (side-fired) but still not "blind" the driver in the closest lane.
4. <u>Color Photography Desirable:</u> Color is a desirable option, but is secondary. Current users report that color is far more defensible in court (for example, the color of the vehicle is easily observed). Although black and white technology is acceptable, the ideal system would have both color and an acceptable flash intensity.
5. <u>Identify Both Driver and Rear License Plate:</u> The system needs be able to identify both the driver and the rear license plate, which appears to require front-and-rear photos.

6. Vendor Compensation Not Tied to Revenue: The cost of the services of a vendor should not be tied to the revenue generated by the system to avoid any conflicts of interest. The "back office" operation could be wholly conducted by the State, or by the vendor, or shared. This should remain an option.
7. System Costs Are Definable: The system costs needs to be accurately estimated by the vendor. The cost estimation should include details of the cost to sell the equipment to the State, to train employees of the State to run the system, what the fixed fee or charge per citation options would be, etc.
8. Download Data in Real Time: The system needs to download data electronically in real time from the camera/sensor unit(s) and transmit it to the "back shop" operations. It is unsafe to require an employee to continually download data at the unit itself.
9. No Bias in Identifying Violations: The system needs to give equal representation of all roadway speed activity. There should be no bias due to vehicle classification, traffic volume, lane position, speed range, or other factors.
10. No Devices in Pavement: The system must not be invasive to the existing pavement because this increases the frequency of lane closures, each of which carries safety risks.
11. Maintain Roadside Crash-Safety: The system needs to satisfactorily address NCHRP 350 roadside crash-safety requirements.
12. Covers Five Lanes: The system needs to cover five freeway traffic lanes.

3.4. VENDOR ABILITY TO MEET IDEAL SYSTEM CHARACTERISTICS

Six vendors (ACS, Peek Traffic Corporations, American Traffic Solutions, LaserCraft, Traffipax, and Redflex) were interviewed by phone and/or email regarding their available technologies in photo speed enforcement. They were each sent a matrix to fill out, and follow-up questions were addressed through phone calls. A matrix shown in Table 1 summarizes their respective answers. This matrix shows that all vendors believe they can meet ideal system specifications with the following exceptions:

1. Mobile System:
   - American Traffic Solutions cannot meet this desired characteristic.
2. Identify Both Driver and Rear License Plate:
   - LaserCraft cannot meet this desired characteristic. Their DTMS System and LaserCam II are designed primarily to photograph vehicles and their license plates from behind.
3. No Bias in Identifying Violations: All vendors who use side-fire systems will have this problem because it is related to the physics of side-fire and not to any particular vendor. Specifically, during heavy traffic, vehicles in nearer lanes block speeding vehicles in farther lanes from being identified.

Table 1: Vendor Response Matrix

Desired Characteristic	Redflex	Peek Traffic	Traffipax	ACS	American Traffic Solutions (ATS)	LaserCraft
1. Mobile System	yes	yes	yes	yes	**no**	yes
2. Easily Relocatable	yes	yes	yes	yes	yes	yes
3. Acceptable Light Flash	yes	yes	yes	yes	yes	yes
4. Color Photography Desirable	yes	yes	yes	yes	yes	yes
5. ID Both Driver & Rear License Plate	yes	yes	yes	yes	yes	**no**
6. Vendor Compensation Not Tied to Revenue	yes	yes	yes	yes	yes	yes
7. System Costs Are Definable	yes	yes	yes	yes	yes	yes
8. Download Data in Real Time	yes	yes	yes	yes	yes	yes
9. No Bias in Identifying Violations	yes(1)	yes(1)	yes(1)	yes(1)	yes(1)	yes(1)
10. No Devices in Pavement	yes	yes	yes	yes	yes	yes
11. Maintain Roadside Crash-Safety	yes	**if gantry used**	yes	yes	yes	yes
12. Covers Five Lanes	yes	yes	yes	yes	yes	yes

(1)Any side-fire camera by any vendor will have bias because of the physics of nearer lanes blocking farther lanes. This is eliminated for gantry-mounted cameras.

Table only includes summary information; see APPENDIX A (page 65) for extensive details and context of Vendor responses.

4. ACCEPTANCE OF PHOTO SPEED ENFORCEMENT SYSTEMS

4.1. FEEDBACK FROM OWNERS OF DEPLOYED SYSTEMS

Thirteen organizations that have used or are currently using a photo speed enforcement system were interviewed via email and phone. These organizations are:

a. District of Columbia Metropolitan Police Department
b. Madrid, Spain
c. City of Boulder, CO
d. Minnesota Department of Transportation
e. City of Charlotte, NC
f. Calgary Police Service, Calgary AB, Canada
g. City and County of Denver, CO
h. City of Beaverton, OR
i. City of Atlanta, GA
j. City of Zurich, Switzerland
k. Jonkoping County Police, Jonkoping, Sweden
l. New South Wales Government under management of Roads and Traffic Authority of New South Wales, Australia
m. City of Portland Police Bureau, Portland, OR

A questionnaire was formulated with extensive guidance from the TAC. This resulted in the following 20 questions:

1. Who is your vendor?
2. Is your system a mobile/portable technology?
3. Have you used this system in a freeway environment?
4. What is the speed of the roadway on which the system is deployed?
5. How long has your system been in place?
6. How do you handle multiple lanes?
7. What type of detection technology do you use?
8. What are your infrastructure requirements (power, connections, structural, etc.)?
9. How many staff does it require to run your system?
10. What is your system's ability to record incidences and transmit them to a central processing facility?
11. Can you capture information on digital format for download?
12. What type of processing services do you use to issue tickets?
13. How successful are you at getting matches with license plates?

14. Do you have front and rear license plates?
15. What are your success rates?
16. How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)
17. What is the public perception of your technology?
18. What type of countermeasures do you observe?
19. What is the annual cost of the system?
20. What is the annual revenue generated?

The answers from each organization were recorded on a questionnaire form. They were summarized in a highly abbreviated format in Table 2 and Table 3 for ease of overview. However, these abbreviated entries lack detail, which is needed for a complete understanding of the unique circumstances of each agency. The reader is encouraged to consult the full detailed questionnaire responses listed in APPENDIX B (page 79).

All of the users report strong public support of their enforcement system except for two that stated there was an even split in public support. Calgary Police Service stated that public support was positive to the degree that there were requests to specifically use photo speed enforcement in certain communities. In Madrid, Spain, the interviewee reported that the public has become more aware of tragedies and deaths related to high speeds and 65% of the public is in favor of the enforcement system (with 15% opposed and 20% who do not have an opinion either way).

Of the thirteen organizations interviewed, seven were either currently implementing or had implemented the enforcement system on major highways. Three of these seven agencies--in Madrid, Spain, New South Wales, Australia, and Zurich, Switzerland--are implementing their automated systems on highways with three or more lanes of traffic in each direction.

The other four highway applications are mobile systems. Those agencies have used or are currently using the enforcement system on multiple lanes of traffic but require manual setup and/or manual monitoring. They typically target only one specific lane using manual methods. Usually, a law enforcement official or other trained personnel will park in a roadside vehicle and target a specified lane. Using the information from the enforcement device(s), violators are either addressed immediately or their information is stored for later download and ticket processing. Other systems are manually set up and left in place to automatically record violations. The equipment is later retrieved and the information downloaded from the equipment and processed.

Table 2: User Matrix--Part A Questions

Agency Name	A. Vendor Name	B. System used in freeway conditions?	C. Speed on road of system deployment?	D. How are multiple lanes addressed?	E. Type of detection used?
1. District of Columbia Metro Police Department	ACS.	Yes, but this has slowed down and now the majority of applications are on residential and arterial roads.	45-50 mph on freeways and 25-40 mph at other sites.	Fixed and mobile units that shoot a narrow beam across the lanes.	Radar.
2. Madrid, Spain	Peek: (Equip. made by LaserCraft but Peek distributes)	Yes.	120 km/h (80-85 mph) on freeways, 90 km/h (55 mph) on 5-6 lanes of traffic, and 100km/h (62 mph) on regular two-way, two-lane roadways.	Gantry and roadside-mounted systems.	LIDAR and Radar.
3. City of Boulder, CO	ACS.	No.	20-30 mph.	We do not handle multiple lanes.	Radar.
4. Minnesota DOT	N/A.	Yes, but only in work zones.	Varied.	The cameras covered all lanes.	Radar.
5. City of Charlotte, NC.	Peek Traffic.	No.	35-55 mph.	Can use on one lane only.	Laser – ProLaser II.

Table 2: User Matrix--Part A Questions (continued)

6. Calgary Police Service	Multa Nova.	Yes.	30 – 110 km/h (18-68 mph).	Cameras monitor up to 4 lanes of traffic.	Radar.
7. City and County of Denver, CO.	ACS.	No.	25-35 mph.	2 lanes handled while mounted in van.	Radar and Wet Film.
8. City of Beaverton, OR.	Redflex.	No.	20-45 mph.	2 lanes handled at the most.	Radar.
9. City of Atlanta, GA.	LaserCraft.	Yes.	55 mph.	Officer-operated laser gun.	Laser – ProLaser II.
10. City of Zurich, Switzerland.	Traffipax/ Robot.	Yes, pole-mounted systems only.	120 km/h (75 mph) on freeways and 80 km/h (50 mph) on country roads.	3 lanes covered by Traffipax systems.	Radar and loops.
11. Jonkoping County Police, Jonkoping, Sweden.	Sensys Traffic.	No.	50, 70, and 90 km/h (31, 43 and 56 mph).	We do not handle multiple lanes.	Radar.
12. New South Wales government	Traffipax and Redflex.	Yes.	110 km/h (68 mph).	Lane specific sensors--piezo electric.	Piezo and Laser-based speed measurement.
13. City of Portland Police Bureau, Portland, OR.	ACS.	No.	20, 30, 35, and 45 mph.	2-3 lanes of coverage.	Radar and Gatso-meter camera system.

Table only includes summary information: see APPENDIX B (page79) for important details and context.

Table 3: User Matrix--Part B Questions

Agency Name	F. Ability to record and transmit incidences to a central processing facility?	G. Success rate at getting matches with license plates?	H. Front and rear license plates?	I. Type of counter-measures observed	J. Annual cost of the system (US Dollars)
1. District of Columbia Metro Police Department	None.	Not available.	Yes, but only picture of rear plate is needed.	Sprays and obstructions.	$475,000 per month.
2. Madrid, Spain	Technically feasible, but do not have authority to do this.	Over 95%.	Yes, but only take picture of rear plate.	None.	Approx. $126,000 to $151,000 per system per site.
3. City of Boulder, CO	None.	73%.	Yes, we take a picture of both.	Plate covers and sprays.	$436,000 in 2004.
4. Minnesota DOT	None.	Very accurate.	Took picture of rear plate only.	None.	Not available.

Table 3: User Matrix--Part B Questions (continued)

5. City of Charlotte, NC	None.	Approx. 90%.	No, only rear plates.	Sprays, tag covers, and tape as intentional. Bike racks and trailer hitches as unintentional.	Not available.
6. Calgary Police Service	None.	Moderate to high rates.	No, rear plates only.	Plastic plate covers and trailer hitches.	Not available.
7. City and County of Denver, CO	None.	Very successful.	Yes.	None.	$1.4 million annually.
8. City of Beaverton, OR	Transmit data via Internet if digital speed van is used.	4% registration loss and 15% gender matching loss.	Yes.	Sprays and plate covers.	Not available.
9. City of Atlanta, GA	None.	None.	Not available.	Laser detectors.	Not available.
10. City of Zurich, Switzerland	Transmit date via phone or fiber optic line.	96% of Swiss-issued license plates.	Yes, but take picture from rear to capture motorcyles.	None.	Not available.

Table 3: User Matrix--Part B Questions (continued)

11. Jonkoping County Police, Jonkoping, Sweden	None.	100% if license plate is available.	Yes, but only picture of front is required.	Not available.	$210,000 per year.
12. New South Wales government	Transmit data via telecommunications line (similar to 56K in U.S.).	Currently use human recognition, but see 80% success rates with electronic plate reading.	Yes, but only take a picture of one plate.	Plate obstructions and sprays.	Confidential information.
13. City of Portland Police Bureau, Portland OR	None.	7% loss due to clarity of license plates, 14% loss due to gender matching, and majority due to loss of driver picture.	Yes.	License plate covers and sprays.	$35,000 to $40,000 per month to ACS.

Table only includes summary information: see APPENDIX B (page79) for important details and context.

4.2. RELATIONSHIP BETWEEN SAFETY AND PHOTO SPEED ENFORCEMENT

The goal of all traffic law enforcement is to improve safety for the traveling public. The logic behind automated photo speed enforcement is that it will improve safety at a reduced cost compared to traditional speed enforcements that are manpower intensive. But any enforcement method, whether automatic or traditional, affects the behavior of motorists in both positive and negative ways. Therefore, agencies attempt to document the net overall effect of automated photo speed enforcement systems.

Countries and agencies that use photo speed enforcement usually investigate the safety trends that might be affected. Typically the longer a system has been operating, the more data has been collected and the more analysis has been preformed. Great Britain initiated the enabling legislation in 1991 (ROSPA 2005) and by 1994 had 6,000 speed cameras operating in England, Scotland, and Wales (Institute of Advanced Motorists 2005). Great Britain's experience is summarized in a recent publication of The Parliamentary Office of Science and Technology (POST), an office of both Houses of Parliament, charged with providing independent and balanced analysis of public policy issues that have a basis in science and technology. This POST report succinctly summarizes the issues, data, and research regarding safety and speed cameras in the United Kingdom (UK) and provides an introduction to the issues. It is quoted extensively below (in British style & spellings):

> **ISSUES**
>
> The effectiveness of speed cameras in reducing speeds, and the number of road crashes and casualties, is widely debated and depends on several factors:
>
> - The causes of road crashes, and the extent to which speed in excess of the limit is a factor.
> - The potential for offenders to be identified.
> - Public attitudes to speed cameras.
>
> These points, along with an overview of the available research evidence, are considered below.
>
> **The causes of road crashes**:
> Research by the Transport Research Laboratory has found that crash risk rises the faster a driver travels, with a driver travelling at 25% above the average speed being 6 times more likely to be involved in a crash.
>
> Even where speed is not the cause of the crash itself, it may worsen the consequences of crashes that occur for other reasons, e.g. aggressive or drink-driving, following too closely behind another driver, or weather conditions.
>
> ***Are speed cameras effective?***
> While it is generally agreed that cameras are effective in certain situations where crashes are caused by excessive speed, there are conflicting views on whether the UK safety camera scheme has reduced overall road casualty figures. This is due to differing interpretations of the available data, some of which are discussed [below] […].

Use of data: It is not straightforward to draw conclusions on the impact of speed camera use from aggregate crash statistics. Trends can arise from many factors (e.g. other road safety measures) in addition to speed enforcement. Also, the way the data are presented is a key factor: for example, casualties per 100,000 population, or per distance travelled. Results can also vary depending on how data are expressed, e.g. injuries, serious injuries, deaths, or a combination of these. Finally, comparisons of areas with different policies need to consider factors such as size of area, population, the type of road network, car usage, and geographic features. […]

Data from camera sites: The Home Office and the DfT [Department of Transport] quote research showing that numbers of people killed or seriously injured are reduced by 35% at camera sites, (taking into account the existing long term downward trend). […]

Overall crash rates: […] DfT figures for numbers killed or seriously injured in UK road crashes between 1990 and 2002 [shows a downward trend]. Some critics, including a minority of academics and motoring organisations, argue that the introduction of speed cameras has slowed the long-term downward trend in crashes […]. However, the DfT believes that their effect on long-term national trends is more likely to be positive, based on research which found that areas with cameras had greater overall reductions in casualties than areas without. […]

Speed cameras have recently been introduced in France, where the success of the British scheme has been cited as motivating the adoption of this particular approach. Speed cameras have also been credited with a 36% reduction in crashes and 74% reduction in fatalities at camera sites in Australia.

Problems identifying and prosecuting offenders

The effectiveness of speed cameras as enforcement tools depends on whether offenders can be successfully prosecuted. There are various ways drivers might attempt to avoid prosecution, some of which apply to any camera type […] while some specific problems arise with certain types of cameras. With rear-facing cameras, which do not photograph the driver, the following scenarios can occur:

- **Denying knowledge**: a registered keeper can claim not to know who was driving the vehicle when the offence occurred. However, the keeper can be charged with failing to nominate the offending driver, which carries a maximum fine of £1,000 and 3 penalty points. A recent government report on road traffic penalties recommended increasing this to 6 points.

- **Use of 'spare' licences**: an offender can avoid licence points by paying another driver to accept responsibility, or using the licence of a non-driver, e.g. an elderly relative. It is not possible to know how often this occurs in the UK.

> In the case of front-facing cameras, identification of speeding motorcyclists is a problem, since they currently only have rear licence plates. The percentage of motorcyclists exceeding 40 mph limits in urban areas is three times higher than with car drivers […]. The police are concerned about the growth of crashes involving motorcyclists and several operations have been undertaken in an attempt to reduce casualties.
>
> **Other methods of avoiding prosecution:**
>
> - **Registering vehicles**: For unregistered vehicles or for those sold on and not registered by the new owner, driver identification is not possible. New rules from 1st April 2004 make it the registered keeper's responsibility to inform the Driver and Vehicle Licensing Agency (DVLA) to whom a car has been sold. The registered keeper of a vehicle also cannot be traced if the vehicle is registered abroad.
> - **Cloning of number plates**: The DfT states that some number plates are 'cloned' to evade identification. Since January 2003, the sale, supply, and registration of number plates has been regulated to attempt to overcome this.
> - **Radar and laser detectors**: These warn drivers of speed cameras in advance, by scanning radar frequencies and detecting laser beams respectively. They have been legal in the UK since 1998 and are widely available. Devices which evade detection by jamming frequencies are still illegal.
>
> (The Parliamentary Office of Science and Technology 2004)

While the UK has arguably the most extensive experience with photo speed enforcement, a few other countries have also performed research on their systems. Three highlights of research from other countries are listed below as well as one from the District of Columbia:

- Hong Kong conducted a pilot test for a speed enforcement camera system and evaluated it for effectiveness according to three aspects: injury traffic accidents, speed measurements, and enforcement. A before-and-after study showed that the system had reduced the number of speeding vehicles by over 65% and archived a 23% reduction in the number of traffic accidents involving injuries. (Hung-Leung, 2000)
- Queensland, Australia, introduced a speed camera program in 1997 using vans at 500 sites, which had grown to 2,500 sites by 2001. A study investigated the crash effects of the program over a four-year period, which resulted in an estimated reduction in fatal crashes of around 45% in areas within 2 km of speed camera sites. Corresponding reductions of 31%, 39%, 19%, and 21% were estimated for hospitalization, medically treated, other injury, and non-injury crashes respectively. In terms of total annual road trauma in Queensland, these savings represent a 32% reduction in fatal crashes, a 26% reduction in fatal to medically treated crashes combined, and a 21% reduction in all reported casualty crashes.

The benefit cost ratio estimated for the program over the period from its introduction to June 2001 was 47. Comparison of the estimated crash reductions and program operational measures showed variations in estimated crash reduction over time were strongly related to the size of the overall program and the density of enforcement. Periods of program growth were also associated with larger crash reductions beyond that expected from the increasing size of the program alone. Higher levels of true randomness in selection of speed camera sites for operation were also associated with higher levels of crash reduction when comparing differential performance of the program across police regions in Queensland. (Newstead 2003)

- British Columbia, Canada, instituted a speed camera program involving 30 cameras. Researchers found a 7 percent decline in crashes and up to 20 percent fewer deaths the first year the cameras were used. The proportion of speeding vehicles at camera sites declined from 66 percent in 1996 to fewer than 40 percent a year later. Researchers also attribute a 10 percent decline in daytime injuries to the speed cameras. And although nearly 250,000 tickets have been issued, nearly two-thirds of those surveyed in British Columbia said they favor the program. (Oesch 2002)
- The District of Columbia's Photo Radar Speeding Reduction Program, initiated in 2001, has reduced aggressive speeding in DC's photo radar enforcement zones. During July 2005, just 3.7 percent of all vehicles monitored by photo radar were traveling above the threshold speed established for the program, compared to rates of 4.4% in July 2004, 7.8% in July 2003, and 9.7% in July 2002. Prior to the program, the aggressive speeding rate was 31% in July 2001 (initial warning period) and 25.5% in August 2001 (first month of ticketing). Since the summer of 2001, aggressive speeding on DC roadways monitored by photo radar has been reduced from almost 1 in 3 motorists speeding aggressively at the beginning of the program to about 1 in 30 motorists in recent months of 2005. (Metropolitan Police Department 2005)

4.3. PUBLIC ATTITUDES TOWARD PHOTO SPEED ENFORCEMENT

4.3.1. Attitudes from Non-Arizona Users of Deployed Systems

Public opinion regarding the use of photo speed enforcement systems varies from country to country and from city to city. Some conclusions have been drawn from the experiences of agencies that have in-place systems. Differences in the cultures of countries may have an impact. It does appear, however, that the methods used to introduce a new system and the openness regarding its operation are key factors regardless of culture differences.

As previously stated, the UK has the most extensive experience with photo speed enforcement systems, dating from 1991. They have explored the question of public acceptance in detail and the issues are well summarized in the same publication previously cited by the Parliamentary Office of Science and Technology. The POST report is again quoted extensively below (with British style & spellings):

Public attitudes to speed cameras

Experiences overseas show that public support can have a major impact on the success of camera schemes. High levels of support for speed cameras in Australia have been attributed to openness, publicity, and communication, which lessened concerns that the scheme was a revenue-raising exercise for the authorities. However, in Canada, despite initially encouraging road safety results, two provinces removed their speed cameras as a result of adverse public opinion. Public attitudes to speed cameras in the UK are mixed.

Some widely voiced opinions, both for and against the use of speed cameras, are outlined below:

Opposition to speed cameras

Objections centre mainly on the following points:

- **Accusations of revenue-raising**: [*A Partnership is the enforcement agency, the courts, and the roadway authority. UK-wide these Partnerships pool all fines into a central federal fund, from which the costs of installation and operation are paid to the Partnerships and the excess is claimed by the federal government*.] The idea that cameras are a revenue-raising tool for the Partnerships, and thus for the government, is prevalent amongst the general public and in the media. Numerous groups and websites exist to promote this view. However, the income generated in excess of operating costs is relatively small (£4.3 million in 2001/02 [from a total of £15.7 million of speeding fines]). There are also claims that cameras are sited for maximum profitability rather than for greatest safety benefits. A review carried out by the DfT in March 2004, in response to these claims, concluded that all cameras were correctly sited according to the guidelines in force at the time of their installation. The AA Motoring Trust has voiced concerns that such claims may result in a loss of public support for speed cameras and for the agencies involved in the Safety Camera Partnerships.

- **Over-emphasis on speed:** Organisations such as the RAC Foundation argue that over-emphasis on speed enforcement leads to a neglect of other types of illegal driving behaviour. For example, drink driving, dangerous driving, and driving while disqualified, are not detected by speed cameras. There have been criticisms of the Durham Road Casualty Reduction Partnership (which covers the one area not taking part in the Safety Camera scheme), which believes that these other factors cause more crashes than speed and that cameras will not help to solve its road casualty problem. Similarly, cameras are criticised by some for replacing traffic patrols. Supporters of the scheme argue that the use of cameras frees up police time and resources to deal with other traffic issues.

- **Human rights**: Several challenges have been made to the system under the Human Rights Act on the grounds that requiring people to identify themselves as the driver equates to self-incrimination and violates the right to silence. However, in December 2000 a ruling was upheld on a

Scottish case, which confirmed that the process does not infringe any human rights.

- **Limited impact on speed**: There are concerns that the effectiveness of cameras could be limited, as drivers may slow down for cameras but speed up afterwards. However, there is some evidence that slight speed reductions are maintained over wider distances.

National news coverage of speed cameras, especially in the tabloid press, has been largely negative. The word 'scameras' has been widely used and campaigns have been run to discredit the Partnerships by suggesting that safety is not their primary aim. Vandalism of cameras is often reported in the press, with cameras shot at, spray painted, set on fire, and even bombed.

Support for speed cameras
Local support
Many community organisations have mounted campaigns for cameras to be installed at particular locations. Some have erected fake speed cameras, operated their own speed detection equipment, or even blockaded roads in an effort to tackle speed-related problems in their communities. A recent survey suggests that, nationally, over 10,000 requests for cameras are received by Partnerships each year, not all of which qualify.

National Support
Many groups, including road safety and transport organisations such as Transport 2000 and the Slower Speeds Initiative, champion the use of speed cameras. These two organisations mounted a legal challenge in 2003 against the requirement that cameras should be yellow and sited conspicuously and, as a result, covert cameras can be used. Transport 2000 is also campaigning for a change to siting rules, arguing that communities should not have to wait until a certain level of death or injury has occurred before they qualify for a camera. Over 30 organisations are part of a Safer Streets Coalition, which calls for the enforcement of speed limits to be given a much higher priority through the use of cameras, more resources for traffic police, and more frequent and severer penalties for speeding offences.

(The Parliamentary Office of Science and Technology 2004)

While the UK's experience addresses the issues, it is within the context of the UK driving and political environment. The perceptions of motorists in any location are highly influenced by their specific environment. This local attitude and participation in speeding varies depending on several factors, which may include the normal behavior of the drivers regarding speeding, the degree of congestion, the accident history in the area, the physical arrangement of the roadway network, the amount and types of traffic control devices, the amount of media attention on traffic issues, and the level of enforcement. These types of factors make it difficult to generalize the experiences of one locale to another. Below are listed some results of opinion sampling from areas where photo speed enforcement systems are deployed. However, public opinion is not static and can change from year to year.

- The Canada Safety Council recently commissioned a survey to find out how Canadians feel about traditional traffic enforcement, including roadside checks, radar, speed traps, and visibility of police in the community, and how receptive they are to the use of high tech devices to enforce traffic laws. The Environics Research Group interviewed 2,114 adult Canadians between December 22, 2000, and January 15, 2001. A majority of 55 percent of Canadians think the general level of traditional traffic enforcement by police, including roadside checks, radar, speed traps, and visibility of police in their community, is about right. A significant minority, 38 percent, think there is not enough enforcement. Few (5%) think there is too much enforcement.

  Canadians were informed that electronic enforcement involves using cameras instead of police to identify vehicles that speed or run red lights. The owner of the vehicle is fined but no points are assigned to anyone's driving record. More than eight in ten Canadians (84%) support the use of photo radar to identify vehicles that break the speed limit in school zones. Just 15 percent are opposed. Moreover, the proportion who strongly support (65%) is more than seven times that who strongly oppose (9%). Two-thirds of Canadians (67%) support the use of photo radar to identify vehicles that break the speed limit on the highway. One-third (32%) are opposed. Moreover, the proportion who strongly support (39%) is twice that who strongly oppose (19%). These results are reported to be accurate to within +/-2.2 percent at a 95 percent level of confidence. (Environics Research Group 2001). A later survey was done in September 2003 and the results closely parallel the earlier one reported here. (Decima teleVox 2003)

- Australian residents were surveyed about a range of issues relating to driving speeds, speed infringements, perceived and preferred speed enforcement tolerances, and attitudes towards speed enforcement measures. Telephone interviews were conducted during May 2002, with a sample of 2,543 people aged 15 years and over residing in the mainland States of New South Wales (NSW), Victoria, South Australia, Queensland and Western Australia. While most people say they normally drive within the speed limit, six in ten indicate that they sometimes drive at higher speeds. Many admit to exceeding posted limits by 10 km/hr or more, in both urban 60 km/hr zones (33% of drivers) and rural 100 km/hr zones (46% of drivers).

  On average, one in five drivers has been booked for speeding in the past two years, though this varies between States: from a low in NSW (12%), to a high in Western Australia (30%). A majority of people in all jurisdictions think that speed limits should be enforced with a tolerance of 5 km/hr or less; substantial minorities favor a zero tolerance approach, in both urban (29%) and rural (24%) speed zones. The community generally believes that enforcement intensities should either stay the same or increase; there is little support for any reduction in current enforcement levels, including the number of speed cameras and the severity of penalties. Overall, 40% of the community supported an increase in the number of speed cameras, 42% supported an increase in speed limit enforcement, and 23% supported an increase in the severity of speeding penalties. Relatively few people favored a reduction in any of these items.

Most licensed drivers agreed that "the possibility of being fined" (83%) or "the possibility of losing demerit points" (75%) are important factors in speed selection. At the same time, most people (80%) agreed "driving safely for the conditions is more important than staying under the speed limit." Less than a third (31%) of people agreed with the proposition that "keeping up with traffic is more important than driving within the speed limit," however, males (41%) were much more likely than females (22%) to hold this view. Support for this statement was also more prevalent among people who had recently been booked for speeding, particularly those booked in the previous six months (48%).

Two-thirds (67%) of those who had been booked said they were detected by speed camera and almost a third (30%) by a mobile patrol vehicle (police car or motorcycle). This was consistent across all States except for Queensland, where half (51%) said they were booked by speed camera and 43% by mobile patrol. Licence holders who had been booked for speeding were typically males in their early 20s. Almost three in ten 20 to 24 year olds reported being booked or cautioned for speeding. There was a clear linear decline in the likelihood of being booked after the age of 24, culminating in less than one in ten being booked after the age of 59 (9%). (Mitchell-Taverner, Zipparo, and Goldsworthy 2003)

- A telephone survey was conducted among 500 residents of Washington, DC approximately 9 months after speed cameras were introduced in August 2001. Almost two-thirds of drivers said speeding was a problem in the District. Considerable awareness of speed cameras was found and overall, 51 percent of drivers favored speed cameras versus 36 percent opposed. Support for camera enforcement was higher among middle-aged and older drivers, among drivers who had not received a speeding ticket in the mail and did not know anyone who had, and among drivers who said speeding was a problem in the District. (Retting 2003)

4.3.2. Public Opinion Survey--City of Scottsdale, Arizona

The City of Scottsdale, Arizona, began operating cameras for red-light running in early 1996 and added photo speed capabilities in 2002. The City has found the program to be successful based on its goal of improving safety, as measured through various statistics dealing with reductions in the number of violations, number of collisions, and number of fatalities. (City of Scottsdale 2005)

The City considers it critical to inform its citizens about the program and to sample their opinions regarding it. They have conducted seven public opinion surveys, beginning with one in May 1996 before installing the first photo enforcement cameras. Since then, they have conducted essentially annual surveys and asked identical questions each year. Using identical questions each year provides strong confidence in the resulting trends. The most current 2005 survey collected its public opinions in December 2004.

Each survey was conducted by Behavior Research Center, an independent Phoenix-based firm that provides opinion research to public and private sector clients (http://www.brc-research.com/). Each telephone survey had a randomly selected sample size of approximately 400 adult, licensed drivers who resided within the corporate boundaries of

Scottsdale. The sampling error varies depending on the sample size. If all of the approximately 400 respondents would be in a group that responds to a question, then at the 95% confidence level the sampling error would be about +/- 5% of percentage stated.

Almost all of the survey questions combine the two different types of photo enforcement and typically use the phrase “photo radar and red light cameras.” Using this phrasing, several survey questions delve into the effectiveness of media advertising of the programs, perceptions about safety, and effects on driving behavior. In general, the results show that a majority of the sample supports Scottsdale’s existing program, which includes both red light and photo radar cameras, and its expansion (see Table 4).

Table 4: Combined Opinions of Scottsdale’s Red Light and Speed Camera Program

QUESTION: "In general, do you support or oppose the use of photo radar and red light cameras?"			
	Support	**Oppose**	**Not Sure**
TOTAL			
	77%	17%	6%
GENDER			
Male	71%	22%	7%
Female	82%	13%	5%
AGE			
18 to 24	71%	24%	5%
25 to 34	81%	14%	5%
35 to 54	70%	24%	6%
55 and over	83%	10%	7%

Note: Table Reads Across
[Source: Behavior Research Center 2005]

One question specifically separated red light and photo radar cameras and shows a significant majority are “more favorable” towards both. This question carried a pre-statement that conditions the response: “Statistics show that, 35% of collisions are due to speeding and 6% of collisions are due to running red lights” (see Table 5).

Table 5: Conditioned Independent Opinions of Scottsdale's Photo Radar and Red Light Cameras

QUESTION: "Statistics show that, 35% of collisions are due to speeding and 6% of collisions are due to the running of red lights. In light of this, are you more favorable or less favorable towards: (READ EACH)"				
	More	**Less**	**No Difference**	**Unsure**
Photo radar	71%	13%	14%	2%
Red light cameras	79%	11%	8%	2%

Note: Table Reads Across
[Source: Behavior Research Center 2005]

4.4. COUNTERMEASURES

Countermeasures are devices used to counteract enforcement programs. Several countermeasures to photo speed enforcement have been identified through searches on the Internet and interviews with current users of photo speed enforcement systems. No independent research was found that documents the effectiveness of countermeasure devices. Most system vendors are familiar with most common types of countermeasures and, in general, do not regard them as particularly effective.

Through the Internet search, the following types of countermeasures have been identified:

- Photo/Laser Jammers
- Radar/Laser Diffusers
- License Plate Covers/Sprays
- Radar/Laser Detectors
- Waxes/Coatings to Reduce Radar/Laser Detection
- GPS Speed Camera Location Systems

Photo Jammers use a sensor to detect the camera flash and instantly flashes the license plate with a burst of white light. This downward flash across the license plate purportedly exposes it with white light so that the camera cannot capture the license plate number. Laser Jammers add laser "noise" to the reflected signal and purportedly cause the speed gun display panel to remain blank (see Figure 4).

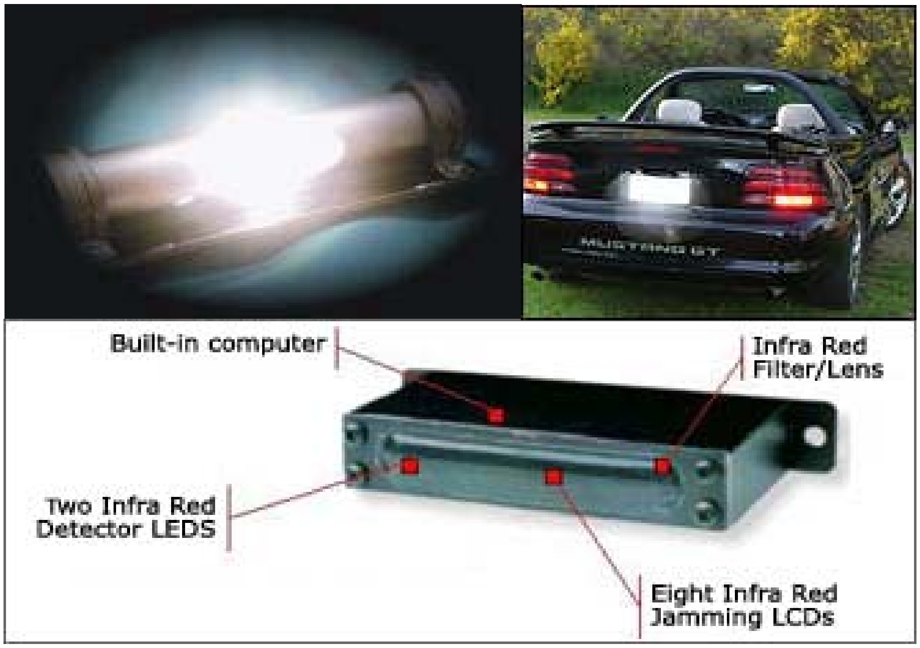

Figure 4: Photo Jammer and Laser Jammer

Top photos from photo jammer ads; photo on bottom from laser jammer ad.
[Source top: Photo Jammers 2005]
[Source bottom: Laser Jammers 2005]

Laser diffusers are designed to detect and deactivate the laser light signal transmitted by the enforcement laser. It purportedly deactivates the speed measurement ability of the laser gun and gives the driver time to react and reduce their speed. The driver is given audible and visual warnings.

License plate covers incorporate a thin diffusion lens and are designed to counteract both speed and red light running overhead cameras. One brand incorporates a plastic cover with light-reflecting crystals. This purportedly serves to overexpose speed and red light running cameras by reflecting a flash back to the enforcement device. Sprays work in a similar fashion in that they purportedly facilitate a reflection of the flash from the enforcement camera back to the device (see Figure 5).

Radar/Laser Detectors detect enforcement devices by detecting the electromagnetic energy emitted from the enforcement device (radar/laser speed gun) that hits the in-vehicle device. The in-vehicle detector alerts the driver of the presence of radar/laser enforcement, purportedly in sufficient time to allow the driver to reduce speed if needed (see Figure 6). Waxes and coatings are sold for use in conjunction with radar/laser detectors and purportedly serve to reduce a vehicle's reflectivity of radar/laser electromagnetic energy.

Figure 5: License Plate Covers and Spray

Photo on bottom left from spray ad; other photos from ads for covers.
[Source top left photo: Reyer and Associates 2005]
[Source all other photos: Phantomplate, Inc. 2005]

Figure 6: Radar Detector

[Source: Escort 2005]

The widespread use of photo speed enforcement in some areas has led to the introduction of GPS technology to warn that a driver is approaching a known location of a photo enforcement camera. These devices integrate a vehicle-mounted GPS unit with a database of known camera locations (Figure 7). One web source in Great Britain states:

> These [devices] constantly know where you are, using the GPS satelites, and have a database of all known camera, speed trap, accident blackspot locations and warn you as you approach them. They don't pick up radar, so they don't give you false alarms. As more Gatso's etc [brand of photo speed camera] are added every day (4,300 of them in March 2004 [in Great Britain]), the manufacturers need to keep updating their database to keep your list up to date. Most of these GPS devices also record the common places for mobile speed traps. As they don't pick up radar they won't defend you against a policeman using a radar gun in a new location, but they will against the 4,300 cameras that are currently installed. All of the devices need to be connected to the manufacturers every few weeks to update their data with new sites. They all do this by using a modem to connect to the Internet/direct and downloading the new data. Some of the units come with a modem and others assume you have one. (Gander 2004)

Figure 7: GPS Speed Camera Location System

[Source: RoadPilot Limited UK 2005]

Countermeasures identified by current users of photo speed enforcement systems include those previously mentioned, such as plate covers, sprays, and laser detectors. Other countermeasures include intentional obstructions such as duct tape and/or electric tape and unintentional obstructions such as trailer hitches and bike racks. For the most part, current users of photo speed enforcement systems report that the majority of countermeasures are ineffective. Additionally, many countermeasures are illegal in Arizona and in many other jurisdictions, so some current users of speed enforcement systems did not have any experience to report. North Carolina prohibits tag covers while Colorado state legislation has made it illegal to obstruct license plates. The District of Columbia passed a law to have a $500 fine associated with placing any obstructions on license plates, while Spain banned all use of countermeasures.

5. CONCEPTUAL DESIGN OF FIELD TRIAL

Although several photo speed enforcements systems are deployed worldwide, none meeting all the desired characteristics for the Phoenix metro freeway system could be found that have been deployed long enough to serve as a model for the development of a field trial. Therefore, the project team proceeded to develop a conceptual "Model RFP."

> *Note: The purpose of the conceptual Model Request for Proposal (RFP) detailed in this chapter is to raise several likely topics that should be considered when an actual RFP is prepared. An actual RFP would only be prepared if a demonstration program was funded at some time in the future. The sole purpose of the language and format of this Model RFP is to describe these likely topics and is not written in the style that would be needed for an actual RFP. It can serve as a guide for anyone who might prepare an actual RFP, should it be desired to do so in the future. It includes the Conceptual Field Plan detailed in Chapter 6. Chapters 5 and 6 together are written as a complete document, therefore they duplicate some information reported elsewhere in this report.*

5.1. MODEL REQUEST FOR PROPOSAL

Model Request for Proposal
Arizona Department of Transportation
High-Speed, Multi-Lane Photo Speed Enforcement System Evaluation at a Demonstration Site

5.1.1. Background

Extreme speeding on urban-area freeways contributes to increased crashes that result in property damage, injury, and fatalities. For transportation agencies, this means more crash cleanup, more infrastructure damage, more repairs, more liability risk, and more tragedy and loss for all involved. This is an area of real concern for the public safety agencies responsible for enforcing speed limits and for transportation agencies responsible for safe public travel and for reducing the effects of high-speed crashes on urban freeways.

It is technically very difficult on a multi-lane freeway to obtain accurate speed data to document the problem. Intelligent Transportation Systems (ITS) now exist to accurately collect such data on municipal streets, along with camera-based technology to effectively enforce safe municipal speed limits. These enforcement technologies are generically often called "speed cameras" and have been effective on municipal streets and at intersections; they are becoming accepted and used across the country.

The challenges of effective photo speed enforcement are much greater on high-speed, multi-lane, limited-access urban freeways, especially in heavy traffic volumes. However, a few system vendors have or are developing systems to meet these challenges and they are being deployed in limited numbers in the United States and Internationally. Evaluation of practical ITS enforcement tools and methods to address this need is a practical, logical, and urgent step to identify ways to address a growing safety and economic problem.

5.1.2. Purpose of Request for Proposal

The Arizona Department of Public Safety (hereinafter called "DPS") and the Arizona Department of Transportation (hereinafter called "ADOT") want to evaluate the current technology for measuring speeds and enforcing limits on Arizona freeways. This RFP is designed to solicit proposals from system vendors who can provide technically viable systems to do this. The demonstration system(s) will be used to collect the data needed to evaluate the technical feasibility of the systems both to collect speed data and to provide a system to use this data to enforce speed limits on Arizona freeways. This data will be used to inform decisions by Arizona's leadership in evaluating the merits of deploying such systems on Arizona's freeways.

5.1.3. Demonstration Site

It is anticipated that one demonstration site will be used and a single system vendor will be selected to provide their proposed photo enforcement system at the site. However, DPS and ADOT reserve the right to select a single vendor for more than one site and/or to select multiple vendors to provide their systems at different sites or the same site. The demonstration site(s) will be a typical freeway location in the Phoenix metropolitan area. The selected system vendor(s) will install and operate their system at the site for the period of time specified. The system will then be removed from the site by the system vendor and the site returned to pre-installation conditions. All DPS and ADOT policies and regulations will be observed at all times and all Arizona laws will be observed. A description of the demonstration site(s) is provided in Section 5.1.10.

5.1.4. Purpose of This RFP Specification

This is not a detailed construction specification and it is not a detailed performance specification. It is written from the perspective of the ideal needs a system must have to be most useful to DPS and ADOT. It is the responsibility of every system vendor who submits a proposal to provide explicit details of how these ideal DPS and ADOT needs will be met. Of equal importance, every system vendor will provide explicit details of any and all deviations from these ideal needs that their system will have. System vendors must be candid in their descriptions. DPS and ADOT acknowledge that probably no photo enforcement system will be able to provide all of their ideal needs given the current state of technology. Furthermore, since currently there is not a substantial deployment of photo enforcement systems in freeway applications, DPS and ADOT will not be able to develop explicit criteria for evaluating the system vendor proposals before the proposals are received and reviewed.

The following sections describe the Technical and Management Needs that must be addressed in a system vendor's proposal. Each section asks for detailed information. The intent of seeking this information is to allow ADOT and DPS to evaluate a system vendor's submitted proposal in two ways. The first evaluation will assess the ability and extent of the proposed system to meet each need described in the RFP. The second evaluation will be to assess how a proposed system compares to all other submitted proposals. These two evaluations will include both the technology and service components proposed by the vendor. The remaining component that will be considered is the cost of the demonstration site system. A system vendor will be chosen based solely on a comparative review of proposals received by DPS and ADOT. DPS and ADOT will base their selection by using their own experience and the information supplied by each vendor to estimate which system might perform best for the demonstration site(s).

5.1.5. List of Technical Needs To Be Met

The system vendor will provide a system that meets these technical needs. The proposal will provide explicit and detailed information on how each need will be met. If a need cannot be met or can only partially be met, the proposal will provide explicit and detailed information on how it deviates from the stated need. The ideal list of DPS and ADOT technical needs are as follows:

1. The system identifies, through clear photographic evidence, both the driver and the rear license plate.
2. The system is a relocatable system. Users, whether they are vendor staff or ADOT/DPS employees, should be able to pull the system (or significant components of the system) in and out easily and relocate it as needed (hereinafter called “plug-and-play” ability). The purpose of this feature is to encourage safe vehicle speeds over the entire freeway system versus a single location on the system.
3. The system complies with NCHRP 350 roadside crash-safety requirements. The equipment itself does not have to have been crash tested if the support system used has been crash tested for similarly placed loads and is on the ADOT Approved Products List.
4. In addition to Item 2, the system would be mobile so that it would be able to be used by the DPS in “real time” as part of a DPS speed enforcement “sweep” operation. The mobile system need not be in a van.
5. The system collects required data in real time and can download all required data in real time to a remote user, such as a data processing center.
6. The system uses low-light flash or a flash outside the visible spectrum, such as infrared. This driver-distraction issue is a priority over any color photographic features that the system may offer. Of particular concern would be the competing needs to have a flash intense enough to reach across several lanes (side-fired) but still not “blind” the driver in the closest lane.
7. The system will collect color photos, although black and white technology is acceptable. The ideal system will have both color and a low flash system.
8. The system will give equal representation of all roadway speed activity. There will be no bias toward vehicle classification, traffic volume, lane position, speed range, or other factors.
9. The system is not invasive to the existing pavement.
10. The system will cover five traffic lanes in a single direction.

5.1.6. List of Management Needs To Be Met

The system vendor will provide a system that can meet the potential future management needs for a day-to-day operational system. While this RFP is for a demonstration site only, the selected system must be able to function in a fully deployed day-to-day environment. The proposal will therefore provide explicit and detailed information on how each management need will be met. If a need cannot be met or can only partially be met, the proposal will provide explicit and detailed information on how it deviates from the stated need. The ideal list of DPS and ADOT management needs are as follows:

- Option 1: Estimated cost of services of vendor for an actual deployed system in ongoing, day-to-day operation. Services are to include all management, construction, operations, and maintenance needed. An example of pricing might be a combination of monthly lump sum cost, a per site lump site cost, and a per citation cost. The proposal may use whatever scheme the system vendor believes is most fair and competitive. The one restriction is that cost of these services will not be tied to the revenue generated by the system.
    - Option 1A: The vendor provides all ongoing services and equipment on a "turn-key" basis.
    - Option 1B: The vendor provides all ongoing services on a "turn-key" basis and the equipment is sold to the State. Although the State will own the equipment, the vendor will provide all services needed for construction, operations, and maintenance.
- Option 2: Estimated cost of services of vendor for an actual deployed system in ongoing, day-to-day operation. State will entirely own and operate the complete system.
    - Option 2A: Vendor provides all ongoing construction and maintenance services. State provides all operations and management services. State owns all equipment. Vendor provides all training and other support services needed by the State to operate and manage the system.

  An example of pricing might be a combination of equipment costs, software costs, training cost per employee, and monthly maintenance cost per site. The proposal may use whatever scheme the system vendor believes is most fair and competitive. The one restriction is that cost of these services will not be tied to the revenue generated by the system. Where pricing is based on units, the number of units needed will be provided. For example, if the cost of training is proposed on a per employee basis, the number of employees needing such training will be specified.

  Information about the sites and traffic conditions are provided in Section 5.1.10. This information is correct to the best of ADOT/DPS's knowledge at the time it is provided, but the vendor is responsible for verifying any information crucial to the proposal. Differences between the information provided by ADOT/DPS and actual conditions during the vendor's contract will not be a basis for a change in the vendor's contract scope, terms of payment, or schedule.

- Method(s) of processing photo speed enforcement data to provide speed violation citations. Note that the costs of these activities are included in Options 1 and 2 above.
- Method(s) of providing chain-of-evidence for speed infraction citations that meets court evidence requirements. Note that the costs of these activities are included in Options 1 and 2 above.
- Method(s) of providing testimony supporting contested speed infraction citations in court(s). Note that the costs of these activities are included in Options 1 and 2 above.

5.1.7. Pricing of System at the Demonstration Site

The total cost to ADOT and DPS of providing a system at the demonstration site will be detailed in the system vendor's proposal. Besides a dollar value, each pricing component will include a detailed description of specifically what is provided in that component and, as appropriate, what is not included in that component. The vendor may organize the pricing components to best suit the vendor's own needs. The vendor's pricing will include everything needed to install, operate, and uninstall the demonstration site. The vendor's proposal will not be contingent in any way on ADOT and/or DPS providing anything to the vendor that is not already specified in the RFP.

5.1.7.1. Period of Continuous Standard Operation at the Demonstration Site

The vendor will operate the system at the demonstration site for a continuous period of 12 calendar months in a mode of standard operation. "Standard operation" is defined as operating the system in a manner equivalent to how the system would be expected to operate as part of a fully deployed system, should one be deployed by ADOT and DPS in the future. Time periods the vendor needs to construct, calibrate, maintain, or perform any tasks that make the system unavailable for standard operation will not be counted as a part of this continuous 12 calendar month period. It is anticipated that the 12-month period will be continuous with no interruptions to perform any tasks that stops the system from functioning in standard operation mode. If such interruptions should occur, then the 12 months time will be the sum of continuous intervals of standard operation. However, no interval will be included in the sum that has a duration of less than 2 months of uninterrupted standard operation.

5.1.7.2. Demonstration Period and Schedule of Activities

The period of time from when the vendor receives notice-to-proceed (hereinafter called "NTP") until the vendor's final withdrawal activities from the site are inspected and approved is called the "demonstration period." The maximum demonstration period allowed will be 18 months. The proposal will provide a schedule of all vendor activities throughout the demonstration period beginning from NTP. The schedule will be in the form of a Gantt chart.

5.1.7.3. Equipment To Be Provided and Its Ownership

All equipment needed to construct, calibrate, operate, maintain, and manage the vendor's system at the demonstration site will be included in the proposal. All costs to remove the equipment from the site will be included in the proposal. The vendor will own the equipment at all times. Since the demonstration site is on the State Highway System, all

ADOT construction and maintenance guidelines, policies, and specifications will apply to the system vendor's equipment.

5.1.7.4. *Construction To Be Provided*
All construction needed to install, calibrate, operate, maintain, and manage the vendor's system at the demonstration site will be included in the proposal. All costs to remove the constructed appurtenances from the site will be included in the proposal. Since the demonstration site is on the State Highway System, all ADOT construction guidelines, policies, and specifications will apply to the system vendor's construction.

5.1.7.5. *Calibration To Be Provided*
All services and equipment needed to set-up and calibrate the vendor's system at the demonstration site will be included in the proposal. Calibration will be done throughout the demonstration period as least as frequently as would be done for a system if it were in standard operation in a fully deployed system. Additional calibration will be done as needed for the field test plan that will be done during the demonstration period. Since the demonstration site is on the State Highway System, all ADOT maintenance guidelines, policies, and specifications will apply to the system vendor's activities.

5.1.7.6. *Operation To Be Provided*
All services and equipment needed to operate the vendor's system in standard operation mode at the demonstration site and/or at the vendors remote data processing location will be included in the proposal. Since the demonstration site is on the State Highway System, all ADOT operations guidelines, policies, and specifications will apply to the system vendor's activities.

5.1.7.7. *Maintenance To Be Provided*
All services and equipment needed to maintain the vendor's system at the demonstration site will be included in the proposal. Since the demonstration site is on the State Highway System, all ADOT maintenance guidelines, policies, and specifications will apply to the system vendor's activities at the demonstration site.

5.1.7.8. *Management To Be Provided*
All services and equipment needed to manage the vendor's system at the demonstration site and/or at the vendors remote data processing location will be included in the proposal. Since the demonstration site is on the State Highway System, all ADOT operations guidelines, policies, and specifications will apply to the system vendor's activities at the demonstration site.

5.1.8. Field Test Plan
Throughout the demonstration period a comprehensive field test plan will be conducted by others, hereinafter called the "field test team." The vendor will provide all services and equipment needed to collect the field test data and transmit it to the field test team. The vendor will manipulate, aggregate, and format the field test data as directed by the field test team before delivery of the data. The field test team will report directly to ADOT/DPS and may be composed of consultants or ADOT/DPS personnel or a combination of the two (the field test plan is detailed in Chapter 6).

5.1.9. ADOT and DPS Provided Items

ADOT and DPS will provide the vendor the following items:

1. Signage of the freeway segment to warn motorist that photo enforcement is in place will be provided by ADOT. The vendor is responsible for coordinating testing with the ADOT traffic control freeway personnel who will add and remove the signage. Most likely, signage will be installed before testing begins and covered and uncovered, as needed, to provide the conditions specific to each field test of the system. Signage may include Variable Message Signs or temporarily installed "permanent" signage.
2. *Additional items will be determined at the time an actual RFP is written.*

5.1.10. Demonstration Site(s) Description

> *Note about Model RFP: For this Model RFP actual sites are not described here. If a demonstration program were funded at some time in the future, then the actual RFP prepared would include detailed site descriptions deemed appropriate at that time.*

The site(s) provided the vendor is described below. It is on the Arizona Highway System within the Phoenix metro area and is a high-speed, limited access, multi-lane freeway.

5.1.10.1. Typical Site of Type A

A *Type A* site would be an eight-lane facility, with four lanes in each direction. Each direction has both left and right paved shoulders. The median is open. Specific site details include:

1. Location, including milepost, map, and site photographs
2. Dimensions
3. Potential existing appurtenances on which systems components could be mounted
4. Approximate traffic volumes

5.1.10.2. Typical Site of Type B

A *Type B* site would be a ten-lane facility, with five lanes in each direction. Each direction has both left and right paved shoulders. The median is closed. Specific site details include:

1. Location, including milepost, map, and site photographs
2. Dimensions
3. Potential existing appurtenances on which systems components could be mounted
4. Approximate traffic volumes

5.1.10.3. *Typical Site of Type C*

A *Type C* site would be either a *Type A* or *Type B* site but is used to demonstrate the "plug and play" features of the system.

5.1.10.4. *Typical Site of Type D*

A *Type D* site would be either a *Type A* or *Type B* site but is used to demonstrate the use of the system in "real time" as part of a DPS "sweep" speed enforcement operation.

6. CONCEPTUAL FIELD TEST PLAN

This conceptual field test plan is part of the "Conceptual Design of Field Trial" as has been detailed in Chapter 5. It is specifically referenced in Section 5.1.8 of the Model Request for Proposal. It is designed to gather the data needed to evaluate the performance and suitability of the vendor's system to meet ADOT's and DPS's needs. Data will be gathered from the demonstration site, the vendor's remote data processing site, and other sources.

> *Note: The purpose of the "Model Field Test Plan" detailed below is to raise several likely topics that should be considered when an actual RFP is prepared. An actual RFP would only be prepared if a demonstration program was funded at some time in the future. The sole purpose of the language and format of this Model Field Test Plan is to describe these likely topics and is not written in the style that would be needed for an actual RFP. It can serve as a guide for anyone who might prepare an actual RFP, should it be desired to do so in the future. Chapters 5 and 6 together are written as a complete document, therefore they duplicate some information reported elsewhere in this report.*

6.1. MODEL FIELD TEST PLAN

6.1.1. System Goal

The goal of a Photo Speed Enforcement System is to improve safety by reducing crashes and resulting property damage, injuries, and fatalities. Differential speed and excessive speed are recognized as contributing factors to increased crashes. Therefore, the objective of the Photo Speed Enforcement System is to change the behavior of drivers who speed such that their actual speeding is curtailed or reduced.

6.1.2. Field Test Plan Team

The Field Test Plan Team, hereinafter called the "Field Team," will be independent from the system vendor. The system vendor's personnel will work with the Field Team personnel to develop the data and analysis required to complete the Field Test Plan. Although there will be overlap, the vendor's personnel will be primarily responsible for gathering the data from the system and manipulating it into various formats needed by the Field Team. The Field Team's personnel will be primarily responsible for analyzing the data and preparing the Field Test Plan Final Report.

6.1.3. Field Test Plan Goal

The goal of the Field Test Plan is to evaluate the suitability and effectiveness of a Photo Speed Enforcement System when operating on high-speed, limited access, multi-lane freeways on the Arizona State Highway System in the Phoenix metro area. To meet this goal, a number of tasks and analyses will be accomplished.

6.1.3.1. Task 1: Determine "Ground Truth" Flow Rates and Speeds

Devices will be installed immediately upstream or downstream of the location of the system that provide individual vehicle counts and speeds by lane. These devices are independent of the vendor's system. These counts and speeds are to be used to establish "ground truth" (baseline) and are needed to aid in establishing the Rates of Capture of the system.

6.1.3.2. Task 2: Determine Rates of Capture

The ideal system would have 100 percent capture rates. Since limitations are present in any system, the effect of these limitations will be quantified during the Field Test Plan. A successfully captured target is one for which a citation is issued to the actual driver of a speeding vehicle. In addition, to be 100 percent successful, all speeding targets would be successfully captured and no false (non-speeding) targets would be captured. Therefore, in order to have the ideal 100 percent overall capture rate, the following eight steps must occur, each with 100 percent accuracy:

Step 1. 100 percent of the vehicles that are speeding must be identified. No non-speeding vehicles can be falsely identified.

Step 2. 100 percent of the license plates of speeding vehicles must be photographed. No non-speeding vehicle license plates can be falsely photographed.

Step 3. 100 percent of the drivers of speeding vehicles must be photographed. No non-speeding vehicle drivers can be falsely photographed.

Step 4. 100 percent of the photographed license plates must be interpreted to yield a license plate number. No photographed license plate can be interpreted to yield a false license plate number.

Step 5. 100 percent of the driver photographs must be interpreted to yield a robust identification photograph.

Step 6. 100 percent of the interpreted license plate numbers must be matched with the registered owners of the vehicles. No interpreted license plate number can be matched with the false registered owners of a vehicle.

Step 7. 100 percent of the driver photographs must be interpreted to yield the gender of the driver. No driver photograph can be interpreted to yield the false gender of the driver.

Step 8. 100 percent of the addresses of the registered owners of speeding vehicles must be matched with a licensed driver living at those addresses of the same gender as identified in the driver photograph. No address of the registered owners of a speeding vehicle can be matched with the wrong licensed driver living at that address of the same gender as identified in the driver photograph.

The preceding eight steps help define the system needed to have an ideal 100 percent overall capture rate. In order to have this overall system capture rate, each step must have an individual 100 percent capture rate without any false captures. These steps help define a quantifiable method for establishing actual vendor system capture rates.

The following eight actual capture rates listed below, as well as other types of rates, will be calculated by the vendor from the data collected in the Field Test:

Capture Rate 1. Vehicles captured speeding relative to total flow rates. Additionally, the lane the vehicle is traveling in will be will be associated with the vehicle's data. This will allow all rates to be determined by individual lane as well as aggregated for all lanes combined.

Capture Rate 2. License plates of speeding vehicles photographed relative to vehicles identified as speeding.

Capture Rate 3. Drivers of speeding vehicles photographed relative to vehicles identified as speeding.

Capture Rate 4. License plate numbers interpreted relative to speeding vehicle license plates photographed.

Capture Rate 5. Robust speeding driver photographs obtained relative to speeding drivers photographed.

Capture Rate 6. Licensed plate numbers matched with the registered owners relative to license plate numbers interpreted.

Capture Rate 7. Gender identified relative to robust speeding driver photographs obtained.

Capture Rate 8. Addresses of registered owner matched with a licensed driver living at those addresses of the same gender as identified relative to vehicle drivers whose gender is identified. Additionally the number of repeat matches will be captured. This will allow rates to be adjusted if it is determined that that repeat matches would be reduced in a system that was actually issuing citations.

The vendor will determine each actual rate listed above in several forms depending on the different aggregations desired. The Field Team will determine the desired aggregations. Rates will be added or deleted by the Field Team at the beginning of the data collection periods. Additionally, rates will also be added or deleted by the Field Team throughout the data collection process based on the ongoing analysis by the Field Team. Some possible examples are every 15 minutes during a day, every hour during a day, average weekday during a month, average weekend day during a month, A.M. peak hour, average late night hours, histograms of time vs. flow, etc. Data will be collected in disaggregate form so it can be manipulated and/or aggregated in various ways by the vendor for analysis by the Field Team. In addition, the vendor will provide the raw disaggregated data to the Field Team. Due to the volume of data, it will not be taken continuously throughout the entire period the demonstration site is operating. Instead, the vendor will collect detailed data using a selective, random sampling plan. This plan will be developed by the Field Team.

6.1.3.3. Task 3: Determine Durability of Any Devices Imbedded in Pavement

If a vendor uses any devices that are imbedded in the pavement, they will be tested for durability. Devices installed, as part of Task 1, that may be imbedded but are used for independent testing purposes and are not part of the vendor's system are excluded from this testing. Data will be collected for the longest period possible, but at least from when the devices are first imbedded until the field trial ends. Data collected will include three types at a minimum: (a) environmental conditions effecting the pavements, (b) volumes of vehicles, by classification, passing over each device, and (c) periodic checking of the accuracy of the devices during the lifetime of the field trial. Additional data may be added or deleted by the Field Team throughout the data collection process based on the ongoing analysis by the Field Team.

6.1.3.4. *Task 4: Determine Rates of Crashes*

Crash data will be collected before, during, and after the period of time the demonstration site is operating. The data will be collected for the periods of time identified by the Field Team. The freeway segments of interest proximate to the test site will be identified. Control data covering other freeway segments will also be identified. The Field Team will identify these segments and arrange to expedite receipt of the data from the agencies involved in collecting the traffic accident reports. The Field Team will make an assessment of the safety impacts if the data collected is sufficient to statistically support such an assessment.

6.1.3.5. *Task 5: Determine Deterrent Effect of System*

Task 5A (Option 1): If “warning tickets” and/or actual speeding citations are approved to be issued during the demonstration site testing, then the Field Team will determine the deterrent effects of the system. The Field Team will set up a “Before and After” plan to gather data for this determination. For example, data could be gathered during five intervals: (1) before the actual demonstration site is advertised but the system is operational and collecting data, (2) after the demonstration site is advertised for a period of time to the public as being operational, (3) after “warning tickets” have been issued for a period of time, (4) after actual citations have been issued for a period of time, and (5) after all advertising and citation activity has ceased for a period of time. Coordination of the vendor’s citation activities with the courts and prosecutors are detailed in Section 6.1.4. The Field Test Team will evaluate the vendor’s effectiveness at providing these activities as part of the Field Test Plan.

Task 5B (Option 2): If warning tickets and citations cannot be issued, a “Before and After” plan will still be developed and implemented by the Field Team except it will be based on only using a Public Outreach Campaign. This will include at least three intervals: (1) before the actual demonstration site is advertised but the system is operational and collecting data, (2) after the demonstration site is advertised for a period of time as being operational, and (3) after all advertising activity has ceased for a period of time.

6.1.3.6. *Task 6: Public Outreach Campaign*

The Field Team will design, plan, and implement a Public Outreach Campaign. The primary target population of the plan will be those drivers who travel the freeway at the demonstration site. The secondary target population of the plan will be those drivers who use the freeways in any part of the Phoenix metro area. The tertiary target group of the plan will be members of the Arizona State Legislature, who will be provided with detailed information packet mailings and given presentations as the opportunities to do so are identified. Public awareness surveys will be conducted to support the “Before and After” studies.

6.1.3.7. Task 7: Estimate Impact of a Future Operational System

One of the objectives of the Field Test Plan is to estimate the impacts a freeway photo speed enforcement system would have if a fully operational system were to be deployed at some time in the future. The Field Team will use the data collected to estimate these impacts on ADOT, DPS, the court systems, and the traveling public. The Field Team will also gather any additional data needed to make these estimates. These impacts include both costs and benefits. One example of potential costs is the cost the increased volumes of citations would have on the courts. One example of potential benefits is the estimate of the reduction in injuries/fatalities and property damage to the traveling public. Another example of potential benefits is the estimate of the impacts to DPS deployment, including such items as increased time available to enforce other non-speeding violations that contribute to safety issues, e.g., aggressive drivers, DUI, and suspended licenses.

In addition to estimating these costs and benefits, the Field Team will analyze and present a Deployment Program to make a fully operational and deployed system revenue-neutral. The primary goal of the system is to reduce crashes by reducing speeding vehicles. The Deployment Program will detail methods that balance the system revenue against the system costs, without creating either a surplus of revenue to the state or an extra cost to the state.

6.1.4. Coordination with the Courts and Prosecutors

Generally, DPS will coordinate initial meetings between the vendor and court and prosecutor personnel that will be involved in the Field Test Plan. Subsequently, the vendor will develop working procedures and coordinate those procedures directly with the court and prosecutor personnel. Specific responsibilities are detailed as follows:

The DPS will be responsible for the following items and activities:

1. *These items will be determined at the time an actual RFP is written.*

The Vendor will be responsible for the following items and activities:

1. *These items will be determined at the time an actual RFP is written.*

7. CONCLUSIONS

The goal of this research was to address the following key Research Question:

> *<u>Research Question</u>: Can any current offerings of vendors of photo speed enforcement systems provide a viable technical solution that will accurately measure the Phoenix metro regional freeway speeding problems, given the needs and constraints of ADOT and DPS? Additionally, can a conceptual trial deployment and accompanying field test plan be developed to demonstrate the technical aspects of potential systems, should it be desired to conduct one in the future?*

The gaps between the current offerings of vendors and the needs of ADOT and DPS are discussed in detail in the following section. The project goal of developing a conceptual trial deployment and accompanying field test plan was met and is presented in Chapter 5 (see page 45) and Chapter 6 (see page 53).

7.1. GAPS BETWEEN IDEAL AND ACTUAL SYSTEMS

This research study has focused on evaluating the technical feasibility of using photo speed enforcement technology on roadways with conditions similar to the freeways of the Phoenix metropolitan area. Six system vendors have been identified through this research that are (1) currently providing similar services to national and international organizations and (2) were responsive to our inquiries. All six vendors have been interviewed regarding their ability to provide a system with the desired attributes as outlined by the TAC and research team for this project.

The ideal photo speed enforcement system will have the characteristics as listed and discussed in Section 3.3 (see page 22). Using these characteristics as a framework, the relevant gaps that this research has identified between the ideal and actual current systems are discussed below:

1. <u>Mobile System:</u> No individual camera/detector unit can truly provide dual service, i.e., no unit can be pulled from a "permanent" location and immediately be used in a "mobile" situation. However, if a multi-unit system is defined as one with different units having different capabilities, versus a system where every unit has identical capabilities, then mobility can probably be effectively achieved.

   A van or other vehicle can be dedicated and equipped as a mobile unit. This is feasible if the system has several other units that are at fixed locations and are not mobile. If a photograph of both the driver's face and the rear license plate is legally required, then the mobile unit will require two cameras. If these two photos must be taken simultaneously, a "slave" unit will have to be deployed at an appropriate distance from the primary mobile vehicle. If it is acceptable to use two photos taken with a slight delay in between, then both cameras can be located in the photo enforcement vehicle itself.

2. <u>Easily Relocatable:</u> All of the systems can probably be organized such that some of the equipment at one location can be removed and relocated to another site that has all of the other equipment/infrastructure needed. The relocatable

equipment would probably be the camera, detector, and possibly some of the communication equipment. The primary purpose of relocation is to reduce the driver slow-down/speed-up behavior that can occur when a fixed location becomes known to drivers. By providing multiple potential sites for the relocatable equipment, each with the required infrastructure, the driver slow-down/speed-up behavior may be reduced. Determining this, as well as the operational needs associated with an equipment move, will require a field trial to fully explore all relevant aspects of this issue. Only one vendor reported that currently its system is not relocatable (see Table 1, page 24).

3. Acceptable Light Flash: The system needs to have an acceptable light flash intensity so that drivers are not blinded as they drive by the operating system. No vendor reported that it has problems with its flash system in this regard. However, using a side-fire system across five lanes of freeway will take considerable flash intensity regardless of whose system is used. How much intensity is needed and its impacts on drivers will probably require a field trial. This problem can be mitigated if gantry-mounted equipment is used, however this design will require more camera/sensors than side-fire equipment does.

4. Color Photography Desirable: Color is a desirable option, but it is secondary if the additional flash intensity needed for color versus black and white blinds the driver. Color is desirable because it increases driver photo clarity. Also, color helps support the assertion that the same vehicle was photographed by the two different cameras, one taking a photo from the front and the other from the rear. As discussed previously, how much flash intensity is needed and its impacts on drivers will probably require a field trial.

5. Identify Both Driver and Rear License Plate: The system needs be able to identify both the driver and the rear license plate. As discussed earlier, this will require two cameras. All vendors can do this, except one who reports that it does not currently provide this in its systems (see Table 1, page 24).

6. Vendor Compensation Not Tied to Revenue: Most vendors indicate that they can provide their systems, and "back shop" processing services, under a number of different cost mechanisms. These range from 100% agency owned and managed to 100% vendor owned and managed, with various combinations in between.

Several municipalities in the United States, including some in the Phoenix metro area, have opted to have the vendor both own and operate the system. Under this arrangement, the municipality has no purchase cost and no staffing/operations obligation apart from some minor contract management costs. From the revenue generated, the vendor is required to pay certain required costs to other parties such as the state, the courts, process servers, etc. The vendor keeps all remaining revenue and assumes all of the business risk for the period of time that the contract runs. The motivation of the vendor is to make a profit and the motivation of the agency is to change driver behavior such that zero violations occur. Agencies typically believe they have enough control over vendors in their contracts to insure that the vendor's "for-profit" motive is successfully managed in the public's best interest.

Most vendors reported that they could sell any equipment and processing software that an agency might want to own, and train any agency staff to do any functions that the agency desired to provide themselves. Additionally, most were amenable to charging lump sum or fixed unit costs for providing various back shop processing services that would be independent of revenue.

7. System Costs Are Definable: Vendors can estimate the costs of the equipment and services that they will provide. But in order to do this, the agency must define the specific infrastructure needed to operate the photo enforcement system on their freeway system. In the case of the Phoenix metro area freeways, the infrastructure needs are only vaguely understood because of the lack of similar systems with sufficient operating history from which to learn. A field trial is needed to help define these infrastructure needs and both the vendor(s) participating and agency will learn much that is currently only conjecture. It is possible that the actual vendor supplied equipment costs may be minor in comparison to the infrastructure costs to locate the equipment on the freeway. While the scope of this research is limited to only the technical aspects of the system, the field test must also address the agency/vendor violation processing and management aspects of the system.

8. Download Data in Real Time: All vendors can use digital cameras to record the photographs. This allows the systems to download data electronically in real time from the camera/sensor unit(s). Different vendors have different methods to process the data in their “back shop” operations, and an agency may choose to do the back shop functions themselves. These types of variables effect how the data can be transmitted electronically to the back shop operations, but theoretically it is always possible to transmit electronic data in real time. Other variables also make this issue complex, such as who provides the follow-up enforcement and prosecution services beyond mailing out a citation. These can include testifying in court and serving citations that are ignored.

9. No Bias in Identifying Violations: The actual technical performance of a system in a high-speed, high-volume, multi-lane freeway situation similar to the Phoenix metro area is largely unknown. Much can be implied from the extensive history of these systems in less technically demanding environments, but agencies having actual experience under conditions similar to the Phoenix metro area were not found. A field trial will be needed to determine how any photo enforcement system equipment actually performs with the criteria set for this project. In theory, the camera/sensors should technically perform in these conditions. However, in practice, the multi-lane, high-volume, high-speed freeway could present problems that would prove significant. This is unknown until a field trial is conducted. Side-fire mechanisms will have inherent bias in that closer lanes will block lanes farthest from the camera/sensor location. If this is significant or trivial, will have to be determined in a field trial.

10. No Devices in Pavement: Ideally the system will not be invasive to the existing pavement. Radar/laser detectors are remote sensors and do not require in-pavement devices. But a field trial will be required to determine their effectiveness, versus in-pavement sensors, under the conditions encountered in the Phoenix metro area freeways.

11. Maintain Roadside Crash-Safety: The system needs to satisfactorily address NCHRP 350 roadside crash-safety requirements. In theory all vendors should be able to do this. Conceptually, all equipment and exposed infrastructure needed by the system will be mounted on crash-tested poles or surrounded with crash-tested impact devices.

12. Covers Five Lanes: Five traffic lanes of coverage from a single side-fire camera/sensor is problematic and essentially untested, especially under high-volume, high-speed conditions. A field trial is needed to adequately address this issue. The results of a field trial should ascertain how many traffic lanes could be effectively covered by a single side-fire camera/sensor. If less than five lanes, then two units on opposite sides of the roadway might be employed to attain five-lane coverage. If four lanes could be covered, an alternative might be to only select freeway sites that have four traffic lanes or to simply omit the fifth lane from coverage.

As noted, a field trial is needed to determine the ability of a system to meet several of the desired attributes. However, as time passes, more agencies will probably be investigating and conducting field trials of systems under freeway conditions similar to the Phoenix metro area. These results, if available, should be reviewed carefully just prior to conducting any proposed field trial because they will help shape the field trial and may eliminate the need to test some attributes that were already tested by other agencies.

7.2. PACE OF TECHNOLOGY DEVELOPMENT

The pace of technology development in the field of photo speed enforcement is driven by demand and competition. Worldwide, the acceptance of these systems by decision-makers appears to be growing at a brisk pace. Typically a jurisdiction will obtain enabling legislation and install its first system. After a few years of slow growth, the number of speed cameras can increase rapidly. For example, in 1991 legislation in Great Britain enabled the use of speed cameras (ROSPA 2005). By 2004 the number of deployed photo speed enforcement cameras had grown to 6,000. In 2003, approximately 2 million speeding offenses were detected by speed cameras, which represented 93% of all speeding citations in the country (Institute of Advanced Motorists 2005). Rising demand drives competition among vendors. The typical result is increases in system features and lower prices.

One technology that shows promise for freeway systems is point-to-point monitoring. This type of detection averages the speed of a vehicle between two points, thus removing the perceived benefits of slow-down/speed-up driver behavior at a known photo speed camera location. In Scotland the point-to-point detectors are visually quite different than the regular speed cameras. The deterrent effect is to make the detectors quite apparent to the motorist so they know their average speed is being calculated over a long stretch of roadway ahead of them (BBC News 2005).

Speeding on freeways in major metropolitan American cities is a common problem. The introduction and success of photo speed enforcement systems in a growing number of American municipalities may create latent demand among state-level highway and police agencies for these systems. This demand may push vendors to develop systems that meet all the ideal characteristics developed by ADOT and DPS for this study. Current offerings by vendors remain untested in the freeway environment, but increasing demand may spur testing that results in solutions to the current perceived shortcomings.

7.3. RECOMMENDATIONS

Advancements are continually being made in photo enforcement systems and it is logical to predict that the ideal technical attributes identified in this research could be met by one or more vendors in the future. At this time, however, gaps exist between the stated capabilities of the current vendor systems and the ideal system characteristics needed for the Phoenix metro area freeways.

Additionally, this research project has focused exclusively on the technical aspects of a photo enforcement system. Whereas the violation processing and management elements will also need to be studied in detail to fully examine the viability of such a photo enforcement system, these aspects are beyond the scope of this project. Until the enforcement management process issues are addressed, no recommendation can be made from this study regarding the usefulness of proceeding with a field trial of photo enforcement for freeways.

APPENDIX A. VENDOR RESPONSES

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Six vendors that offer photo speed enforcement systems responded to inquiries about their systems and provided demonstrations to the research project TAC.

The vendors also responded to a survey about their systems' abilities to meet the desired system characteristics detailed in Section 3.3 (see page 22). Their simple yes/no responses are summarized in Table 1 (see page 24) and are listed on the following pages in their entirety. Each ideal characteristic is listed and each vendor's response then given.

A.1. MOBILE SYSTEM

Redflex: The Redflex photo enforcement system can be used either remotely tripod-mounted or with a van in an air-conditioned environment, as used by the Cities of Scottsdale and Paradise Valley. The system can be deployed to the roadside or set back from the median lane to provide safe deployment for both the operator and equipment.

Peek Traffic: Yes, base MSSS hardware configuration is tripod mounted.

Traffipax: Traffipax offers several different Photo systems for speed enforcement, all of which are mobile. These systems all employ either parabolic or slot radar depending on which system and model is ultimately selected. The Photo Radar systems described below are integrated with either the 2 megapixel SmartCamera or the 10.7 megapixel SR 520 depending upon the configuration selected. Listed below are the various systems that Traffipax could offer to ADOT.

A. Photo radar system mounted in steel cabinet on wheels (dimensions are approximately 3 feet tall by 1.5 feet wide by 1.5 feet deep, weight is approximately 60 lbs). This model is designed to be transported in a van, SUV, or on a trailer and wheeled out of the transporter to be left at the desired site to operate in an automatic mode. A single person can handle the loading and unloading of the cabinet system.

B. Photo radar system mounted on a trailer which is towed similar to a typical "speed trailer." The profile of such a system is larger than the cabinet and therefore, cannot fit in tight spaces; however, this system does not have to be loaded and unloaded from a vehicle. Additionally this photo radar system can be combined with an actual "speed trailer" to allow for an integrated system whereby drivers see their speed displayed on the LED display (this additional function would not work well in heavy traffic).

C. Pole mounted system that is designed to be "plug and play" in that the inner housing which contains the actual photo radar system can be instantly removed via several mounting brackets from the outer housing on a pole and reinstalled in another outer housing on a different pole, and be instantly operational. Often these systems are rotated between multiple sites where the empty outer housings function as dummy sites.

D. Photo radar system mounted in a van.

ACS: While the van provides the easiest method of mobile deployment, we do have available a "roadside" box that can be moved from location to location.

ATS: No.

LaserCraft: LaserCraft offers two photo speed enforcement products: the DTMS System and LaserCam II. The DTMS is a fully automated photo speed system that can be deployed in pole, trailer, or van mounts. The DTMS requires no operator but can be used in manned speed vans. The LaserCam II is a hand-held device that integrates a digital camera and laser speed gun. The LaserCam II must be operated by a public safety officer and can be used from any standard patrol vehicle or with a tripod mount at roadside or on overpasses. The LaserCam II offers the greatest "plug-and-play ability" as it is completely portable and connects to any standard desktop or laptop computer, including patrol car laptops. The DTMS offers great flexibility in its mounting because it requires no special offset calculation or positioning.

A.2. EASILY RELOCATABLE

Redflex: The Redflex mobile speed enforcement system is easily relocatable and can be set up in deployment situation for a DPS sweep operation either in a van or mounted on a mobile tripod with access to battery power.

Peek Traffic: Yes, if trailer-mounted. If gantry-mounted, the PC and some hardware are moveable.

Traffipax: Of the options described above, the cabinet mounted system, trailer mounted system, and the van-mounted system would not have to be deployed at pre-determined intervals or locations. The pole-mounted system would obviously be limited to deployment at those sites where the infrastructure had been installed. The Traffipax photo radar system can be mounted on most existing poles that are already on the shoulder or median of the highway.

ACS: Same as item Item A.1.

ATS: The cameras may be installed at fixed locations over the roadway, attached to existing gantries or bridge structures. The enclosures will be mounted permanently, and are designed to enable easy access to the equipment for rapid removal and re-installation. In the event that the cameras are to be used for point speed measurement rather than point-to-point, video loops may be used to detect speed violations at the initial point of measurement. Results will be assessed in real time, and the camera may be configured to alert a waiting patrol car or motor officer.

LaserCraft: The DTMS System in a van or trailer mount is completely relocatable. Since the system uses laser rather than radar or in-ground sensors, the system can be driven to any site and set up within minutes. Because the system measures speeds at angles more in line with the flow of traffic, the van mounted or trailer mounted DTMS requires no angle measurement or exact positioning like across-the-road radar. The pole mounted DTMS does require some wiring installation at each new site to connect to power and to connect the camera and computer units. Therefore, relocating this type of DTMS is more time consuming. However, the live DTMS Systems can be used with inoperative or "dummy" units to give the appearance of greater area coverage. The LaserCam II is a portable handheld device, which is designed to be moved from site to site with the operating officers.

A.3. ACCEPTABLE LIGHT FLASH

Redflex: Redflex has delivered systems to international clients with infrared flash with no additional illumination and infrared non-visible flash systems and achieved outstanding results, with vehicles being unaware of the enforcement process taking place. Non-visible flash is likely to be limited in its success in up to two-lane enforcement (for face photography) due to the difficulty in projecting the required power levels. Redflex is the only USA vendor with experience in the delivery of both technologies. Visible flash units are used in three to four lane configurations in the City of Scottsdale (five in other cities) to achieve color face photography with excellent results. There have been no reported incidents of drivers being "blinded" or vehicles exhibiting sudden stops or behavior that is unsafe to other road users over the past three years of fixed photo enforcement in 55 mph speed zones. The acceptance of monochromatic face photos by Arizona courts is unknown. The position and height of the flash and the overall reflector design (proprietary) is critical to achieve the correct operation.

Peek Traffic: Colorized filter can be installed on the flash to reduce glare.

Traffipax: Traffipax offers a completely invisible laser flash that would be used for the camera capturing the license plate on the rear of the vehicle and a "near invisible" red flash that would be used for the capture of the driver's face. Such a configuration is currently used in Europe where it is employed in the Mont Blanc tunnel. The authorities in France were concerned about the distractions caused by a visible flash in a tunnel and through extensive R&D, Traffipax/Robot developed a dark filter for the red flash which the French authorities have accepted as "invisible." This is a significant installation as it is the only successful and proven deployment of an "invisible flash" that has been able to consistently capture a clear recognizable image of the driver's face in very limited light conditions. The use of laser and red flash require black and white images.

ACS: Of particular concern would be the competing needs to have a flash "bright" enough to reach across several lanes (side-fired) but still not "blind" the driver in the closest lane. Any white flash no matter its light output will be highly distracting to drivers. Infrared flash is available. Monochrome imagery uses an infrared flash.

ATS: We plan to use IR illumination for the face shots and either IR or white light for the rear shots. IR is generally invisible to the human eye, but will not enable color photography. The white light for the rear shot will enable color images, but will not blind the driver because the illumination will be similar to a standard overhead street light, or alternatively, a small, ultra-fast LED strobe unit may be used.

LaserCraft: LaserCraft has performed extensive research on illumination for photo enforcement systems and worked with numerous jurisdictions to provide the best possible nighttime operation for their application. LaserCraft has found that any roadside flash is hazard to drivers and an annoyance to residents and businesses near the photo-enforced site. For this reason, LaserCraft has designed the DTMS System to work in low light conditions with only steady state lighting such as is provided with standard streetlights. LaserCraft has also worked extensively with infrared illumination and have found that infrared light is ineffective for photographing drivers' faces duty to thermal shadowing and windshield distortions. We strongly believe that any direct visible illumination of a driver's face is dangerous and even more so when that light is flashed or strobed. In most states, roadside illumination sufficient to photograph drivers' faces violates state guidelines on the veiling luminance and position requirements for roadside lighting. Therefore, we strongly caution against using any flash or strobe with any photo enforcement system and further advise against any direct illumination of drivers' faces.

A.4. COLOR PHOTOGRAPHY DESIRABLE

Redflex: The Redflex system has both capabilities and can be easily configured to operate in both modes. The Redflex system uses a special proprietary lens system that is able to image in both spectral frequencies.

Peek Traffic: Yes, color, digital 5.3 megapixel images.

Traffipax: Traffipax offers both color and black and white capability with all camera systems. Color images do require the use of white flash. Traffipax could filter the white flash so as to reduce the intensity as much as possible but still retain the ability to penetrate a vehicle windshield in the furthest lane; however the white flash, even filtered, will be more visible than the red flash.

ACS: Although black and white technology is acceptable, the ideal system would have both color and a low flash system.

1. 2 megapixel color with 70watt flash
2. Monochrome with Infrared flash

ATS: See response to item A.3 above.

LaserCraft: The DTMS System captures wide-angle color images as well as black and white images of vehicle identifiers (license plates). The LaserCam II uses one high-resolution digital color camera.

A.5. IDENTIFY BOTH DRIVER AND REAR LICENSE PLATE

Redflex: Redflex has demonstrated the ability to capture both rear and front plate and driver face images in 58 U.S. cities.

Peek Traffic: Yes, front and rear high resolution, 5.3 megapixel, digital photos.

Traffipax: Traffipax would employ either a "master-slave" system or a system comprised of two different units to accomplish the requirement of capturing both a frontal image to capture the drivers face and rear image to capture the license plate. There are advantages and disadvantages to both types of configurations.

A. Master-Slave: In order to meet this requirement in other programs, Traffipax has generally employed a master-slave system where a single radar antenna triggers both cameras simultaneously (the Traffipax/Robot program in Switzerland employs this type of configuration). In this case, the master camera takes a picture of the approaching traffic while the slave camera (deployed approximately 75 yards prior to the master camera) takes a picture of the rear of the vehicle to show the license plate. Generally this configuration is only successful across a maximum of 3 lanes as the slave camera would have to be deployed so far away from the master camera to cover 5 lanes that the image of the license plate might not be clear and it is likely that other vehicles could block the slave image of the offender vehicle when trying to take the picture from so far away. *Per recommendations at the conclusion of this document, it would be necessary to have systems deployed on both sides of the road to reliably cover five lanes*. When using a container-mounted system in a master-slave configuration, it is slightly more complicated than having just two systems back to back because it would require deploying two separate units on each side of the highway and measuring out the correct distance between the master and slave to assure they were deployed properly.

B. Two Separate Systems, Back to Back: A system setup can be employed where a separate camera and radar system are housed in the same unit, aimed in different directions so as to capture both the front and rear, albeit from two completely autonomous units. This system is much less cumbersome to set up if a container mounted or trailer mounted system were to be desired but would cause a potential issue as to chain of evidence because of the time difference between the capture point for the approaching shot and the departing shot. There would be different databars in the front and back image for each vehicle since the speed detected when the vehicle was approaching could be different from the speed detected as the vehicle departed. This gives rise to the issue of which speed is the speed to be considered for issuance of the citation. Additionally, if a vehicle switched lanes, it would cause another issue as well as the fact that could be difficult to prove that the front image showing the driver face and back images of the violating vehicle license plate are definitively of the same vehicle.

The majority of Traffipax/Robot existing programs that require both front and back photos are using a master-slave configuration with the systems pole mounted.

ACS: Yes.

ATS: The system will be configured with a set of cameras, one to capture the front and another to capture the rear end of the vehicle.

LaserCraft: The DTMS System and LaserCam II are designed primarily to photograph vehicles and their license plates from behind. For all systems currently on the market, it is extremely difficult to acquire usable images of a driver's face. This inevitably results in a high number of discarded violations, which severely limits the effectiveness of the photo enforcement program. Even when a driver photo is acquired, these pictures are often of poor quality, well below the standard normally required to assign criminal liability. By using such images to assign liability to the driver, the local government inevitably opens the door to time consuming appeals and court challenges.

A.6. VENDOR COMPENSATION NOT TIED TO REVENUE

Redflex: Redflex is able to offer a fixed price for the hardware on a lease basis and a processing fee per violation captured that compensates Redflex for the processing labor component.

Peek Traffic: Fixed fee pricing (monthly lease).

Traffipax: Traffipax would propose a fee for service that includes two components:

1. Flat monthly fee for lease of equipment and maintenance (cost of installation and training would be built into the monthly) or outright purchase.

2. A per citation fee for processing.

Traffipax is willing to consider other options for fee structure that ADOT might wish to utilize.

ACS: ACS desires a flat monthly fee.

ATS: We offer service level agreements, which may include a menu of services, which include: Installation & Field Operations, Hardware and Software Support and Maintenance, Business Process Management/Outsourcing, and a range of consulting services. Payment for all services offered is charged based on agreed pricing structures, which are not based on violations, tickets issued, or revenue collected.

LaserCraft: LaserCraft has worked with numerous local governments in states where statutory requirements preclude the vendor from charging a fee per ticket, and the company is very flexible in its pricing structures.

A.7. SYSTEM COSTS ARE DEFINABLE

Redflex: Redflex has the broadest range of solutions and the most qualified engineering team in Arizona to partner with ADOT to trial systems and optimize the solution to meet the ADOT needs. The cost of the system will depend on the final technical specification, quantity, contract duration, hours of operation, and expected volume.

Peek Traffic: Turnkey direct sale, monthly lease, or per citation.

Traffipax: Approximate Cost of Traffipax Services

A. Equipment fee

	Fee for monthly lease of Equipment	**Fee to Purchase Equipment**	**Installation**	**Maintenance**	**Training**
Photo Radar System mounted in a cabinet	\$2,100-\$2,400	\$88,000-\$100,000	Included	Included only in lease option	Included
Photo Radar System mounted on a pole	\$2,100-\$2,400	\$88,000-\$100,000	Not Included	Included only in lease option	Included
Photo Radar System mounted on a trailer	\$2,250-\$2,700	\$94,000-\$112,000	Included	Included only in lease option	Included

- *System - all system prices above are for complete master-slave systems (includes two cameras and associated components and housings).*
- *This pricing does not include an option for a van-mounted system. If this option were desired, pricing would be similar to that for the container mounted system (excluding the van).*
- *Variance in the monthly lease and purchase price is based on options such as flash type and model digital camera utilized.*
- *Monthly lease price is based on 60 month term.*

Pricing to monitor five lanes in both directions: This would require the use of four master-slave systems to completely cover all five lanes under all traffic conditions. Assuming the systems were pole mounted, the same poles could be used in the median for the installation of systems monitoring both directions of traffic flow, therefore, a total of six poles. The cost of the equipment would be approximately $350,000 - $400,000 for an actual installation. Traffipax would reduce the cost for purposes of the pilot to cap the equipment cost at $300,000. This projection does not include the cost of pole installation.

B. Citation Processing fee: Per Citation fee of $7 - $12 depending upon the scope of services provided. Higher citation fees would be required to support the provision of such services as staffing a local "walk-in" customer service facility, support in appeals processes, and collections of unpaid citations. Lower citation fees could be provided if services simply include processing, mailing, and tracking without any customer support functions for the general public.

ACS: Can sell entire turnkey system with training for the State to operate or assistance to the State. To be discussed.

ATS: (*No response from vendor*).

LaserCraft: While we find that a monthly fee which includes equipment lease, processing services, and maintenance is often the most practical way for a local government to pay for our systems, LaserCraft has also worked with several local governments that have chosen to buy equipment and pay a periodic fee for service and maintenance. Once system requirements are provided, LaserCraft will gladly provide itemized pricing for equipment, software, installation, citation processing services, and maintenance.

A.8. DOWNLOAD DATA IN REAL-TIME

Redflex: The system collects data in real time and is able to display an offence or "next vehicle" for testing purposes on a flat panel monitor within a second of the offence. Operator controls, via the software, are provided to set up the system, location codes, and speed thresholds. Data is stored on non-volatile media.

Peek Traffic: Yes, digital images and data are time stamped at creation. Can be transmitted wirelessly or via high-speed connection.

Traffipax: The system always collects date in real time. If a pole mounted system is utilized, the data could be downloaded to the processing facility in real time as communication lines would be run to the poles to allow a DSL connection. If a cabinet, trailer or van system is utilized, it would be necessary to wait until the end of the deployment to download the data or if the system were to be used in a predetermined geographic region a wireless system could be used if ADOT desired data downloads in real time. This would require wireless hubs to be set up in the vicinity of the planned deployment.

ACS: Yes.

ATS: All data is collected in real time and may be accessed over the Inter/intra net. Users may access the information or, alternatively, it can be "pushed" based on rules.

LaserCraft: The DTMS System captures all images in real-time and saves them to a local hard disk. These files can be uploaded to a central site by DSL, cable, wireless modem, or other broadband connections as often as is practicable for the processing center. The system also provides a live video signal from all of its Laser/Camera assemblies. This signal can be connected to a locality's traffic monitoring system. The LaserCam II captures images and stores them real time to the camera flash memory card. This information is then transferred to the operator's computer either in the vehicle or back at a central office.

A.9. NO BIAS IN IDENTIFYING VIOLATIONS

Redflex: Redflex can deliver three types of systems, each with specific general strengths. All systems will perform to requirement for speed range, lane position, or type of vehicle.

1. Road based sensors are suited to high volume, high lane count roads such as freeways with three or more lanes and ADT's of 80,000 plus that can detect and process 99.9% of all vehicles.
2. Radar based sensors are easily set up and deployed in a mobile situation that can enforce up to five lanes of traffic, provided only one vehicle is in the beam. (lower density traffic). The Redflex system is tested on each deployment for calibration using an electronic tuning fork.
3. Laser based sensors approved by IACP target specific vehicles and require operator selection of vehicles. The density of vehicles is not a limitation provided the vehicle is in the field of view of the operator.

Peek Traffic: Yes, updating tracked vehicles 21 times per second. Vehicle tracking 5 to 186 mph. Radar tracks speed, direction, distance, and time of vehicles.

Traffipax: The Traffipax Photo Radar system does not have any bias due to speed range or vehicle classification. The system does, however, have a bias for lane position depending upon the density of traffic and, in a related manner, also to traffic volume. If two vehicles enter the thin radar beam at the same time, the system will not take a reading in order to prevent errors. This situation only occurs in very heavy traffic. Additionally, it is more likely that the system will encounter radar shadow issues in the furthest lanes from the location of the system. This issue can be remedied by deploying two systems on each side of the road with the sensitivity of the radar tuned so as to only cover two or three lanes. Additionally, the Traffipax system is designed to capture two images of both the front and back of the vehicle in order to have a second verification of the speed (verification is done by using time/distance between the first set of images and second set). This secondary verification of speed can be critical in that it is possible with any “across the road radar” system to have a radar reflection off certain types of material so as to cause the speed of the detected vehicle to be compounded and actually perceived to be far in excess of actual speed. The only method for ensuring this situation does not occur is to have the secondary verification of speed.

ACS: Yes.

ATS: If all moving lanes are enabled, then all speeds will be monitored and reported.

LaserCraft: The DTMS System gives full representation to all vehicle types. The system can detect speeding in both small vehicles like motorcycle, low profile vehicles, and large trucks. Because the system uses no flash, it does not have to wait for a flash recycle before it can acquire a second image. This allows the system to capture violations for multiple violators closely following each other. Because the system uses one laser sensor per lane, the system can capture simultaneous and near simultaneous speeders in multiple lanes. The laser-based system offers a further advantage over radar-based systems in multilane settings with high traffic counts. Because of the tighter beam focus of laser, our systems can offer positive vehicle identification of individual speeding vehicles. Most radar systems cannot distinguish between all of the vehicles that may pass through its beam at one time. At best, some radar-based systems can offer an estimate of the location of a speed reading to guess which vehicle in a particular photograph may have been the speeder. With the DTMS and LaserCam II systems, occasionally, some vehicles photographs are blocked or shadowed by other vehicles. In a pole mounted configuration this can sometimes be addressed by repositioning the camera and the enclosure.

A.10. NO DEVICES IN PAVEMENT

Redflex: Complies with both Laser and Radar based systems. See answer above.

Peek Traffic: Tracking radar detection, no road surface detectors required.

Traffipax: The Traffipax system employs “across the road radar.” There is no need to for any sort of invasive installation on the freeway with the use of radar.

ACS: Yes.

ATS: Correct.

LaserCraft: The DTMS System and LaserCam II use the ProLaser III Lidar device manufactured by LaserCraft and sold by Kustom Signals Inc. No other sensors above or in ground are required.

A.11. MAINTAIN ROADSIDE CRASH SAFETY

Redflex: The Redflex system will comply with NCHRP 350 part four.

Peek Traffic: Any gantry used would meet NCHRP 350. The trailer mounted MSSS meets MUTCD parts 6E-7, 8 & 9.

Traffipax: Traffipax will ensure that the Photo Radar system addresses NCHRP 350 roadside crash-safety requirements for whichever type of system configuration is selected as follows:

A. Pole mounted system is installed on new or existing poles; if new poles are installed, they are installed in conformance with NCHRP requirements (e.g., with break-away poles for the median and shoulder where necessary).

B. Container mounted or trailer mounted system would be protected by approved crash impact barriers (sand or water barrels) where exposed proximity to vehicle traffic required.

ACS: Yes, when radar is installed in the radar van. NCHRP does not apply to radar in the roadside box.

ATS: Cameras will be mounted overhead.

LaserCraft: The DTMS System can be mounted to new or existing roadside light or utility poles. The system can also be mounted in an NCHRP category IV sign trailer which can be further placed behind a crash barrier. The van-mounted system can similarly be placed behind a crash barrier or vehicle with a crash attenuator. The LaserCam II can be operated in a patrol vehicle parked at roadside or on overpasses. This vehicle can be placed behind a crash barrier or at a sufficient safe distance from the roadside.

A.12. COVERS FIVE TRAFFIC LANES

Redflex: All Redflex systems will have the ability to enforce vehicles out to the fifth lane of traffic. NOTE: ADOT should, in Redflex's opinion, be wary of vendors who purport to offer radar based solutions that offer vehicle discrimination when more than one vehicle is in the beam. While theoretically possible, the ability to make an error exists and the technology is unlikely to be accepted by the courts.

Peek Traffic: Yes, system configurable-single or multiple lane coverage.

Traffipax: The system would reliably cover five lanes of traffic in a master-slave configuration under all weather and lighting conditions if two separate systems were employed in a parallel configuration; one on the highway shoulder to monitor the two outer lanes and the other system on the median, monitoring the inner three lanes. If the cost of two separate master-slave systems were to be considered prohibitive to ADOT, Traffipax would recommend a single master-slave system, mounted on poles in the median. This setup could only guarantee reliable coverage of three lanes in heavier traffic flow but theoretically could monitor all five lanes from a perspective of the radar coverage and the capability of our 10.7 megapixel camera.

ACS: While the Radar system is capable of detecting violations over four to five lanes of traffic, it becomes consistently more difficult to illuminate a drivers face, whether a white or infrared flash is used. Light only travels so far.

ATS: One camera per lane of travel.

LaserCraft: The pole mounted DTMS System can cover all lanes of traffic (description of a five lane setup is described above). All LaserCraft systems use one LIDAR device per each lane monitored. This allows the system to provide positive vehicle identification of individual speeding vehicles with absolute certainty. Other systems that use a single sensor, such as a radar device, to cover multiple lanes of traffic cannot provide absolute vehicle identification. A local government using such a system on multiple lanes and in heavy traffic runs the risk of ticketing the wrong vehicle. The van and trailer mounted systems only contain one laser and, therefore, only monitor one lane at a time. If the van-mounted systems are attended by an operator, the system can be repositioned periodically to cover all lanes of traffic. The LaserCam II system is a handheld device that uses a single laser speed gun, and similarly, it monitors one lane at a time. However, the LaserCam II must be aimed by the operator on individual vehicles, and therefore, the operator can potentially track speeds in all lanes as they move from one car to the next.

APPENDIX B. USER INTERVIEWS

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Thirteen agencies that use photo speed enforcement systems were interviewed by telephone and/or email. A set of twenty questions, developed in conjunction with the TAC, was asked and their responses recorded. Their responses were summarized in Table 2 and Table 3 (see page 27) and are listed on the following pages in their entirety.

B.1. WASHINGTON, D.C., METRO POLICE DEPARTMENT

(1). Who is your vendor?

ACS.

(2). Is your system a mobile/portable technology?

We have 5 fixed systems and 10 mobile systems. The mobile systems consist of 2 marked police units and 8 unmarked police units. These mobile systems are deployed throughout the city.

(3). Have you used this system in a freeway environment?

Yes, some systems have been used in the freeway environment, but we have slowed down on this and only use occasionally. The majority of our applications are on residential and arterial roads (most mobile and all fixed). Some mobile enforcement is done on freeways and highways.

(4). What is the speed of the roadway on which the system is deployed?

The speed on the freeways is 45-50 mph and other sites are 25-40 mph.

(5). How long has your system been in place?

The mobile program was started in the summer of 2001 with 5 vehicles. The first fixed system was installed in February 2004, with others sites following in February 2005.

(6). How do you handle multiple lanes?

We use both mobile and fixed systems on multiple lanes. Both systems have a narrow beam that shoots across all lanes and addresses the speed of vehicles crossing that path. The mobile system essentially is a parked police unit with a sworn officer inside (who has had radar training). This car is parked on the side of the road and monitors 3 lanes of traffic in one direction. The fixed systems are pole-mounted and monitor 2 lanes in one direction. Hashed marks have been painted on the roadway in places with fixed systems so that time-distance formulas can be used to back up the data on speeders.

(7). What type of detection technology do you use?

We use Doppler Radar on all systems (fixed and mobile).

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

Deferred question to another person who was not available for comment.

(9). How many staff does it require to run your system?

Deferred question to another person who was not available for comment.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

None. All images are manually downloaded and taken to the processing facility by a technician. We are using wet film technology at this time. There is no instant or live transmission.

(11). Can you capture information on digital format for download?

Deferred question to another person who was not available for comment.

(12). What type of processing services do you use to issue tickets?

ACS does all the back-office processing and customer service. They deal with the processing of photos, vehicle tags, and generate citations. A police officer then reviews all the information and signs off for issuance of citation.

(13). How successful are you at getting matches with license plates?

Deferred question to another person who was not available for comment.

(14). Do you have front and rear license plates?

Yes, but we only take a picture of the rear license plate. The District of Columbia requires a registered owner liability only.

(15). What are your success rates?

Deferred question to another person who was not available for comment.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

The system is very effective. When we started, between 1/3 and 1/4 of vehicles were traveling at a speed over the threshold limit. Currently, there are 1/30 or 1/33 traveling above the threshold speed limit. We have also seen a steady decrease in crashes related to speed. In 2001, there were 38 fatalities due to speeding. In 2004, this number was 17.

(17). What is the public perception of your technology?

Overall, there is a very strong public support. People living in neighborhoods love it, while commuters, the local AAA and the media (most notably, the Washington Times) hate it. Most of the drivers (3 out of 4) who get ticketed are those from outside the District of Columbia area.

(18). What type of countermeasures do you observe?

The District of Columbia passed a law to have a $500 fine associated with placing any obstructions on license plates. We found that most countermeasure devices do not work anyway. We have seen sprays and obstructions (such as smoky covers).

(19). What is the annual cost of the system?

In the beginning, we paid ACS a fee for each ticket paid, however we went away from this in the spring of 2002. We currently pay a flat fee of $475,000 per month for our radar enforcement program.

(20). What is the annual revenue generated?

Since August 2001, 1.3 million tickets have been issued and over 950,000 tickets have been paid. This results in over 72 million dollars in revenue. In March 2005 alone, a revenue of 1.9 million dollars was seen.

B.2. MADRID, SPAIN

(1). Who is your vendor?

Have a local company that we call for repairs. Equipment manufactured by LaserCraft but Peek has rights for distribution.

(2). Is your system a mobile/portable technology?

We have both fixed and mobile systems. Seven selected sites, where high accident rates have been identified, use mobile systems. Mobile systems consist of vans and tripod-mounted systems (we are moving away from tripod-mounted systems). Fixed systems consist of side of road or gantry installations. Both LIDAR and Radar technologies are used. Spain uses systems that are as automatic as possible and thus, require no human intervention.

(3). Have you used this system in a freeway environment?

Yes, the system is currently being used to cover five lanes of traffic. In this application, gantry-mounted systems are required to adequately capture all vehicles.

(4). What is the speed of the roadway on which the system is deployed?

The speed on the freeways is 120 km/h or approximately 80-85 mph. When in close proximity to cities, this speed limit changes to 90 km/h, with five to six lanes of traffic coverage. Regular two-way, two-lane roadways operate at 100 km/h.

(5). How long has your system been in place?

The first system was installed in 1973 with radar technology. Fixed locations began in 2001. We will add 500 new fixed units giving us a total of 706 fixed systems by the end of 2007. Currently we have 200 fixed systems, 285 van mounted systems, and 60-70 tripod-mounted systems.

(6). How do you handle multiple lanes?

With gantry-mounted systems, we can monitor five lanes at a time. Most violations occur in the two or three leftmost lanes. Roadside-mounted systems monitor the first and second leftmost lanes only. The leftmost lanes have the highest speeds.

(7). What type of detection technology do you use?

Currently use LIDAR and Radar detection technology.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

We require at least 64 fiber optics cables, network connections with fiber optic, live video from all sites, at least 5 kW of power to run equipment (flash, cameras, computers, and fans), surge protection, lightning strike protection, overpass gantry (must be accessible) ,and cabinets (must have locks and be vandal-proof).

(9). How many staff does it require to run your system?

Most systems are fully automatic. Tickets are currently processed through a processing company. A new and upcoming program is to have a control center that will implement several license plate recognition systems.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

Although this feature is technically feasible, only an enforcement system can do this due to legal issues.

(11). Can you capture information on digital format for download?

Yes, but we do not hold the information for longer than 30 days.

(12). What type of processing services do you use to issue tickets?

Processing services are provided by a processing company at this time. This processing company is separate from the vendor and is contracted.

(13). How successful are you at getting matches with license plates?

Our license plate matches are very successful, at over 95% on all systems. This rate is over 98% on very good systems (those systems that have different settings for different devices and have application setting changes). Factors that impede license plate recognition are damaged plates, no plates or tow ball hitches.

(14). Do you have front and rear license plates?

Yes, we have both front and rear license plates but only take a picture of the rear plate due to privacy issues.

(15). What are your success rates?

Our capture rate is above 99%.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

Our system is very effective. We have seen a dramatic reduction in crash rates. The number of incidences is less in installed places. There has been a 30% reduction in speeding in 2 years and an 11% reduction in fatal crashes and injuries, while there has been a traffic increase of 5%.

(17). What is the public perception of your technology?

Overall, the public has become more aware of tragedies and deaths related to high speeds. Currently, 65% find the system favorable, 15% are opposed, and 20% do not have an opinion either way.

(18). What type of countermeasures do you observe?

Spain has banned all countermeasures so we do not have any experience with these.

(19). What is the annual cost of the system?

The system costs 55 million euros (approximately $69 million USD) for 3 years (500 systems). This cost includes installation only, not maintenance. Maintenance is awarded after the system is installed and costs approximately 2-5% of the overall system cost. The system average annual cost is 100,000 to 120,000 euros (approximately $126,000 to $151,000 USD) per system per site.

(20). What is the annual revenue generated?

I am not at liberty to disclose this information. I will give an estimate of 150 million euros (approximately $189 million USD). We do not pay vendors for citations, only for installation and maintenance.

B.3. CITY OF BOULDER, COLORADO

(1). Who is your vendor?

ACS

(2). Is your system a mobile/portable technology?

Our system is a mobile system – it is deployed in a van. We currently have 1 van in operation.

(3). Have you used this system in a freeway environment?

No, we only deploy in neighborhood areas on two lane roads with 10,000-15,000 vehicles per day. The Legislature ruled that photo radar systems can only be used in areas that have speed limits with 35 mph or less (schools, construction zones, and city parks).

(4). What is the speed of the roadway on which the system is deployed?

20-30 mph.

(5). How long has your system been in place?

7 years, going on 8. We began in the fall of 1998.

(6). How do you handle multiple lanes?

We do not handle multiple lanes.

(7). What type of detection technology do you use?

We use radar systems mounted in the van. The whole unit is part of the camera system.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

At some locations, the van has a concrete pad built for parking purposes. The equipment inside the van requires recharging by the mobile unit.

(9). How many staff does it require to run your system?

There are two technicians in each van.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

We only utilize wet film technology so there is no current ability to transmit information about violations. We will be upgrading to digital systems shortly.

(11). Can you capture information on digital format for download?

No.

(12). What type of processing services do you use to issue tickets?

We have a contract with ACS, so they process all violations based upon our business rules.

(13). How successful are you at getting matches with license plates?

In 2004, 73% of all violations detected resulted in letters sent out to speeders (successful match with license plates).

(14). Do you have front and rear license plates?

Yes. We take a picture of both the front and rear plates. We have a dual camera system due to the state of Colorado's enabling legislation that requires a picture of the driver and the license plates.

(15). What are your success rates?

80% of the photographed license plates are readable and 80% of notices are paid on notice (the other 20% of unpaid notices are due to address problems).

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

An example statistic is for one location where there were 110 violations per hour at the start of the project and is now currently at 20 violations per hour. We do not have any accident information available.

(17). What is the public perception of your technology?

There remains an even split in the public perception of the technology.

(18). What type of countermeasures do you observe?

Colorado State legislation made it illegal to obstruct license plates. We have observed countermeasures such as plate covers and sprays, but most of these products are ineffective.

(19). What is the annual cost of the system?

The total cost of the system to the City, including vendor costs (leasing of equipment and processing of violations) in 2004 was $436,000.

(20). What is the annual revenue generated?

Since the fall of 1998, the revenue generated has varied from -$138,000 to +$159,000 dollars, with a net negative value of $180,000. The city limits the fine per ticket to $40.

B.4. MINNESOTA DEPARTMENT OF TRANSPORTATION

(1). Who is your vendor?

We used two different vendors. One went out of business and the other has changed ownership so many times I don't know what they are called now.

(2). Is your system a mobile/portable technology?

The systems were portable, very easy to set up and use. We did the testing in the late 1990's, and it was only in work zones.

(3). Have you used this system in a freeway environment?

Almost all the testing we did was on freeways, but again, only in work zones.

(4). What is the speed of the roadway on which the system is deployed?

The speeds varied from location to location, but all had reduced speed limits due to the work zones.

(5). How long has your system been in place?

Not applicable.

(6). How do you handle multiple lanes?

The cameras covered all lanes.

(7). What type of detection technology do you use?

Radar.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

The units were self-contained. They were powered by boat batteries.

(9). How many staff does it require to run your system?

One person could set the system up and run it.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

Not applicable.

(11). Can you capture information on digital format for download?

We only used wet film.

(12). What type of processing services do you use to issue tickets?

Actual tickets were not issued, as this was just a test of the equipment.

(13). How successful are you at getting matches with license plates?

The cameras were quite accurate. If the vehicle had a license plate that was not damaged or dirty, the number showed up very well on the picture.

(14). Do you have front and rear license plates?

We took pictures of the rear plates only.

(15). What are your success rates?

About 70% of the vehicles had plates we could read.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

Not applicable.

(17). What is the public perception of your technology?

When we were doing the testing, we had an independent survey taken that showed about 80% of the public supported photo enforcement.

(18). What type of countermeasures do you observe?

Not applicable.

(19). What is the annual cost of the system?

Not applicable.

(20). What is the annual revenue generated?

Not applicable.

B.5. CITY OF CHARLOTTE, NORTH CAROLINA

(1). Who is your vendor?

Peek Traffic

(2). Is your system a mobile/portable technology?

Yes, our systems are installed in vans.

(3). Have you used this system in a freeway environment?

No, we are currently limited by the Legislature. We are in a test period until 2006 and are examining 14 high crash corridors.

(4). What is the speed of the roadway on which the system is deployed?

35-55 mph

(5). How long has your system been in place?

Our system has been in place since August 2004.

(6). How do you handle multiple lanes?

Since we use lasers, we can only capture one lane. We pick out one lane (out of 4-8 lane corridors) and move the technology around (aim the laser at different lanes).

(7). What type of detection technology do you use?

We use laser technology – ProLaser II.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

For the van, we need van stabilizers (such like those required for RV's) to limit shaking, personal computer, desk, chairs, and camera systems. We also had to install windows (oval, 4'x10") into the units.

(9). How many staff does it require to run your system?

Our staff work two shifts per day, seven days a week. This requires six people a day to operate three vans.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

We do not transmit data in real time. All information is downloaded at the end of the 2nd shift.

(11). Can you capture information on digital format for download?

Yes. We store information on the hard drive which then goes into a thumb drive and gets transported to the office.

(12). What type of processing services do you use to issue tickets?

Peek is responsible for all the processing. Peek decodes the information and determines ownership. The information then gets sent to the Florida office for approval and matching of tags. It then returns to Charlotte for Peek approval. The Police Department also has to approve it and then to goes back to Peek (either Charlotte or Florida) for generation of citation.

(13). How successful are you at getting matches with license plates?

I would estimate it to be about 90%, although we have trouble at night with glare and lighting in pictures. We currently take the picture from 500 feet.

(14). Do you have front and rear license plates?

No, we only have rear plates. A facial picture is not required.

(15). What are your success rates?

Information not provided by interviewee.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

We are currently examining this and will have a full report at the end of our trial period.

(17). What is the public perception of your technology?

70% of the people are in favor of this technology. We did public service announcements before deployment so approximately 89% were aware of the program.

(18). What type of countermeasures do you observe?

We have observed sprays, tag covers, tape (duct tape or electrical), and bike racks that have been left on intentionally. Trailer hitches also naturally cover tags. North Carolina currently prohibits tag covers.

(19). What is the annual cost of the system?

Deferred question to another person who was not available for comment.

(20). What is the annual revenue generated?

Information not provided by interviewee.

B.6. CALGARY POLICE SERVICE, CANADA

(1). Who is your vendor?

Multa Nova - now

American Traffic Solutions - future

(2). Is your system a mobile/portable technology?

Mobile

(3). Have you used this system in a freeway environment?

Yes

(4). What is the speed of the roadway on which the system is deployed?

30 – 110 km/hr

(5). How long has your system been in place?

17 years

(6). How do you handle multiple lanes?

Vehicle is parked parallel to the roadway and monitors up to four lanes of traffic; whether it is one or four lanes, the vehicle is deployed.

(7). What type of detection technology do you use?

Radar DRS 2

Wet Film

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

Battery power, mounted in the vehicle, and charged for 8 hours

(9). How many staff does it require to run your system?

One operator, one analyst, one Police Officer

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

Disc or CD is utilized to capture data, which is data entered into a computer at a central processing facility, within the Police Service.

(11). Can you capture information on digital format for download?

Yes

(12). What type of processing services do you use to issue tickets?

Offense notice is generated via computer, which is attached to a summons created from the data on the offence notice.

(13). How successful are you at getting matches with license plates?

I don't have stats on the capture rate, but it is moderate to high.

(14). Do you have front and rear license plates?

Rear plates only.

(15). What are your success rates?

Varies.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

Photo Radar has shown a decrease in crashes and speeds at sites throughout the City of Calgary.

(17). What is the public perception of your technology?

The Public has accepted the technology and often requests it to enforce the speeds in their communities. In fact, a recent poll of Canadians suggests that 68% of the population support photo radar.

(18). What type of countermeasures do you observe?

Motorists will cover their plates with plastic and obstruct the view with trailer hitches.

(19). What is the annual cost of the system?

I don't have that data; only available through the office of the Chief of Police

(20). What is the annual revenue generated?

I cannot provide that information; only available through Finance.

B.7. CITY AND COUNTY OF DENVER, COLORADO

(1). Who is your vendor?

ACS

(2). Is your system a mobile/portable technology?

They are all mobile units (three vans).

(3). Have you used this system in a freeway environment?

No. This system is used only in residential, school, and safety zones. We are limited by the Legislature.

(4). What is the speed of the roadway on which the system is deployed?

The speed is between 25 and 35 mph.

(5). How long has your system been in place?

7 years.

(6). How do you handle multiple lanes?

The system can handle two lanes while mounted in a van.

(7). What type of detection technology do you use?

We use Radar and wet film. We will be moving to a digital system in the near future.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

I do not know much about the technical aspects but I know that a special battery is required along with the other equipment (camera, radar, and laptop).

(9). How many staff does it require to run your system?

The Police Department has four van operators and one supervisor. There is one civilian operator (with special authority) in each van.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

We do not currently transmit data because we use wet film technology.

(11). Can you capture information on digital format for download?

No.

(12). What type of processing services do you use to issue tickets?

The vendor sends out citations and does all the back-office work.

(13). How successful are you at getting matches with license plates?

Very successful.

(14). Do you have front and rear license plates?

Yes. We photograph the driver and both front and rear license plates.

(15). What are your success rates?

We have a 60-70% issuance rate.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

We have seen a 5% reduction in speeds.

(17). What is the public perception of your technology?

There is a 50/50 split in public opinion. They have a more positive perception of red light systems.

(18). What type of countermeasures do you observe?

None that I am aware of.

(19). What is the annual cost of the system?

According to the contract, the annual cost is $1.4 million annually.

(20). What is the annual revenue generated?

I do not have enough information to answer this.

B.8. CITY OF BEAVERTON, OREGON

(1). Who is your vendor?

Redflex.

(2). Is your system a mobile/portable technology?

Yes, we use a speed van.

(3). Have you used this system in a freeway environment?

No, we are currently deploying in school zones, major streets, and neighborhoods (20%, 45%, and 35%, respectively).

(4). What is the speed of the roadway on which the system is deployed?

20-45 mph

(5). How long has your system been in place?

We started out in January 1996 with a different vendor.

(6). How do you handle multiple lanes?

We handle two lanes at the most.

(7). What type of detection technology do you use?

We use radar technology.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

We lease all equipment from Redflex.

(9). How many staff does it require to run your system?

The vans only require one police officer to operate it.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

We transmit data over the Internet through a wireless connection if we have digital speed van.

(11). Can you capture information on digital format for download?

Yes.

(12). What type of processing services do you use to issue tickets?

Redflex is responsible for all processing services.

(13). How successful are you at getting matches with license plates?

We have less than a 4% registration loss and approximately 15% gender matching loss.

(14). Do you have front and rear license plates?

Yes.

(15). What are your success rates?

We have seen the rates lower from 6% to less than 2% in neighborhoods.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

We have not measured this.

(17). What is the public perception of your technology?

The technology is very popular, with 2/3 of the public supporting it.

(18). What type of countermeasures do you observe?

We have seen sprays and plate covers. These are mostly ineffective. Gender matching is the biggest problem that we face.

(19). What is the annual cost of the system?

Information not available from interviewee.

(20). What is the annual revenue generated?

Information not available from interviewee.

B.9. CITY OF ATLANTA, GEORGIA

(1). Who is your vendor?

Laser Craft is the vendor and the gun is the Pro Laser II. The system was purchased.

(2). Is your system a mobile/portable technology?

It is a portable system that is held in a suitcase type container that the officers can just carry and set up in their squad cars.

(3). Have you used this system in a freeway environment?

The system is used in a freeway environment as well as city streets.

(4). What is the speed of the roadway on which the system is deployed?

The speed of the freeways is typically 55 miles per hour.

(5). How long has your system been in place?

The current system has been in place for eight years, but they used radar before that.

(6). How do you handle multiple lanes?

The officer will be on the shoulder and visually detect a car speeding and then will shoot the vehicle with the laser (the shiniest part of the vehicle) and get a confirmation of the speed and then go after the speeder. Sometimes the officers will team up and one will operate the laser while the other goes after the violators.

(7). What type of detection technology do you use?

Laser is the type of detection used.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

Again the system is carried in a suitcase and plug into the cigarette lighter for power.

(9). How many staff does it require to run your system?

The minimum staff required to run the system is one officer.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

None.

(11). Can you capture information on digital format for download?

No.

(12). What type of processing services do you use to issue tickets?

None.

(13). How successful are you at getting matches with license plates?

None.

(14). Do you have front and rear license plates?

None.

(15). What are your success rates?

Information not provided by interviewee.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

Information not provided by interviewee.

(17). What is the public perception of your technology?

The public perception is very positive.

(18). What type of countermeasures do you observe?

Laser detectors are found as the countermeasures.

(19). What is the annual cost of the system?

Not sure.

(20). What is the annual revenue generated?

Not sure.

B.10. CITY OF ZURICH, SWITZERLAND

(1). Who is your vendor?

Traffipax/Robot

(2). Is your system a mobile/portable technology?

We utilize both mobile and portable systems from Traffipax/Robot. The portable systems are systems mounted on poles where we employ a master-slave configuration consisting of two integrated cameras on separate poles to capture both the driver from a position in front of the vehicle and simultaneously a picture of the license plate with a picture taken from the rear. The detection devise is a planar radar antenna. Because of the high priority placed on accuracy for our programs in Switzerland, we require dual sets of images and radar reading for each violation so that a validation may be performed of the radar reading by using the time/distance method. This validation is performed by the software. The systems are considered portable because we have both dummy and live installations with appropriate infrastructure and outer housings and the actual inner housings containing the radar sensor and camera are rotated between. Drivers never can be certain as to the location of the live systems. The mobile systems are vehicle-mounted systems that use radar projected at an angle from the vehicle (across the road radar) to detect speed offenders. The vehicle-mounted systems operate from the roadside.

(3). Have you used this system in a freeway environment?

The pole-mounted systems are currently employed on freeways.

(4). What is the speed of the roadway on which the system is deployed?

The speed limit on freeways is 120 km/h (approx. 75 mph) and on country roads the speed limit is 80 km/h (approx. 50 mph).

(5). How long has your system been in place?

We have had various configurations of the current system in place for over 10 years.

(6). How do you handle multiple lanes?

Our freeways generally don't exceed three lanes in any direction. The systems provided by Traffipax/Robot have the capability to monitor three lanes.

(7). What type of detection technology do you use?

As explained above we use a planar radar antenna for freeway applications, which projects the beam across the roadway. We also use loops for some of the older installations on secondary roads.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

The pole-mounted systems require a power source and a communication line to download data. I don't have any data on the specifics of the poles or other infrastructure specifications.

(9). How many staff does it require to run your system?

We have a number of processors, supervisors, and technicians involved in the program, however, because many of them are not involved full time, this is difficult to answer.

However, I would estimate that our program requires approximately six full time people to operate a program with 24 sites and 16 live systems being utilized throughout, producing approximately 2800 citations per month.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

Because we have a mix of older installations and newer installations, the capabilities vary. The newer installations use a phone line or fiber optic line to allow real time download of data.

(11). Can you capture information on digital format for download?

The newer installation use digital cameras. There’s also a proprietary format for encryption and protection of the digital data.

(12). What type of processing services do you use to issue tickets?

We use software provided by Traffipax/Robot to process, issue, and track tickets.

(13). How successful are you at getting matches with license plates?

I do not have the knowledge to compare our success rate with those of other entities. We generally match 96% of Swiss issued license plates.

(14). Do you have front and rear license plates?

We require both front and rear license plates for cars. However, we must capture a picture from the rear to ensure motorcycles are detected.

(15). What are your success rates?

Excluding non-controllable events, we issue approximately 92% of citations.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

Because our system has been in place for many years, our focus is not on tracking a reduction in crashes but maintaining an effective deterrent.

(17). What is the public perception of your technology?

In European countries, photo enforcement is considered a critical component of traffic safety and widely used. In Switzerland, the use of photo enforcement is accepted on par with that of a police person manually enforcing a traffic violation.

(18). What type of countermeasures do you observe?

I am not aware of any countermeasures.

(19). What is the annual cost of the system?

We do not track a separate cost for operation of the program from other operations. There are one-time costs for equipment procurement that are tracked, however, the time of the personnel involved in the support of the program is not tracked separately from time spent on other activities.

(20). What is the annual revenue generated?

I do not have the authority to disclose this information.

B.11. JONKOPING COUNTY POLICE, SWEDEN

(1). Who is your vendor?

Sensys Traffic, situated in Jonkoping, Sweden. This is a small company with approximately 20 employees. Although we were referred by Peek Traffic representatives, we do not use their products per se.

(2). Is your system a mobile/portable technology?

We have both. We've got one bus in which a mobile automated traffic control camera is placed. We've got 24 fixed measuring cabinets in which two mobile cameras can be placed. The measuring cabinets are positioned in a distance of about 5 miles.

(3). Have you used this system in a freeway environment?

No, we haven't.

(4). What is the speed of the roadway on which the system is deployed?

The measuring cabinets are placed on parts of roads where the speed limit is set to 50, 70, and 90 kilometers.

(5). How long has your system been in place?

Our first measuring cabinets are 5 years old.

(6). How do you handle multiple lanes?

We have not tested the technology on roads with multiple lanes.

(7). What type of detection technology do you use?

We are using radar technology. Photo of the cars as well as data (date, place, and speed) are saved on a digital hard drive.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

We have both power and telephone lines connected to the measuring cabinets. The data cannot be obtained without us taking the whole camera down. The measuring cabinets are placed about one meter from the road and are about 2-3 meters high.

(9). How many staff does it require to run your system?

In Jonkoping County Police, we've got three policemen working with this type of speed enforcement.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

Right now we do not have the possibility to do this. The Swedish police are working with this question. In 2006 this might be possible.

(11). Can you capture information on digital format for download?

Yes, this is what how we work today.

(12). What type of processing services do you use to issue tickets?

Personnel from within the police department review the photographs and send the tickets by mail to the driver of the vehicle.

(13). How successful are you at getting matches with license plates?

If the car has a license plate, there are no problems at all to see which car it is.

(14). Do you have front and rear license plates?

Yes, we do. The cameras only take photos on the front of the car.

(15). What are your success rates?

About 80 percent of all fast runners get caught. All non-Swedish are though generally very hard to catch. We have no legal right to rapport a non-Swedish vehicle today.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

Yes, we have seen positive results. The average speeds on the actual roads have been reduced by 5-10 kilometers per hour. We have also seen a very big difference in the frequency of crashes on these roads. I cannot give you any precise statistics, but I estimate that crashes have been reduced with at least 50 percent.

(17). What is the public perception of your technology?

People living by these roads are very positive. They experience a more quiet and calmer situation. Their experience is that the speed has gone down. The average driver who gets caught isn't more negative to this kind of traffic control than other types.

(18). What type of countermeasures do you observe?

Due to language differences, a common understanding of this term could not be reached.

(19). What is the annual cost of the system?

About 1.5 million SKR per year (or approximately $210,000 USD).

(20). What is the annual revenue generated?

Last year (2004) about 800 drivers were reported with these cameras. This might have generated an income of about 1 million SKR. But I'd like to estimate the income of the society as much bigger. Crashes have been reduced by 50 percent and the income/profit to the society is huge.

B.12. NEW SOUTH WALES ROADS AND TRAFFIC AUTHORITY

(1). Who is your vendor?

ROBOT GBR (Traffipax) and Redflex Traffic Systems. They used to use three vendors and so their equipment is split about 1/3 from each vendor. The advantage is to have more competitive prices. They purchase the equipment.

(2). Is your system a mobile/portable technology?

Not for most of the program. They are fixed units and we currently have 112.

(3). Have you used this system in a freeway environment?

Yes.

(4). What is the speed of the roadway on which the system is deployed?

110 kmph.

(5). How long has your system been in place?

Up to 5 years.

(6). How do you handle multiple lanes?

Lane Specific Sensors – Piezo electric. We do not use radar.

(7). What type of detection technology do you use?

Piezo and Laser based speed measurement. They have been using the laser but haven't integrated it with cameras yet.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

Varied, but singular roadside housings up to 4 lanes. Some form of telecommunications link (wireless or other), at least 30-50 amps of power and roadside enclosures (equipment setting on poles at approximately street light height).

(9). How many staff does it require to run your system?

28 Staff throughout the state in various roles.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

Yes, our system is fully automated. It is fully network infringement delivery with security and site access monitoring. It uses a telecommunications line to transmit data (similar to 56K in U.S.).

(11). Can you capture information on digital format for download?

All systems currently deployed are digital.

(12). What type of processing services do you use to issue tickets?

We utilize the Police infringement-processing bureau for issuing infringement notices.

(13). How successful are you at getting matches with license plates?

In our primary speed enforcement systems, we do not use NRS (Number-plate Recognition System), which is an electronic plate reading, but we have trialed it in point-to-point enforcement trials with up to 80% success rates. In our primary systems, visual interpretations are conducted (human recognition).

(14). Do you have front and rear license plates?

Yes. We deploy bi-directional enforcement in some of our sites so we cover both plates. We only take pictures of one plate, it could be either plate, depending on the site.

(15). What are your success rates?

They have a high level of confidence for being able to successfully photograph all of the recognized speeders. Around 95% of the license plates that are photographed are readable. They don't photograph faces of the speeders. About 85% of the addresses of the registered owners of the speeding vehicles are matched with a licensed driver living at those addresses of the same gender as identified in the photo.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

Yes, substantial compliance in the area of enforcement.

(17). What is the public perception of your technology?

Reported 80% acceptance of the need for the technology and a vocal 20% who disagree with its use.

(18). What type of countermeasures do you observe?

The most notable ones are those that try to obscure the plate (for example, positioning of the plate in relation to the camera, tow bars, tape, etc.). Sprays and other countermeasures are mostly ineffective.

(19). What is the annual cost of the system?

Confidential information. I cannot give you an answer to this question.

(20). What is the annual revenue generated?

The program is run on a road safety budget, and does not receive direct funding from infringement generation. Cannot give you an answer to this question.

B.13. CITY OF PORTLAND POLICE BUREAU, OREGON

(1). Who is your vendor?

ACS.

(2). Is your system a mobile/portable technology?

We have a mobile system. We use three vans, two of which are owned by the City and one is leased from ACS.

(3). Have you used this system in a freeway environment?

No, we are limited by ordinance. We only implement on surface streets.

(4). What is the speed of the roadway on which the system is deployed?

The speed limits are 20, 30, 35, and 45 mph. We just finished an 8-week program with the Portland DOT in school zones.

(5). How long has your system been in place?

Our system has been in place since 1999.

(6). How do you handle multiple lanes?

We can cover two to three lanes of traffic. It depends on how the van is parked.

(7). What type of detection technology do you use?

We use radar technology and the Gatsometer camera system.

(8). What are your infrastructure requirements (power, connections, structural, etc.)?

We use a van equipped with ACS-provided tools (camera, etc.).

(9). How many staff does it require to run your system?

We need two full-time officers to deploy the van and enforce one location for 4 hours at a time. We also use five part-time officers.

(10). What is your system's ability to record incidences and transmit them to a central processing facility?

None. We use 35mm film. An officer loads the camera system and unloads it at the end of the day. He turns it in and ACS processes the data. Officers keep a manual log and confirm ACS findings.

(11). Can you capture information on digital format for download?

No. We use a memory card for downloading purposes.

(12). What type of processing services do you use to issue tickets?

ACS handles 99% of the workload. They provide and analyze the film and print citations, so they basically do all the back office work. The citations are signed by officers and ACS does the mailing.

(13). How successful are you at getting matches with license plates?

We have a 7% loss to clarity of license plates, 14% loss to gender matching, and the majority of losses due to unclear driver pictures (windshield glare, dark interior, etc.).

(14). Do you have front and rear license plates?

Yes. We capture both the front and rear license plates and the driver.

(15). What are your success rates?

We have a 60-70% success rate in regards to capture rate.

(16). How effective is your system? (Are you seeing a reduction in crashes or seeing any positive results?)

We have not adequately measured this information.

(17). What is the public perception of your technology?

Most people do not trust the radar and suspect cheating. However, the majority of people support the system.

(18). What type of countermeasures do you observe?

We have seen license plate covers and sprays. These methods are mostly ineffective.

(19). What is the annual cost of the system?

For the Photo Radar program, we usually pay $35,000 to $40,000 per month to ACS. The system usually pays for itself.

(20). What is the annual revenue generated?

The annual revenue generated is approximately $500,000 in a year.

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