

# Pilot Study of Automated Red Light Enforcement

Conducted for the  
**Alabama Department of Transportation**



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16. Abstract Alabama and the City of Birmingham have been identified by a national safety organization as having red light running (RLR) fatality rates among the worst in the nation. This project confirmed that problem by identifying 47,501 RLR crashes in Alabama over a nine-year period. There were 16,306 injuries and fatalities in these crashes. A RLR camera system installed in Tuscaloosa for a year found further confirmation of the problem. It detected 13,647 violations out of 2,726,061 vehicles that passed through the system (one out of every 200 vehicles).  The project investigated how the RLR camera system operated, tested its accuracy, and looked at camera installation and operation at three different intersections. The camera performed within the accuracy and efficiency characteristics advertised by the vendor. All data was transmitted quickly to a Web site, where it was analyzed and stored for viewing. The research team analyzed the results of the Tuscaloosa pilot project, and made the following recommendations:  <ul style="list-style-type: none"> <li>• An Alabama oversight committee should be formed to encourage adoption of RLR camera programs.</li> <li>• Legislation should be pursued in Alabama to enable automated enforcement of RLR.</li> <li>• In selecting sites for RLR cameras, the primary criteria should be crash history, violation history, opinions of local traffic engineers and law enforcement officials, and similar factors.</li> <li>• Fine revenues collected from RLR camera citations should be distributed according to the provisions in Alabama House bill 683, introduced in the 2001 Legislature.</li> <li>• Where excess revenues (beyond the cost of the RLR camera program) are generated, they should be dedicated to safety and road projects in the host city.</li> </ul> The research staff strongly encourages the adoption of automated enforcement of RLR in Alabama, as a safety countermeasure to mitigate the approximately 5,278 RLR collisions that occur each year, and to reduce the approximately 1,812 Alabama citizens injured and killed each year in these collisions.					
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## **Executive Summary**

This report documents an investigation of a red light running camera enforcement system. The project was conducted by the University Transportation Center for Alabama (UTCA), the Alabama Department of Transportation (ALDOT), the Tuscaloosa Department of Transportation (TDOT) and Precision Traffic Systems, Inc. (PTS).

RLR camera enforcement systems are now used in 68 jurisdictions in 15 states and the District of Columbia. They have been shown to reduce violations, crashes, injuries and fatalities. Surveys have shown that the public strongly supports their use as safety devices, and the courts have long ago addressed and answered all legal issues concerning their use.

Alabama and the City of Birmingham have been identified by a national safety organization as having red light running (RLR) fatality rates among the worst in the nation. This project confirmed that problem by identifying 47,501 RLR crashes in Alabama over a nine-year period (5300 per year). There were 16,306 injuries and fatalities in these crashes.

A RLR camera enforcement system was installed in Tuscaloosa for slightly over a year to observe traffic and identify the number of violators and their characteristics. The RLR camera detected 13,647 red light violations out of 2,726,061 vehicles that passed through the system (about one out of every 200 vehicles). The sheer volume of violations was another confirmation that there is a RLR safety problem in Alabama.

The project investigated how the RLR camera system operated, tested its accuracy, and looked at camera installation and operation at three different types of intersections. In all situations, the camera was easy to install and calibrate, and performed within the accuracy and efficiency characteristics advertised by the vendor. All data was transmitted quickly via fiber optical cable to a PTS Web site, where it was analyzed and stored for viewing by UTCA, ALDOT and TDOT managers.

This report outlines the results of RLR installations in other cities, reviews general implementation guidelines, discusses initial and recurring costs of operation, and provides a cost-effectiveness analysis. The research team analyzed this and much other information, including the results of the Tuscaloosa pilot project, and made the following recommendations:

- An oversight committee should be formed to encourage adoption of RLR camera programs in Alabama.
- Legislation should be pursued in Alabama to enable automated enforcement of RLR. This legislation should be modeled after the national law, tailored to fit Alabama situations.
- The primary purpose of a RLR camera system should be to improve safety.

- In selecting sites for RLR cameras, the primary criteria should be crash history or potential for crashes. Additional criteria include violation history, opinions of local traffic engineers and law enforcement officials, and other factors.
- When installing a RLR camera, cities should use a series or orderly steps to increase the likelihood of success in reducing violations and crashes.
- Financial arrangements will vary from city to city, but should be robust enough to ensure proper operation of the system. RLR camera systems should generate enough revenue to offset the major costs of the systems.
- Fine revenues collected from RLR camera citations should be distributed according to the provisions in Alabama House bill 683, introduced in the 2001 Legislature.
- Where excess revenues (beyond the cost of acquiring and operating the RLR camera program) are generated, they should be dedicated to safety and road projects in the host city.

The research staff strongly encourages the adoption of automated enforcement of red light running in Alabama, as a safety countermeasure to mitigate the approximately 5,278 RLR collisions that occur each year, and to reduce the approximately 1,812 Alabama citizens injured and killed each year in these collisions.

# **Section 1**

## **Introduction**

### **Problem Statement**

Red light running (RLR) is a major national safety concern. According to the Federal Highway Administration's "Stop Red Light Running" program, approximately 106,000 crashes, 89,000 injuries and 1,036 deaths in the U.S. were attributed to red light running in 2000 (FHWA 2002). Studies have shown that crashes resulting from red light running tend to be more severe than other crashes because the vehicles usually hit at right angles, and vehicles offer little protection to occupants during side impacts. Unfortunately, police officers find it difficult to enforce red light violations because they often must observe and follow violators through the light in order to ticket them, which can endanger the officers. In addition, communities usually do not have adequate police officers to patrol intersections as often as needed to ticket all the violators.

One potential way to address these challenges is the use of red light camera technology, which can improve efficiency of enforcement and safety. Jurisdictions throughout the U.S. that have implemented red light camera technology reported reductions in violations ranging from 20 percent to 87 percent. Half of the jurisdictions reported between 40 percent and 62 percent reductions (Maccubbin, et al. 2001).

### **ALDOT Role in the Project**

The Alabama Department of Transportation (ALDOT) has an excellent safety program and routinely looks for opportunities to improve roadway safety. Data indicated that intersection crashes were a growing problem in the state, and ALDOT officials decided to investigate ways to improve intersection safety through the use of automated traffic enforcement equipment. At this point, ALDOT organized a research project to determine the level of red light running in Alabama and to investigate the feasibility of using RLR automated enforcement to improve safety at signalized intersections. In February 2001, ALDOT contracted with the University Transportation Center for Alabama (UTCA) to conduct a pilot project with the assistance of two Alabama cities.

### **Objectives**

UTCA established the following objectives for the study:

- Determine the ambient types and rates of red light violations.
- Determine the feasibility of automated red light camera enforcement in Alabama.
- Verify that red light camera systems are accurate and can be used to detect red-light violations effectively.

- Determine the extent to which a red light camera system can decrease crashes, injuries and fatalities.
- Determine the cost effectiveness of red light camera system
- Determine the legal and administrative steps for issuing citations.

### **Project Team Description**

A project team was assembled to conduct the research. It was composed of representatives from agencies and organizations interested in traffic safety: the Federal Highway Administration (FHWA), ALDOT, the City of Tuscaloosa, the City of Mobile, the City of Montgomery, and UTCA of the University of Alabama. Project team members included the following:

- Linda Guin, FHWA
- Wes Elrod, ALDOT
- Ray Pugh, ALDOT
- Waymon Benifield, ALDOT
- Joe Robinson, City of Tuscaloosa
- David Griffin, City of Tuscaloosa
- Jon Howell, City of Tuscaloosa
- Chris Golden, City of Tuscaloosa
- Locke Bowden, City of Montgomery
- Bill Metzger, City of Mobile
- Fred Brown, City of Mobile
- Dan Turner, UTCA
- Thitipat Supriyasilp, UTCA
- Ravindra Wijesundera, UTCA

### **Project Research Activities**

This project was initiated with a series of team meetings to define the pilot project goals, procedures, and desired outcome. UTCA was responsible for conducting the project, but the project team contributed substantial assistance through the following actions:

- Identifying the need for automated enforcement.
- Providing coordination and support to research investigators.
- Investigating the most appropriate equipment for the study.
- Identifying vendors that were interested in cooperating with this project.
- Selecting facilities and sites for the field tests.
- Installing and operating the camera system.
- Providing technical guidance and expertise to the investigators.
- Conducting seminars for other organizations and press conferences to demonstrate the equipment and to promote public awareness.
- Evaluating and documenting the results.

## **Report Organization**

The report is organized into eight sections. Section 1 contains the introduction to the report. The literature review is presented in Section 2, which outlines many issues related to red light running enforcement such as effectiveness in other jurisdictions, legal issues, social issues, etc. Red light running safety issues in Alabama and the City of Tuscaloosa are provided in Section 3. Section 4 describes the pilot project conducted in Tuscaloosa. A brief overview of the red light camera used in the project is described in Section 5. The accuracy of the red light camera's speed measurement is evaluated in Section 6. Section 7 presents the occurrence and nature of red light violations in Tuscaloosa. Conclusions and recommendations based on the previous sections are provided in Section 8.

## **Section 2**

### **Literature Review**

Red light running is an important safety issue and a significant cause of vehicle crashes. In the United States, more than 1.8 million motor vehicle crashes occur at intersections annually. There were 106,000 RLR crashes that caused 89,000 injuries and 1,036 deaths in 2000 (FHWA 2002). Red light running is also a major problem in Alabama. According to statistics from the Insurance Institute for Highway Safety (IIHS), Alabama had the fifth worst red light running fatality record of any state in 1999 (IIHS 2000).

In the early phase of this research project, Hill, et al. (2001) conducted a comprehensive literature review. The purpose was to familiarize all team members with automated enforcement concepts, and to provide background information so the project team could select sites, equipment, test procedures, etc., for the field tests associated with the project. Two UTCA reports were generated by the literature review, “An Overview of Automated Traffic Enforcement Programs” (UTCA report 00470-1) and “An Overview of Legal Issues Related to the Automated Enforcement of Traffic Laws” (UTCA report 00470-2). Several important conclusions were drawn from the reports. The general conclusions from Report 00470-1 are repeated in Table 2-1. The conclusions regarding legal issues are repeated in Table 2-7 later in this report.

In addition to the reports by Hill, et al. (2001), this section will review red light running and the effectiveness of automated red light running enforcement programs in the United States. Legal, social and other issues related to red light running enforcement are included in this discussion.

#### **Definition of Red Light Running**

Passetti and Hicks (1997) defined a red light violation as follows:

*...when the front wheels of a vehicle enter the defining boundary of an intersection (usually the stop bar or crosswalk) after the traffic signal changes to the red phase and the vehicle proceeds through the intersection while the signal is red.*

Although this definition is not universally accepted, it does provide a good starting point for the research. However, some jurisdictions allow a short time period after the light has turned red before considering it to be a violation. For example, in Fairfax, Virginia, an elapsed time of 0.4 seconds (from beginning of red until the vehicle entered the intersection) was used to define red light running (Retting, *et al.* 1999, Fairfax). Among those jurisdictions providing a “grace period” between the beginning of red and vehicle entry, 0.2 and 0.3 seconds seem to be the most commonly used values.

**Table 2-1 Material from executive summary and conclusions, UTCA report 00470-1**

### **Executive Summary**

UTCA has conducted a research project for ALDOT to gather and analyze data to define the nature of certain types of traffic violations (i.e., red light running and speeding) in Alabama, and to determine whether significant traffic safety improvements can be achieved through the use of automated traffic enforcement equipment. This report was prepared to document the findings of the first portion of the project—determination of the state of practice in automated enforcement.

Report 470-1 provided a general orientation to automated enforcement for transportation officials (and to some extent to members of the interested public). It provided an overview of automated enforcement techniques, relevant technologies, and typical issues confronted during implementation and operation of automated enforcement systems. Subjects covered included typical programs, camera types, legal issues, implementation issues, site selection issues, case studies, and conclusions. Transportation officials and public-policy decision makers should find this material useful in determining the appropriateness, feasibility, and application of automated enforcement as a safety tool in Alabama.

### **Conclusions**

This report provided an overview of automated enforcement. Automated enforcement was defined, technologies were reviewed, and case studies were presented. Finally, the current status of automated enforcement in Alabama was discussed.

The following summary conclusions were drawn regarding automated enforcement in general:

- Automated enforcement systems are an efficient supplement to traditional enforcement techniques.
- Ensure that a comprehensive public awareness campaign is conducted prior to implementation. This campaign should focus on the safety benefits of the proposed program. Consider the use of signage at enforcement sites.
- Involve the local judiciary in the implementation process.
- Enabling legislation MUST be in place in order to operate an automated enforcement program.

The following conclusions specifically address RLR automated enforcement:

- 35 mm camera systems are the most widely used; however, technological advances are bringing both digital and video camera solutions to the forefront.
- Red light camera systems are costly (\$50,000+ per approach) and for this reason must be carefully located at intersections where their presence can generate the most benefit.
- Jurisdictions should readily explore all options concerning financing of RLR programs, including leasing of camera equipment and sharing of revenue with the camera provider in exchange for installation or other services.
- Citations issued should be “civil penalties” issued to the owner of the vehicle; this eliminates the need to identify the driver and leads to a greater public acceptance of the program.
- Placement of RLR cameras should be based upon a detailed analysis of traffic characteristics and crash history at the intersection, as well as both public and law enforcement input.
- This project did not find any red-light camera program that, once operational, was terminated. This indicates that public approval for such programs is high and that the programs can be viewed as successful.

The following conclusions are related to photo radar automated enforcement:

- In the United States, photo radar should be employed primarily in residential and other low volume settings (because of potential public disapproval of photo radar use on interstates and major arterials).
- When used in a residential setting, photo radar has been shown to be more cost effective than traditional speed reduction techniques (speed bumps).
- Use of photo radar must be restricted to the limits proscribed in the laws allowing its existence (see Anchorage case study).
- A number of photo radar programs have been terminated. Implementation and operation of photo radar programs must be undertaken carefully and the possibility that the program may be rejected by the public should be considered.

The definition of RLR in Alabama was important to this study. Under Alabama law, a vehicle that enters an intersection (crosses the stop bar) after the signal changes from yellow to red commits a violation. This definition also includes right-turning vehicles. The following paragraphs from Section 32-5A-32(3), Code of Alabama 1975, define a red light violation:

*Vehicular traffic facing a steady circular red signal alone shall stop at a clearly marked stop line...and shall remain standing until an indication to proceed is shown...*

*Except when a sign is in place prohibiting a turn, vehicular traffic facing any steady red signal may cautiously enter the intersection to turn right...after stopping...*



In addition to acquiring the legal definition of RLR in the state, UTCA researchers investigated how various jurisdictions interpret and enforce it. On the extreme side, some cities cite any vehicle that enters the intersection after onset of red, even if the vehicle stops with only one axle past the stop bar. But most jurisdictions issue citations only when a vehicle enters the intersection after onset of red and continues through the intersection. Some jurisdictions only cite violators who are blatant or who run the red light at high speed, under the assumption that these types of RLR are most likely to cause serious collisions.

### **Frequency of Red Light Running**

Several methods have emerged for measuring RLR. These include the number of violations per day, number per hour, number per hour per lane, rate per 1,000 vehicles passing through the signal, rate per 10,000 vehicle cycles, and rate per 100,000 population. The most popular current method is violations per 1,000 vehicles, although it appears that the rate per 10,000 vehicle-cycles method is gaining popularity. In addition to measuring violation rates, it is important to measure how many violations result in crashes. Both the number of crashes and the severity of crashes are important.

Washington, D.C. installed its first two RLR cameras in 1999 (Campaign, 2003). At one intersection a camera documented 7,600 violations in a month. Even though this appears to be an overwhelming number, it is not unusual in large, congested urban areas.

Research conducted in Fairfax, Virginia on nine intersections found a rate of 36.8 violations per 10,000 vehicles (Retting, *et al.* 1999, Fairfax). Another study conducted at 14 intersections in Oxnard, California found a rate of 13.2 violations per 10,000 vehicles (Retting, *et al.* 1999, Oxnard). In a study conducted in Arlington, Virginia, two intersections were observed over a period of 2,394 hours, and an average frequency of 3.0 violations per thousand vehicles was found (Retting, *et al.* 1998).

Another study conducted at 13 intersections in Iowa found red light violation rates ranging from 0.45 to 38.50 per 1,000 vehicles. It also documented rates that ranged from 0.09 to 9.78 violations per hour (Kamyab, *et al.* 2000).

Bonneson, et al. (2002) conducted a study at ten intersections (two approaches per intersection) in five Texas cities. The overall average was 4.1 red light violations per 1,000 vehicles, and the violation rate for individual intersection approaches was as high as 10.8 per 1,000 vehicles. Bonneson surmised that RLR was a function of the number of signal cycles, because each new red phase represented an opportunity for RLR to occur. He calculated the rate in terms of (vehicle volume  $\times$  number of cycles) and found an average rate of 1.0 violation per 10,000 vehicle-cycles at his sites.

Green (2000) observed 15 intersections throughout Melbourne and Victoria, Australia. The researcher found an average rate of 2.4 RLRs per hour, 3.9 RLRs per 1,000 vehicles, or one RLR approximately every 25 cycles.

A study was conducted at three intersections in Singapore by Lum and Wong (2003), with a duration of one continuous week of observation. The study documented frequencies ranging from 16.0 to 330.0 violations per lane per day on weekdays (Monday to Friday), and 5.0 to 244.1 violations per lane per day on weekends.

A study of RLR crashes on a national basis found an average rate of 2.5 fatal crashes per 100,000 residents for the 5-year period, 1992-1996 (Retting, et al. 1999, Prevalence). The rate ranged from 0.21 to 8.11 crashes per 100,000 population for various cities. In other words, some cities had population-based fatal RLR rates that were 40 times worse than others.

Based on these studies, it is clear that RLR violation rates vary widely. This is illustrated in Table 2-2. Because the rates vary so widely, it is important to use care and to thoroughly evaluate existing data when selecting sites for enforcement projects.

**Table 2-2 RLR rates from literature review**

Location	Number Intersections	Average Violations Per 1000 Vehs	Max Rate	Min Rate
Oxnard, CA	14	1.32		
Fairfax, VA	9	3.68		
Arlington, VA	2	3.0		
Iowa	13		38.5	0.45
Texas	5	4.1	10.8	
Australia	15	3.9		

### **Characteristics of Red Light Runners**

During 1994, Retting and Williams (1996) conducted research at signalized intersections in Arlington County, Virginia to compare characteristics of red light runners and their vehicles, with those who had an opportunity to run red lights but did not. The study consisted of 1,373 observations, 462 red light runners and 911 compliers. As a group, red light runners were younger, were less likely to wear safety belts, had poorer driving records, and drove smaller and older vehicles than compliers.

Another study was conducted using red light running crashes obtained from the Fatality Analysis Reporting System (FARS) and the General Estimates System (GES) on a national basis. A total of 3,753 fatal crashes and 257,849 injury and property damage crashes were studied. Compared with other drivers, red light runners were more likely to be male, younger than age 30, have records of moving violations and convictions for driving while intoxicated, have been driving with invalid driver's licenses, and have consumed alcohol before the crash (Retting, et al. 1999, Prevalence).

### **Reductions in Red Light Violations and Crashes**

Research indicates a significant decline in vehicles committing traffic signal violations at “enforced” intersections. Retting, et al. (1999, Oxnard) studied the influence of red light camera

enforcement in Oxnard, California. Nine camera intersections, three non-camera intersections, and two control intersections were observed. The non-camera intersections were the sites that had not been identified for camera installations. The study revealed that red light violation rates were reduced by 40 percent at camera intersections and 50 percent at non-camera intersections, only four months after enforcement began.

The program in Washington, D.C. has been very successful (National Campaign, 2003). The District deliberately saturated with cameras at 39 locations in 2001. Over the first two years, RLR violations decreased by 64 percent. The reduction in fatalities was just as impressive. In 1998, 15 percent of all traffic fatalities were attributed to RLR. This fell to three percent by 2001, an 80 percent reduction. The director of the program said, "Our philosophy is that we want to modify people's behavior... Instead of seeing a yellow light and pressing the gas, you start putting on the brakes." The police selected intersections where RLR was a problem, based upon factors like fatalities, serious crashes and citizen input ("We get a ton of requests"). The accuracy of citations has been insured by assigning two police officers to review the photos before the citations are mailed.

A program implemented in Montgomery County, Maryland has received high attention. In 1999, 26 intersections were selected for automated camera enforcement. During the 2003 "National Stop on Red" week, officials announced that the number of citations (and thus violations) had dropped 21 percent between 2000 and 2002 (Kunkle, 2003). The same officials announced that the program would be expanded to 45 intersections, and commented, "We don't want people to die in traffic accidents. I think that the entire traffic safety and pedestrian program we've been using for the past few years is really paying off."

Another study was conducted using crash data from the California Statewide Integrated Traffic Records System (SWITRS). Crash data from 29 months before camera installation and 29 months after installation were analyzed. As the result of the camera enforcement program, overall crashes at signalized intersections throughout the city decreased by seven percent and injury crashes decreased by 29 percent. Right-angle crashes, the type associated with red light running, decreased by 32 percent, and right-angle injury crashes decreased by 68 percent (Retting and Kyrychenko 2001). These reductions occurred at intersections with and without cameras.

In Howard County, Maryland, four years after implementation of the red light cameras, the number of crashes at every camera location decreased, ranging from 21 percent to 37.5 percent (Maccubbin, *et al.* 2001). An evaluation conducted later reported a 70 percent reduction in RLR violations at the camera locations (HCPD 2002).

Maccubbin, *et al.* (2001) looked at nationwide data and reported violation reductions ranging from 20 to 87 percent, with half of the jurisdictions reporting between 40 percent and 62 percent reductions in red light violations.

A similar study in Fairfax, Virginia included nine intersections. Three months after enforcement began, Retting, *et al.* (1999, Fairfax) reported nine percent reductions in violation rates per

10,000 vehicles across camera and non-camera intersections. One year after enforcement began, there was a 40 percent reduction in violations per 10,000 vehicles.

An evaluation of a RLR camera program in Perth, Australia was based on before/after crashes at 58 camera intersections with observation periods ranging between one and 9.5 years (Radalj 2001). The study found a 5.2 percent reduction in injury crashes and a 72.7 percent reduction in fatal crashes at these intersections.

Victoria, Australia started its RLR camera program in 1983. By 1997 the program included 35 cameras rotated among 132 sites around the Melbourne metropolitan area. Passetti and Hicks (1997) cited two studies evaluating the results of the program. One study conducted in 1988 found a 30 percent reduction in right-angle crashes and a 10.4 percent reduction in fatalities from crashes. Another study, in 1995, found reductions in RLR violations between 35 and 60 percent, and 32 percent decrease in right-angle crashes.

South investigated 46 camera intersections in Melbourne Australia (South, et al. 1988). The study included 50 non-camera intersections that served as control sites. The research team analyzed accidents by type, to identify whether RLR-related accidents were increasing or decreasing after installation of the camera. They also analyzed non-RLR accidents to understand the background situation for accidents. The results are shown in table 2-3.

**Table 2-3 Crash rates changes from RLR camera installation  
(South et. Al, 1988)**

Accident Type	Change	Statistically Significant?
Right angle	-32%	Yes
Right angle (turn)	-25%	No
Left against through	+2%	No
Rear end	-30.8%	No
Rear end (turn)	+28.2%	No
Other	-2.2%	No
All crashes	-6.7%	No
Number of casualties	-10.4%	Not reported

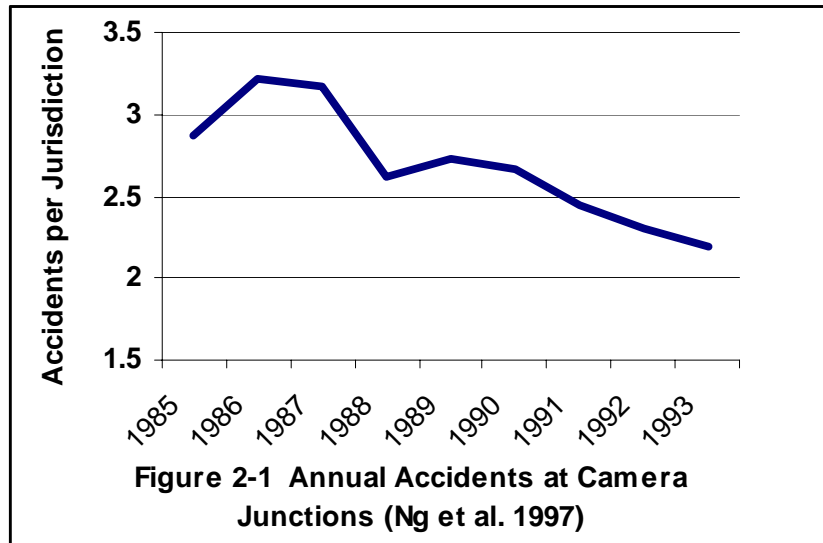
Five years of before data and three years of after data were analyzed using a 2 by 2 contingency table and a Chi Square test. Of the eight types of accidents examined, two showed increases and six showed decreases. Half of the crash types showed double digit changes, but only one (right angle crashes) was statistically significant. The table illustrates the difficulty in establishing the credibility of published reduction rates. Simply stated, virtually all studies in the existing literature had some flaw in the study procedure.

The reductions in violations and crashes have been summarized in Table 2-4. Although there is a wide variation, it is clear that camera enforcement of RLR is effective.

**Table 2-4 Reported reductions from camera RLR enforcement**

Location	Crashes Camera Ints.	Crashes at all Ints.	Rt. Angle Crashes all Ints.	RLR at Camera Ints.	RLR at all Ints.	Fatal Crashes	Injury Crashes
Oxnard, CA				-40%	-50%		-29%
Washington, D.C.	-64%					-80%	
Montgomery Co., MD				-21%			
SWITRS, CA		-7%	-32%				-68%
Fairfax, VA				-40%	-40%		
Howard County, MD	-21.60%	-21.6% to -37.5%		-70%			
Perth, Australia						-72.7%	-5.2%
Victoria, Australia			-32%	-30% to -60%	-30% to -60%	-10.4%	
Melbourne, Australia		-6.7%		-32%			
U.S., Nationwide				-20% to -87%	-20% to -87%		

Existing RLR camera installations have caused reductions in violation rates, but the declines did not always remain constant from year to year. Crash reduction rates typically decreased over time, as more and more drivers modified their behavior and stopped running red lights. An example is shown in Figure 2-1. The figure is not representative of all sites; it is just one example of what can happen.



There is an implication in this figure. The cost effectiveness of red light cameras declines over time because there are less violators paying fines. If the decision to install a RLR camera is based largely on cost effectiveness, the diminishing violation rate must be included in the analyses.

***Why so Much Variability?***

Many RLR studies were identified during the literature review. They often included information about the number of violations, and about reductions in violations and crash rates after

implementation of red light cameras. As noted in tables 2-2 and 2-4, there was a high degree of variability from site to site. Part of this was due to differences in traffic patterns, intersection geometry, driving pressures and enforcement patterns from location to location.

However, a large part of the variability may be due to the nature of the studies conducted at the various sites. Most of them appear to lack scientific design and statistical rigor. This was one of the primary findings of National Cooperative Highway Research Program Synthesis Report 310, released in 2003 (NCHRP 2003). After looking at all previous studies, the strongest statement that the NCHRP researchers could make was "...initial experience with red light cameras implies that their presence reduces the frequency of red light running; however, it is not clear whether a net safety gain is realized. As red light violations are reduced, angle crashes should also be reduced. But there is a concern that rear end crashes will increase." In effect, the average crash severity typically decreases (because right angle crashes are more likely to cause injuries and fatalities than rear end accidents) but the overall number of accidents might actually go up.

### ***Which Crash Reduction Rates are the Best?***

Actually, no crash reduction factor is best for all times for all intersections. The study that came closest to establishing a general value was the NCHRP synthesis project (NCHRP 2003). The researchers surveyed traffic engineers in all states and communities known to be using RLR cameras, and performed a literature review on all available U.S. and international red light studies. Many useful conclusions were drawn, but the primary finding seemed to be that there were flaws in virtually all existing studies. The flaws were not always fatal, but they did detract from the reliability of the crash reduction values and the acceptability of the conclusions drawn by the researchers.

The NCHRP researchers decided to perform their own analysis of RLR crash reductions based upon the best results and best databases from previous work. After a thorough review, the researchers concluded that only two studies from scientifically controlled experiments produced datasets of sufficient content and accuracy for their study. A comprehensive META analysis was used. This procedure involves six statistical and graphical tests to evaluate the overall effect of a measure like installing a RLR camera. The researchers used data from Howard County, Maryland and Charlotte, North Carolina for the study. Data were available for 42 intersections, which were subjected to three of the six normal META tests.

The initial evaluation determined that the data were not skewed. This indicated that the mean crash values before and after installation of the cameras reflected a good sense of the overall treatment effect. The modality test indicated that the two data sets could be combined to provide a meaningful effectiveness of the treatment. The outlier test indicated that the mean values were hardly affected by removal of individual intersections with crash rates that fell far from the mean. (These outlier points sometimes dominate statistical tests).

The META analysis confirmed that positive results had occurred after installation of RLR cameras. The researchers noted a reduction of approximately 26 percent in both rear end and right angle crashes. However, they stated "The results should not be emphasized, and caution should be exercised when reviewing this study and applying the results." The primary reason for

this disclaimer was the relatively small amount of data upon which it was based (two locations, 42 intersections), compared to the large number of programs currently operating around the world.

Part of the information obtained through the NCHRP survey of practicing traffic engineers helped to explain some of the variability in the literature. The traffic engineers held a strong belief that the presence of RLR camera warning signs and public information programs influenced drivers and effected the reductions in violations and crashes. This effect applies not only to the approach where the camera is installed, it also “spills over” to other intersections in the vicinity of the camera. So it is natural that jurisdictions with larger and better public awareness programs would experience larger reductions. It is hard to account for this factor in evaluating raw traffic accident data.

The NCHRP study can be summarized rather simply. The researchers noted that there is an obvious positive affect of installing red light running camera systems. Using the best data and a powerful statistical procedure, they estimated the that right angle and rear end crashes are reduced 26 percent. However, they used strong disclaimers in describing this finding due to the limited amount of data upon which it was based.

The true effects of RLR cameras can not be established with certainty from existing research. At best, the average reduction in violations per site, the decline in red light running over time, the reduction in injuries and fatalities, and the effects on specific types of accidents (right angle, rear end, other) must be estimated from existing (flawed) studies as guides. The researchers called for additional studies using scientifically designed testing methods, control sites, and statistical procedures that recognized “regression to the mean” and other statistical procedures that are commonly accepted for dealing with accident data.

## **Red Light Cameras**

Three types of cameras are currently used for automated red light running enforcement: wet film (35 mm) cameras, video cameras, and digital imaging cameras (Smith, *et al.* 2000). Typically, the cameras work in the same way. They are connected to traffic signals and to speed sensors. The sensors are usually inductance loops buried in the pavement at the crosswalk or stop line, or radar units mounted on nearby poles.

The system monitors the traffic signal and triggers the camera to photograph the license plates of vehicles entering the intersection after the light has turned red, with a pre-set minimum speed and within a specified time after the signal has turned red. The cameras are programmed not to photograph vehicles turning right on red or vehicles caught in the intersection when the light changes. Two pictures are taken of each violating vehicle; one just before the vehicle crosses the stop line and a second when the vehicle is in the intersection. The red traffic signal indications show in both pictures. The photographs include the license number of the vehicle, the date, time, place, vehicle speed, and elapsed time from the light turning red to the time the photo was taken (Harris 2002). This identifying information is used to issue a citation to the violator.

## Public Support of Red Light Cameras

A study conducted by Retting and Williams (2000) examined acceptance of red light cameras in ten U.S. cities. Five of the cities had red light camera enforcement programs: Charlotte, North Carolina; Fairfax, Virginia; Mesa, Arizona; Oxnard, California; and San Francisco, California. Five of the cities did not have red light cameras: Arlington, Texas; Charlottesville, Virginia; Fresno, California; Ft. Lauderdale, Florida; and Raleigh-Durham, North Carolina. A total of 2,181 telephone interviews were conducted: 1,164 in cities with cameras and 1,017 in cities without cameras. Public support of red light cameras ran very high. Support ranged from 77 to 84 percent in cities with red-light cameras, and 72 to 82 percent in cities without cameras. A summary of these findings is shown in Tables 2-5 and 2-6.

**Table 2-5 Percent of drivers who favor red light cameras in cities with cameras**

City	Population	Percent
Fairfax, Virginia	21,000	84%
Charlotte, North Carolina	441,000	82%
Oxnard, California	151,000	79%
Mesa, Arizona	345,000	78%
San Francisco, California	735,000	77%

**Table 2-6 Percent of drivers who favor red light cameras in cities without cameras**

City	Population	Percent
Ft. Lauderdale, Florida	152,000	82%
Raleigh-Durham, North Carolina	477,000	76%
Arlington, Texas	295,000	74%
Charlottesville, Virginia	41,000	74%
Fresno, California	396,000	72%

Similar support was found in Alabama during a 2002 survey by the Alabama office of the American Automobile Association (AAA-Alabama, 2002). Several interesting conclusions can be drawn from the 769 responses. First, the respondents identified “aggressive driving” as the situation that most endangered them. Second, one in six of the respondents identified red light running as the most common form of aggressive driving (Table 2-7). Third, 77 percent of the 769 individuals responding to the survey were in favor of red light cameras.

**Table 2-7 AAA-Alabama survey results (AAA-Alabama, 2003)**

What do you see as the most common form of aggressive driving on our roads?		
<b>16.2% - Red light running</b>		
<b>Do you favor or oppose the use of advanced technology such as cameras to assist in enforcement of red-light running?</b>		
<b>77.3% - favor</b>	<b>13.9% - oppose</b>	<b>8.8% - don't know</b>



## **General Estimate of Costs**

Most of the early cameras used for red light running enforcement were 35-mm wet-film camera systems. The cameras, including installation, cost about \$50,000 to \$60,000 each. The system required an additional \$25,000 for detectors, equipment cabinets, and mounting pole installations. The operation and maintenance costs of each camera system were about \$5,000 per month. For the standard digital camera system, the camera and installation of associated equipment costs approximately \$100,000 (Maccubbin, et al. 2001). Although the early installations were almost all wet-film, digital cameras are now the most popular mode because methods have been devised to encode the digital photo files to prevent tampering. A more detailed discussion of RLR system costs can be found in Section 8 of this report.

## **Legal Issues**

As mentioned in the introduction to this Section, UTCA conducted a review of legal issues in the initial stages of this project and published the results as UTCA report 00470-2 (Hill, et al. 2001, Legal). The important conclusions of that effort are repeated in Table 2-8, and other legal issues noted in the report are summarized in the next few paragraphs.

In 2002, the Federal Highway Administration found that red light camera enforcement programs were being conducted in 15 states, Washington, D.C., and 68 communities (FHWA 2002). The states were New York, Virginia, Delaware, Maryland, North Carolina, Georgia, Pennsylvania, Ohio, Pennsylvania, Arizona, Colorado, Washington, Oregon, and California. Georgia adopted RLR camera legislation in 2002, and other states are considering it.

Alabama Code does not allow automated red-light running enforcement programs. Appendix A contains two pieces of example legislation that might help the next time that the Alabama Legislature considers such a bill. The first is a “model law” for RLR programs, developed by the National Committee for Uniform Traffic Laws and Ordinances (NCUTLO 2001). It contains many of the provisions of legislation adopted by other states. A copy of the model law may be found in Appendix A1 of this report. The second example is the Act introduced in the Alabama Legislature in 2001. It is in Appendix A2, and contains many of the provisions of the model law.

The issue of privacy is an important concern. People have strong perceptions of privacy while driving in their automobiles. Legal experts have concluded that red-light-running enforcement does not violate a citizen’s legal right to privacy. Implementers may discharge part of the public’s concern over the issue by photographing vehicles from the rear showing only the rear license plate, instead of the front showing the front plate and the driver. In that case, the citation must be issued to the registered owner of the vehicle because of inability to identify the driver. This may require changes in the severity of the penalty associated with citations (Turner and Polk 1998).

The court system has clearly determined that RLR systems are legal, but they are still contentious. Hill’s report offered the following advice about making them more acceptable:

- Post signs in the automated enforcement area to warn motorists.
- Conduct a public awareness campaign so that citizens are aware of the camera program.

- Photograph the vehicle license plates, not the face of the driver.
- Use flash units to let motorists know that the camera has photographed their vehicles.
- Never use blurry or unclear photos as the basis for a citation (most jurisdictions have the photos reviewed by law enforcement officers prior to mailing).
- The violation should be charged to the owner of the offending vehicle as a civil infraction, not a moving violation (since the vehicle owner is cited it is not necessary to identify the driver; there are no “points” assessed against the driver’s license of the owner)
- Mail the citations promptly so that the incident is fresh in the driver’s mind.
- Allow the vehicle owner to view the photographs prior to the court date (most jurisdictions include the photos in the citations package; this has contributed to the immediate and high rate of payment of citation fines).
- Include a “rebuttable presumption” provision that allows the vehicle owner to avoid the citation by proving that some other individual was driving the vehicle.

**Table 2-8. Material from executive summary and conclusions, UTCA Report 00470-2**

**Executive Summary**

This interim report was prepared to document the legal issues relevant to automated enforcement. These issues are controversial; however, they can be addressed through careful crafting of enabling legislation and careful operation of the automated enforcement system. Although the subject is both sensitive and cumbersome, this study found that automated enforcement is not likely to violate due process or to infringe upon an alleged violator's right to present a defense.

Enabling legislation is needed because current Alabama law requires that a violator receive a citation and summons at the time of the offense, and automated enforcement systems are unable to meet this requirement. Separate enabling legislation should be offered for photo radar and red light running camera systems due to the differing legal requirements and differing sensitivities of the public. Red light camera systems are far less contentious than photo radar and should thus be the primary focus of initial attempts to introduce automated enforcement.

Transportation officials and public-policy decision makers should find this material useful in determining what actions to take to implement and operate an automated enforcement system within the constraints of the law.

**Conclusions**

The legal issues confronting those interested in the implementation and operation of an automated enforcement program are potentially cumbersome. The following points are presented in summary:

- Automated enforcement systems are not likely to be found in violation of due process standards; however, precautions should be taken to minimize the possibility of due process challenges.
- Automated enforcement is not likely to infringe upon an alleged violator's right to present a defense.
- Unmanned photo radar devices are not recommended because "tracking history" of an alleged violator cannot easily be obtained.
- Manned photo radar units are acceptable because the attending officer can maintain tracking history.
- Red light camera systems are far less legally contentious and should thus be the primary focus of initial attempts to introduce automated enforcement to Alabama.
- Current Alabama law requires a violator to receive a citation and summons at the time of the offense. Automated enforcement systems are unable to meet this requirement, thus any enabling legislation must include a provision to overcome this.
- House Bill 683, introduced in 2001, was a major improvement over previous automated enforcement legislative efforts in Alabama. The bill appeared to be similar to legislation enacted in other jurisdictions and could serve as a model for future legislative efforts within Alabama.
- There should be separate pieces of enabling legislation for photo radar and red light running camera systems due to the differing requirements (i.e. photo radar should be manned, whereas red light running systems are unmanned).

In conclusion, the legal atmosphere surrounding automated enforcement can be intimidating; however, legal hurdles can be easily overcome with the careful crafting of enabling legislation and careful operation of the automated enforcement system.

**Citations and Fines**

Virtually everyone believes that more enforcement is needed, and that higher enforcement levels improve safety. That belief will be strengthened with the release of this report, documenting the RLR situation in Alabama. But at the current time, virtually every law enforcement agency in Alabama is stressed to the limit. There are just not any more officers to put on the road to enforce red light running laws.

Interestingly, research has shown that there is a relationship between safety and traffic citations (Brandt 2003). Researchers at the University of Toronto School of Medicine screened the

records of about 9,000 drivers involved in fatal crashes in a ten year period. Prior to these crashes, the drivers had received approximately 21,500 citations for moving violations.

The researchers found that traffic tickets had a statistically significant influence on driver behavior. In the weeks following receipt of a citation, the risk of a fatality in a traffic crash was reduced by 35%. The effect was greatest when the citation penalties were greatest (\$100 ticket and three points on the driver’s license). This effect wore off over time. The researchers estimated that one fatality was prevented for every 80,000 citations issued; one emergency room visit per every 1,300 citations, and \$1,000 in societal costs saved per every 13 citations. The general findings should be applicable in the United States because traffic laws in the two countries are similar. However, the savings per citation would need adjustment.

One issue that can be controversial is the amount of the fine associated with a RLR violation. Many states use the same fine for officer-issued and camera-issued citations. The National Campaign to Stop Red Light Running (Campaign, 2002) published the fines in several states, as shown in Table 2-9. Of the seven jurisdictions in this limited survey, the average citation fine was about \$98.

**Table 2-9. 2001 RLR fines for citations issued by camera systems**

State or Jurisdiction	Fines
Washington, D.C.	\$75
Virginia	\$50
Maryland	\$75
California	\$271
Washington	\$86
North Carolina	\$50
Delaware	\$75

***Alabama Fines***

Red light fines vary in Alabama. At the time of publication of this report, the fine for a red light violation in Tuscaloosa was \$130. For each citation, the revenue from paid fines was distributed as follows:

City of Tuscaloosa	\$20.00
Municipal court	15.00
Municipal Corrections Fund	36.50
State of Alabama	<u>58.50</u>
Total	\$130.00

On the surface, the \$130 fine seems high enough to discourage red light running, especially when compared to the fines shown in Table 2-8. So why does the problem persist at such a high magnitude? It is because the size of the fine is not sufficient to deter RLR. It takes both a large fine and a high probability of conviction to modify driving behavior. In Alabama, the second factor is problematic in many jurisdictions – law enforcement agencies are overworked and can not dedicate enough personnel to RLR enforcement to control the problem.

So what fine should be used for camera RLR citations? Most agencies use the same dollar amount for the fine of both officer-issued and camera-issued citations. The UTCA researchers recommend that the same practice be used in Alabama.

That raises a side issue of paying for the RLR system and its operation. This topic is covered in some detail in Section 8, and it is clear that \$20 per citation distributed to the City will not cover the cost of the RLR system. It will be necessary to break away from the Tuscaloosa fine distribution model to acquire and operate a camera system.

The most recent attempt to enable RLR cameras (Alabama House Bill 683, The Red Light Safety Act of 2001) recognized that a different fine distribution system was needed. It established the fine as a civil penalty not to exceed \$100 plus costs, to be distributed as follows:

General Fund of host municipality	80%
ADECA Law Enforcement/Traffic Safety Unit	10%
Administrative Office of Courts	5%
General Fund of the State of Alabama	5%
Total	100%

The model law (Appendix A1) suggests that collected fines be used only for highway safety functions and projects, which includes obtaining and operating the RLR camera system. This would be a good feature to incorporate into any enabling legislation offered in Alabama.

## Summary

This section has provided an overview of RLR and the effectiveness of automated RLR enforcement programs in the U.S. RLR has been defined, case studies in many jurisdictions have been presented, privacy and legal issues have been discussed, and important conclusions from two UTCA reports have been reviewed.

Automated red light camera enforcement has been used successfully in a number of U.S. jurisdictions to reduce the number of red light violations and crashes associated with them. RLR crash reductions such as those stated in this section have become of interest to ALDOT. The Cities of Tuscaloosa, Mobile and Montgomery have demonstrated their support and it appears that support is growing in other sectors of the state. Automated red light camera enforcement technology is being investigated in this project as a potential safety tool. The literature review conducted in this chapter indicates that the benefits of RLR camera enforcement in other states can be transferred to Alabama.

## Section 3

### The Alabama RLR Crash Situation

To understand the extent of the red light running problem in Alabama, safety analyses were conducted from two sources of information. One was a study conducted by the Insurance Institute for Highway Safety (IIHS). The second involved Alabama red light running crash data. The crash analysis was conducted using nine years of data, 1993 to 2001, for both the state and the City of Tuscaloosa. The primary tool used in the analysis was the CARE software, which is described in Appendix B. An example of a CARE work screen is shown in Figure 3-1.

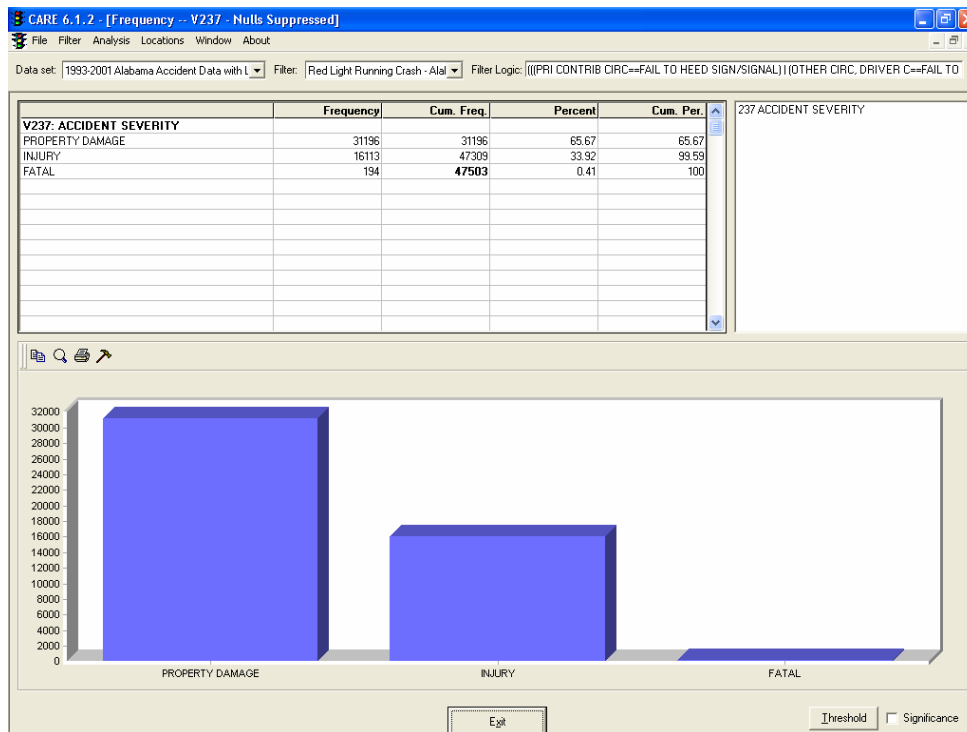


Figure 3-1. An example CARE work screen listing red light running crashes in Alabama

### Alabama RLR Crashes Compared to National Rates

According to the IIHS, Alabama ranked fifth of all states in RLR fatalities for the years 1992 to 1998. 5,951 deaths were documented for a rate of 2.3 per 100,000 people for the nation, while Alabama had 3.4 traffic deaths per 100,000 people (IIHS 2000). In the same study, Birmingham ranked sixth among U.S. metropolitan areas. These facts indicate that red light running is a severe problem in Alabama. Tables 3-1 and 3-2 show the number of deaths, by states and cities from red light running crashes cited by IIHS, prioritized by death rate.

**Table 3-1. States with highest death rates in red light running crashes per 100,000 people, 1992-98**

State	Population	Death	Rate per 100,000
Arizona	4,280,998	305	7.1
Nevada	1,529,841	59	3.9
Michigan	9,655,540	355	3.7
Texas	18,677,046	663	3.5
Alabama	4,255,686	143	3.4
New Mexico	1,670,580	56	3.4
Florida	14,197,723	434	3.1
California	31,645,023	956	3.0
Delaware	717,499	21	2.9

Sources: Fatality Analysis Reporting System, U.S. Department of Transportation; population data from U.S. Census Bureau, 1992-98

**Table 3-2. Cities with highest death rates in red light running crashes per 100,000 people, 1992-98**

City	Population	Death	Rate per 100,000
Phoenix, AZ	1,125,599	122	10.8
Memphis, TN	614,067	49	8.0
Mesa, AZ	333,756	26	7.8
Tucson, AZ	445,840	34	7.6
St. Petersburg, FL	237,480	18	7.6
Birmingham, AL	256,386	18	7.0
Dallas, TX	1,047,816	73	7.0
Albuquerque, NM	412,625	28	6.8
Louisville, KY	260,572	17	6.5
Detroit, MI	998,523	65	6.5

Note: cities with population more than 200,000

Sources: Fatality Analysis Reporting System, U.S. Department of Transportation; population data from U.S. Census Bureau, 1992-98

## Analysis Procedure for Alabama

CARE is designed for problem traffic crash identification and countermeasure development. In Alabama, RLR crashes are not easily defined from the crash database, so an estimate was made using combinations of related variables. The first step was to identify variables that defined red light running. The researchers looked into all variables in each data reporting category from the Alabama traffic crash reporting form, and three were identified:

- The “Fail to Heed Sign/Signal” variable from the “Primary Contributed Circumstances” category,
- The “Fail To Heed Sign/Signal” variable from the “Other Circumstances” category, and
- The “Running Red Light” variable from the “Citation Charged” category.

The next step was to create special CARE filters to screen the data and obtain a file of all red light running crashes. The filters required use of AND/OR logic. The two “Fail to Heed Sign/Signal” variables were combined with the “Running Red Light” variable by OR logic. Then sign-related intersection crashes were removed. With this newly created filter, all possible red-light-running-related crashes were covered.

After the filters were created, all desired RLR crash information was obtained by selecting appropriate commands from the CARE menu tab. An example of a CARE “create-filter” work screen is illustrated in Figure 3-2.

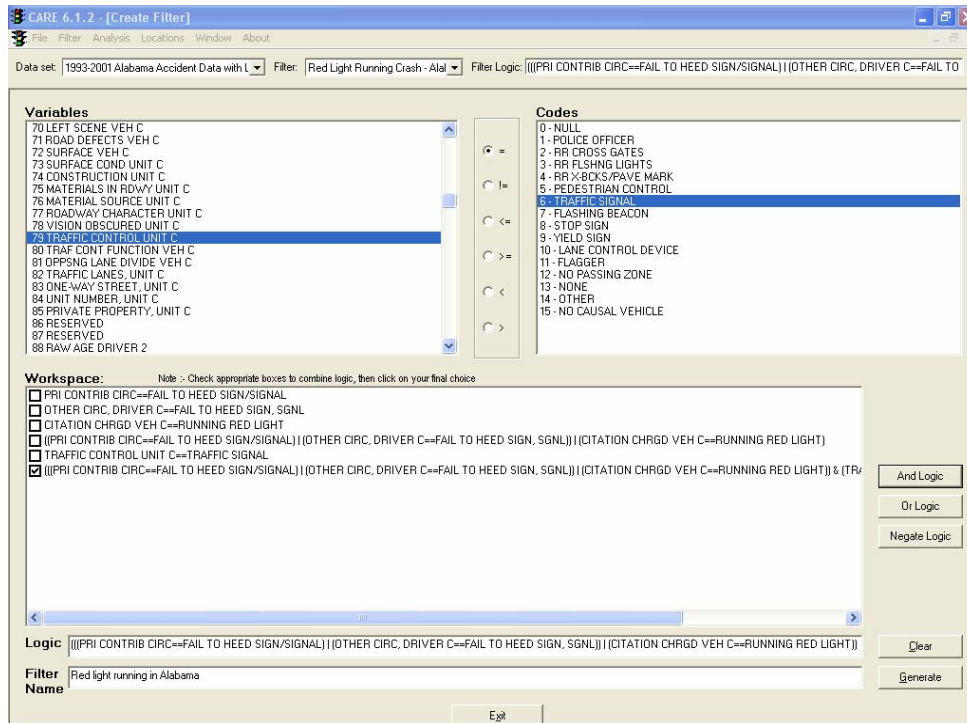


Figure 3-2. CARE “create-filter” work screen showing Alabama red light running filter

Even though Alabama is largely rural, the number of RLR related crashes in 1993-2001 was large. Crashes at signalized intersections and crashes involving red light running for metropolitan areas in Alabama are summarized in Tables 3-3 and 3-4, respectively. They show that RLR crashes (47,501) account for 21 percent of total crashes (230,170) at signalized intersections statewide. The five highest crash rate cities (i.e., Birmingham, Montgomery, Huntsville, Mobile and Tuscaloosa) accounted for 48.3 percent (22,922) of the 47,501 RLR related crashes during the years 1993-2001. Birmingham had the most red light running crashes (8,207) and the highest number of deaths (27). Montgomery ranked second with 4,783 crashes and 17 deaths, followed by Huntsville and Mobile. Tuscaloosa ranked fifth with 2,350 crashes and eight deaths.

Table 3-5 lists statewide RLR-related crashes for nine years. An average of 5,278 RLR crashes occurred annually. The table indicates that the number of RLR crashes was fairly consistent over



the nine-year period, ranging from 5,069 to 5,460. About 1,811 injuries and fatalities resulted from those crashes.

**Table 3-3 Crashes at signalized intersections in major cities for 1993-2001**

City	Property Damage	Injury	Fatal	Total	Percent
Birmingham	24384	7108	52	31544	13.70%
Mobile	18159	4621	25	22805	9.91%
Montgomery	16241	5222	40	21503	9.34%
Huntsville	14151	4471	50	18672	8.11%
Tuscaloosa	9086	2588	16	11690	5.08%
Dothan	4711	2160	15	6886	2.99%
Decatur	4125	1130	12	5267	2.29%
Hoover	4287	869	1	5157	2.24%
Jefferson Rural	4040	976	10	5026	2.18%
Gadsden	3470	1115	16	4601	2.00%
Other Cities	76660	20176	183	97019	42.00%
<b>Total</b>	<b>179314</b>	<b>50436</b>	<b>420</b>	<b>230170</b>	<b>100.00%</b>
<b>Percent</b>	<b>77.91%</b>	<b>21.91%</b>	<b>0.18%</b>	<b>100.00%</b>	

**Table 3-4 Red-light-running-related crashes in major cities for 1993-2001**

City	Property Damage	Injury	Fatal	Total	Percent
Birmingham	5412	2768	27	8207	17.28%
Montgomery	3023	1743	17	4783	10.07%
Huntsville	2630	1514	19	4163	8.76%
Mobile	2314	1095	10	3419	7.20%
Tuscaloosa	1497	845	8	2350	4.95%
Dothan	861	750	6	1617	3.40%
Gadsden	751	397	5	1153	2.43%
Anniston	708	395	2	1105	2.33%
Decatur	720	342	6	1068	2.25%
Florence	647	267	5	919	1.93%
Other Cities	12631	5997	89	18717	39.40%
<b>Total</b>	<b>31194</b>	<b>16113</b>	<b>194</b>	<b>47501</b>	<b>100.00%</b>
<b>Percent</b>	<b>65.67%</b>	<b>33.92%</b>	<b>0.41%</b>	<b>100.00%</b>	

**Table 3-5. Alabama red-light-running related crashes by years**

Year	Property Damage	Injury	Fatal	Total
1993	3464	1659	21	5144
1994	3495	1732	15	5242
1995	3517	1830	21	5368
1996	3561	1876	23	5460
1997	3440	1847	24	5311
1998	3475	1793	22	5290
1999	3442	1927	26	5395
2000	3330	1717	22	5069
2001	3470	1732	20	5222
<b>Total</b>	<b>31194</b>	<b>16113</b>	<b>194</b>	<b>47501</b>
<b>Percent</b>	<b>65.67%</b>	<b>33.92%</b>	<b>0.41%</b>	<b>100.00%</b>

## RLR Crashes in the City of Tuscaloosa

Tables 3-6 and 3-7 document crashes at signalized intersections, and crashes involving RLR for the City of Tuscaloosa from 1993 through 2001. By comparing the crash data in Tables 3-6 and 3-7, it can be seen that RLR crashes (2,350) in Tuscaloosa accounted for 20 percent of the total crashes (11,690) at signalized intersections over a nine-year period. Approximately 260 crashes occurred annually as a result of red light running, and about 36 percent of these crashes resulted in an injury. RLR-related crashes in Tuscaloosa are listed by years in Table 3-7. This suggests that red light running remained a significant road safety problem in Tuscaloosa throughout the study period.

**Table 3-6 Tuscaloosa crashes at signalized intersections**

Year	Property Damage	Injury	Fatal	Total
1993	924	248	1	1173
1994	949	297	1	1247
1995	983	280	3	1266
1996	949	280	3	1232
1997	960	300	1	1261
1998	1133	298	2	1433
1999	1054	334	2	1390
2000	1008	266	0	1274
2001	1126	285	3	1414
Total	9086	2588	16	11690
Percent	77.72%	22.14%	0.14%	100.00%

**Table 3-7 Tuscaloosa red-light-running related crashes**

Year	Property Damage	Injury	Fatal	Total
1993	205	90	1	296
1994	159	101	1	261
1995	176	89	1	266
1996	167	96	1	264
1997	146	116	1	263
1998	160	82	0	242
1999	165	108	2	275
2000	149	79	0	228
2001	170	84	1	255
Total	1497	845	8	2350
Percent	63.70%	35.96%	0.34%	100.00%

## Summary

This section has identified that RLR crashes have been prevalent and severe for at least nine years. IIHS identified that Alabama had the fifth highest RLR fatality among all states, and that Birmingham had the sixth highest rate among U.S. cities. A review of Alabama traffic accident data showed that an average of about 5,300 RLR crashes occurred annually between 1993 and 2001. Over 47,000 people were killed or injured in these crashes. These statistics indicate the need for this project.

## **Section 4**

### **Red Light Camera Pilot Project**

#### **Overview**

In response to a high occurrence of RLR crashes, the Tuscaloosa Department of Transportation volunteered to host a RLR camera pilot project as part of its continued and determined efforts to improve traffic safety in Tuscaloosa. In addition, TDOT volunteered to use its highly developed Traffic Management Center to monitor traffic conditions and to collect data for the project. This section of the report describes how the RLR camera demonstration project was conducted by TDOT and UTCA, with the support of ALDOT.

#### **Selection of RLR Equipment Vendors**

During the first portion of the project, team members identified the desired types of applications (RLR cameras), the desired types of sites, and the types of data to be collected. In the next phase of the project, the cities of Tuscaloosa and Mobile contacted vendors and discussed capabilities and financial options for the equipment. About that time, the State of Georgia enacted RLR legislation, and vendors became more interested in that state than in this project. Consequently, the City of Mobile was not successful in securing a RLR equipment vendor. By August 2001, TDOT identified Precision Traffic Services (PTS) of Austin, Texas as an interested and qualified vendor. The City of Tuscaloosa agreed to install the equipment, and ALDOT agreed to reimburse TDOT's costs and to supply funding to insure PTS's equipment (all PTS equipment and services were provided to the project at no cost).

#### **Site Selection**

Based on crash statistics at intersections and TDOT officials' experiences, three test sites were selected. They were the intersections of Alabama Highway 69 and Skyland Boulevard, Lurleen Wallace Boulevard South and Stillman Boulevard, and Hargrove Road and McFarland Boulevard. The selected sites were adjacent to TDOT traffic surveillance camera locations, which allowed acquisition of additional traffic information while RLR data was being collected by PTS.

At each intersection, one approach was selected for the study. PTS designed a layout for each site using information from TDOT. The PTS installation diagrams and details for each site are provided in Appendix D. The project was designed so that TDOT could rotate the PTS camera from site to site, with a minimum 30-day trial at each location.

## Site Locations and Descriptions

The study sites were located in different areas of the city, on different types of roadways. They were all four-way intersections, but had different speed limits, lane arrangements, traffic characteristics, and traffic volumes.

Site 1 was the intersection of Highway 69 and Skyland Boulevard. The study approach was on Highway 69 southbound, a multi-lane arterial (two left-turn lanes, two through lanes, and one right-turn lane) with a high traffic volume and a speed limit of 55 mph. Highway 69 is a continuation of I-359, an Interstate spur with full controlled access and a speed limit of 65 mph. This is the first at-grade intersection for vehicles that have been traveling at high speed for several miles on I-359, and for vehicles exiting a nearby Interstate highway (I-20/59). The site has experienced a number of high speed crashes, including fatal accidents, over the past few years.

Site 2 was the intersection of Lurleen Wallace Boulevard South and Stillman Boulevard. This intersection is located in downtown Tuscaloosa, and experiences saturated flow conditions in the afternoon peak hour. Lurleen Wallace Boulevard southbound is a multi-lane, one-way arterial (three through lanes, one left-turn lane, and one right-turn lane) with a high traffic volume and a speed limit of 45 mph. Vehicle speeds are controlled by signal system progression. This intersection is an interior intersection in the progression system (i.e. not the first or last intersection in the system), and experiences platoon flow.

The last location, Site 3, was the intersection of Hargrove Road and McFarland Boulevard. The study approach is on Hargrove Road westbound. It is a multi-lane urban minor arterial (one left-turn lane, one through lane, and one shared right-turn/through lane) with a medium traffic volume and a speed limit of 40 mph. It intersects a high volume, divided, multi-lane urban major arterial where the signal is interior to major arterial signal system with two-way signal progression programming. The speed limit is 50 mph. This site allowed RLR study of a minor street approach instead of a major street approach like the two previous sites.

The characteristics of each intersection are summarized in Table 4-1. Figures 4-1, 4-2, and 4-3 show the locations of the study sites and nearby TDOT surveillance cameras.

**Table 4-1 Characteristics of Tuscaloosa study sites**

Characteristic	Site 1	Site 2	Site 3
<b>Intersection</b>	Hwy-69 and Skyland Blvd.	Lurleen Wallace S. Blvd. and Stillman Blvd.	Hargrove Rd. and McFarland Blvd.
<b>Study Approach</b>	Southbound of Hwy-69	Southbound of Lurleen Wallace S. Blvd.	Westbound of Hargrove Rd.
<b>Approach Lanes</b>	5 lanes	5 lanes	3 lanes
<b>AADT (veh/day)</b>	25,000 <sup>a</sup> (65,000) <sup>b</sup>	29,600 <sup>a</sup> (37,200) <sup>b</sup>	8,600 <sup>a</sup> (71,200) <sup>b</sup>
<b>Speed Limit (mph)</b>	55	45	40
<b>Cycle Length (sec)</b>	95	80	120
<b>Amber Duration (sec)</b>	4.0	3.5	4.0
<b>All-Red Duration (sec)</b>	1.5	1.0	1.0

<sup>a</sup> Values are 2002 annual average daily traffic in vehicles per day for the study approach.

<sup>b</sup> Values enclosed in parentheses are 2002 entering volume for the total intersection in vehicles per day.

## Summary

After the research team had defined the types of equipment and sites desired for this project, TDOT secured a RLR camera system vendor as a research partner. Precision Traffic Systems provided its equipment and services at no cost for the duration of the project.

TDOT provided a list of potential sites for the pilot demonstrations. Three were selected by the research team based upon their history of RLR crashes and their varied geometric and traffic characteristics.



Figure 4-1. Site 1 – Highway-69 and Skyland Boulevard

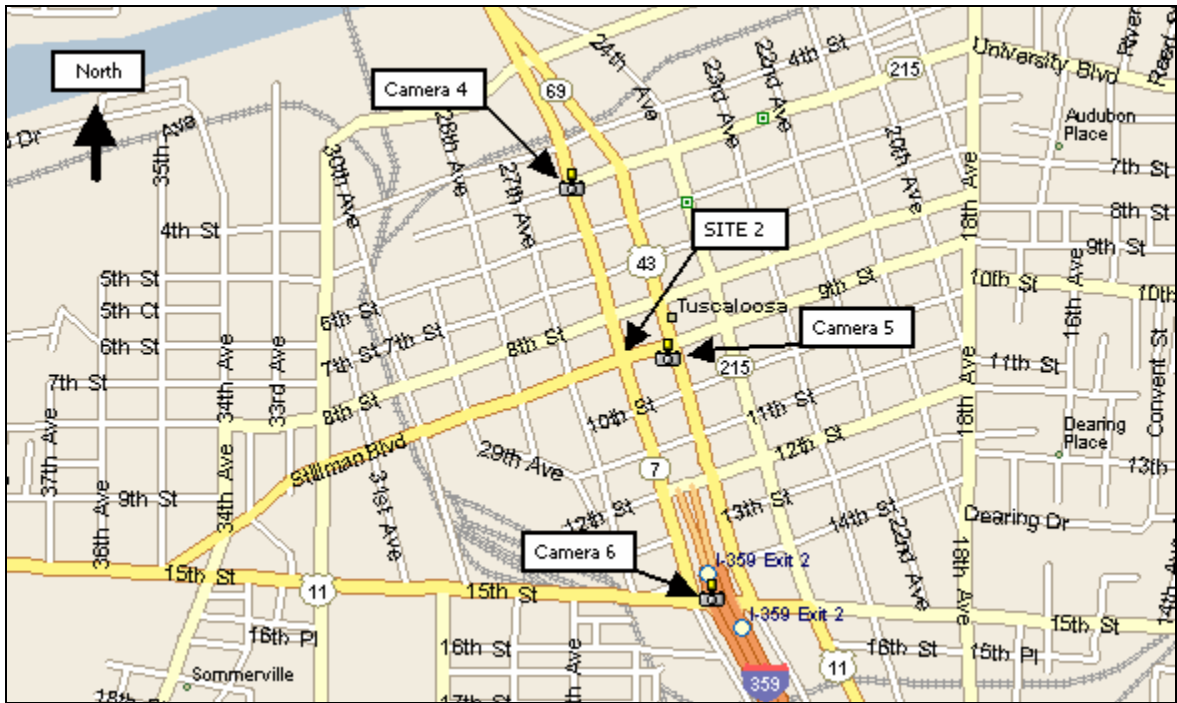


Figure 4-2. Site 2 – Lurleen Wallace South Boulevard and Stillman Boulevard



Figure 4-3. Site 3 – Hargrove Road and McFarland Boulevard

## **Section 5**

### **Overview of PTS System**

This section provides a brief overview of the PTS red light running automated enforcement system. The bulk of this narrative was taken from documentation and specifications provided by PTS.

#### **Equipment**

The Precision Traffic Systems equipment is composed of two major parts, the at-intersection equipment and the web-application data server. The data server is described in more detail later in this section. The at-intersection equipment is composed of a camera and a computer.

In less than one day, an experienced road crew can ready an intersection, including preparing the traffic control cabinet, cutting road loops, and laying wire. The PTS equipment can be installed and configured, including tuning the camera field of view, in the same work day.



**Figure 5-1. Traffic Control Cabinet**

## ***Camera***

The digital camera used by PTS delivers 30-bit true color and 1300 x 1000 pixel resolution. This ultra-high image quality provides remarkably clear pictures of violating vehicles. PTS software can automatically adjust exposure levels to provide high quality images in changing lighting conditions. The camera has a variable zoom lens that allows a range of camera locations that can cover up to three lanes of traffic. The electronic shutter provides excellent reliability, as do the automatic and remotely adjustable exposure settings.

Standard PTS camera features include:

- 30-bit true color,
- Fully digital progressive scan,
- 1300 x 1000 pixel resolution,
- Variable zoom lens (10 mm to 75mm) for range of camera locations,
- Coverage up to three lanes per camera,
- Electronic shutter for better reliability (no moving parts = longer lasting system),
- Automatic and remotely adjustable exposure settings,
- 1/8 inch aluminum enclosure,
- Cooling fan, and
- Glass heating element.

## ***Computer***

The at-intersection computer is enclosed in a case of 1/8 inch aluminum and is double key-locked. The enclosure is mounted approximately three to five feet high on the same pole as the camera. Power, data, and control cables are run to the equipment in the cabinet, and from the computer to the camera.

The software allows the configuration of several parameters during installation. This significantly reduces the time and cost associated with system installation and performance tuning. These parameters include:

- Loop locations by lane,
- Speed limit,
- All red timing,
- “Grace period” after beginning of red,
- Image acquisition timing, and
- Data collection timing (e.g., begin at 8:00 AM and halt at 7:00 PM).

## **Data Analysis**

After the initial installation, it is usually possible for the local traffic engineering organization to periodically move the camera to a new location using its own personnel. Fine tuning of the camera can be accomplished remotely by PTS from its home office in Austin.



PTS offers a powerful yet easy way to use dynamic, Internet browser-based data analysis and reporting application suite. Traffic and violation data, including summary reports, are available immediately. The effects of changes in engineering, signal timing, or enforcement can be analyzed in real time.

Reports are generated on-demand and are updated continuously with data being delivered from PTS controllers at the intersection. Customers can view detailed (up-to-the-minute) data from a single intersection, or consolidated data from multiple intersections in multiple jurisdictions across weeks, months, or years. Figures 5-2 and 5-3 are examples of typical output.

## Summary

The UTCA researchers and TDOT managers found the PTS system easy to install, align, test and operate. In all aspects it operated as advertised. PTS was supportive and efficient throughout the project. For additional discussion of the system components, and for a discussion of installation and maintenance, the reader is referred to Appendix C.

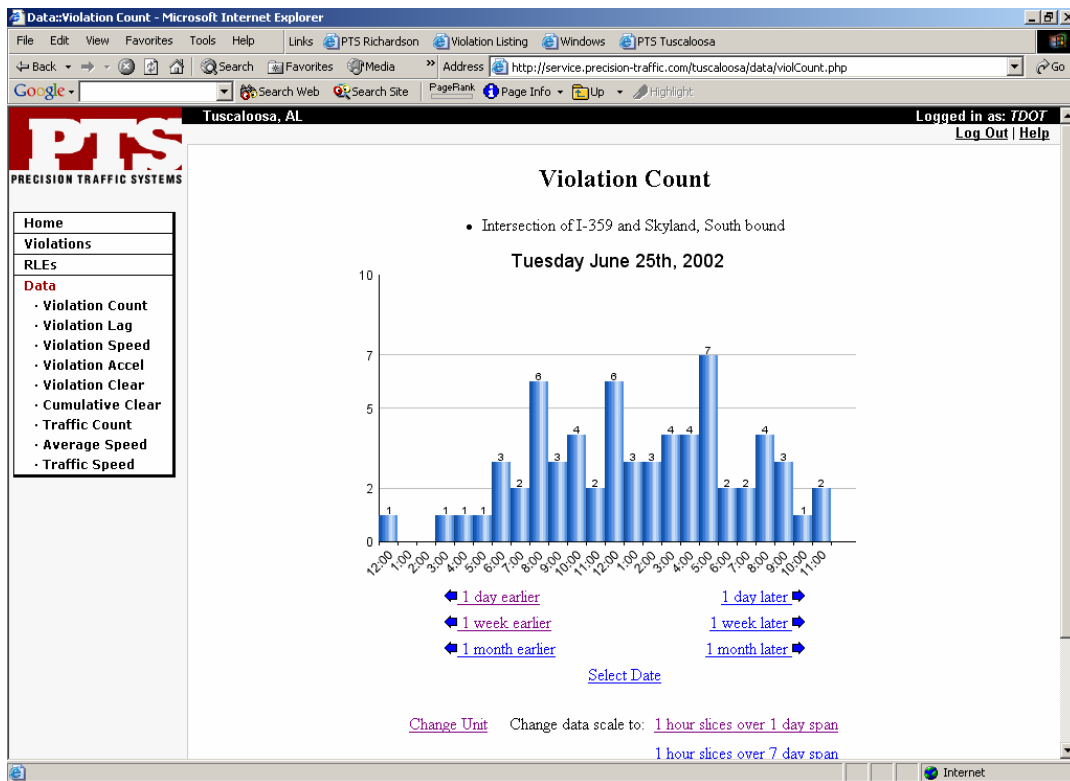


Figure 5-2. Violation count, one hour slices over one day span

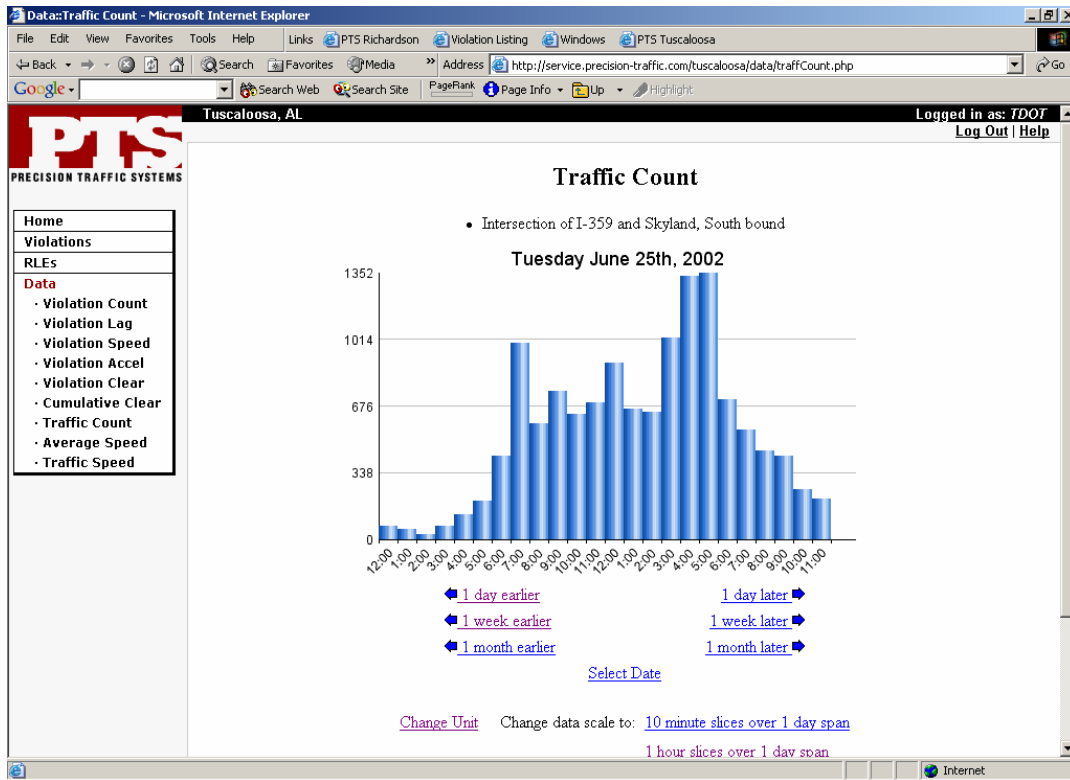


Figure 5-3. Traffic count, one hour slices over one day span

## **Section 6**

### **Investigation of Speed Measurement and System Accuracy**

#### **Overview**

One purpose of this research was to examine the accuracy of RLR camera systems. Since there is no national standard for verification of RLR systems, the researchers devised a test. Speeds measured by the PTS system were compared with two commonly used speed detection devices, an Autoscope and a radar gun.

Autoscope is a video detection system developed by Image Sensing Systems, Inc. It uses machine vision technology to collect traffic data. It can determine vehicle speeds and lengths, traffic volumes, delays, queue lengths, and other parameters at an intersection. It consists of a machine vision processor (MVP) camera, hub-interface panel, hub, and a supervisor computer. MVP creates an advanced video processor that accurately detects vehicles by combining a video camera with an electronic lens control, a digital image processor, and a communications port.

Accurate measurement of vehicle speed is important for red light camera technology. A red light camera system is connected to traffic signals and to speed sensors close to the crosswalk or stop line. The system monitors the approach traffic signal and triggers the camera to photograph the license plates of vehicles entering the intersection after the light has turned red, with a pre-set minimum speed and a specified “grace period” after beginning of turned red. The camera is programmed not to photograph vehicles caught in the intersection when the light turns red. As shown by Figure 6-1, two pictures are taken of a RLR vehicle: one before the vehicle crosses the stop line and a second when the vehicle is in the intersection (Harris 2002). These photographs are used to confirm that the vehicle entered the intersection after the light turned red.

Some cities allow vehicles at some low speed (threshold speed) to pass the detection zone without being considered as running the red light. For example, red light camera enforcement in Oxnard, California, used a minimum travel speed of at least 15 mph as one of the criteria for issuing red light camera citations. This helped to eliminate false detections from emergency vehicles and right-turn-on-red vehicles (Retting, et al. 1999, Oxnard).

A speed-measurement test was conducted as part of the verification of the equipment’s capability. The test and test results are discussed in the section.



**Figure 6-1. Pictures showing a violating vehicle entering the intersection (signal is red)**

Specifications and capabilities of the PTS red light running equipment were obtained from the equipment vendor, and are provided in the Appendix C. However, the most important information concerning the performance of the camera came from actual demonstrations at three study sites in Tuscaloosa. The feasibility of using a red light camera system was largely determined by the results of these demonstrations. One noteworthy part of the demonstration involved thousands of photographs taken by the system. The UTCA research staff and TDOT employees manually reviewed them and concluded that the overall operation of the system was satisfactory, and was as advertised by the vendor.

### **Speed Study Sample Size Determination**

To evaluate the accuracy of speed detection by the PTS system, the sample size had to be large enough to be representative of the population and had to be obtained randomly. Assuming that the samples were normally distributed, a sample size with 95 percent confidence was determined as follows.

$$n = (1.96)^2 \frac{\sigma^2}{e^2} \quad \text{Equation 6-1}$$

Where:  $n$  = sample size  
 $\sigma$  = standard deviation  
 $e$  = tolerance

The standard deviation was assumed to be 5 mph, as most field values for speed studies are close to this. Tolerance in this study was the amount that the speed estimate could vary above or below the actual speeds. The required sample sizes for various tolerances are shown in Table 6-1.

All speed measurement systems have some amount of error. Determination of speeds with absolute precision is exceptionally expensive, and is not necessary for normal traffic engineering

purposes. The key is to ensure that a speed measurement has sufficient accuracy for the intended purpose.

**Table 6-1 Required sample sizes tolerances**

Tolerance (mph)	Sample Size (vehicles)
0.10	9600
0.20	2400
0.33	882
0.50	384
0.67	214
0.75	171
1.00	96

As seen from the table, setting the tolerance as low as 0.10 mph for this study required an enormous sample size of 9,600 vehicles. The researchers concluded that checking PTS speed predictions to 0.1 mph would not be necessary to accurately detect red light violations. If the tolerance was  $\pm 0.5$  mph, the average speed could be determined within one mph (i.e., rounded to the next full mph). This was an acceptable and reasonable accuracy because many police radar units “round down” to the next full integer number. Since the PTS detector is very close to the stop bar, there is not enough time for minor errors in speed measurement to make a substantial difference in the system operation. For example, if the speed of a 40-mph vehicle is in error by 0.5 mph when passing over the PTS detector, then its arrival at the stop bar is only about 0.07 feet, or about 0.001 seconds, different from a perfect measurement. As vehicles travel faster, the difference becomes smaller. Since this project was primarily concerned with high speed RLR situations (which can cause severe collisions), the tolerance of 0.5 mph was reasonable and acceptable. Therefore, the minimum sample size for this test was 384 vehicles.

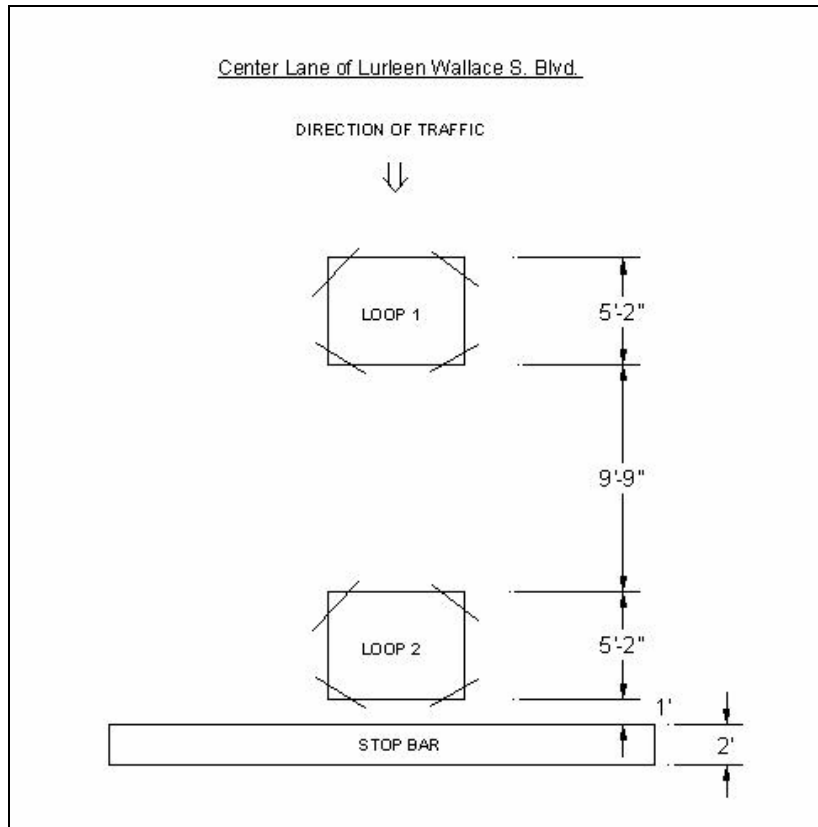
## Data Collection

Data for the speed measurement evaluation was collected at project site 2. The PTS system at this site used dual inductive loops for detection. The inductive loops measure changes in magnetic flux lines as a vehicle travels over the device. The loops also gather traffic volume data and determine vehicle speed and length. The PTS system performance was evaluated against two commonly used speed detection devices, an Autoscope and a police radar gun (KUSTOM HR-12) on October 31, 2002. The speed data were collected on the center lane of Lurleen Wallace South Boulevard for a period of one hour (9:30 a.m. to 10:30 a.m.). The data was gathered by TDOT, UTCA, a police officer, and a PTS system operator.

Prior to the test, TDOT installed an Autoscope about 30 feet from the outside edge of the test lane. Both Autoscope and the PTS system were configured to measure speeds of individual vehicles. The preparation required that all three devices measure the speeds of the same vehicles. Moreover, the speeds had to be measured in the area close to the stop bar where the inductive loops were installed. The layout of the inductive loops at this site is shown in Figure 6-2.

To perform the test safely and to allow a complete view of observed vehicles, the two left lanes were blocked during the test, as shown in Figure 6-3. In addition to human observation, vehicles

were observed and recorded by two TDOT pan-tilt-zoom surveillance cameras and one UTCA video camera.



**Figure 6-2. Layout of the inductive loops on the center lane of Lurleen Wallace South Boulevard**

The speed of every through vehicle was collected by the Autoscope and inductive loops of the PTS system. The officer who operated the radar gun measured the speeds of random vehicles for which he was confident of getting correct speeds. Because the radar gun had to follow a vehicle for some distance to lock onto the speed value, observations could not be obtained for all vehicles passing through the test site. This difference allowed the researchers to obtain speed data in a random manner, as expected in the sampling plan.



Figure 6-3. Layout of the cones blocking the two left lanes

### Statistical Analysis

The data was “cleaned” by carefully matching speeds from all three devices, and confirming that all were obtained from the same vehicles. This was done by reviewing videotapes from the UTCA and TDOT cameras. After speeds were matched, the first 10 minutes of the data were discarded to make sure that the data takers were thoroughly familiar with the procedure and that the test had stabilized. This produced a total of 474 speed observations. To determine whether there were significant differences between the three devices, an analysis of variance was applied using a Repeated Measures Design.

#### *Repeated Measures Design*

This method is applied when multiple observations are made upon the same subject. In this study, the speed of each vehicle (i.e., subject) was detected using three different devices, the PTS detector (inductive loops), Autoscope, and radar gun.

Let  $Y_{ij}$  represents the observation for speed of vehicle  $j$  measured by device  $i$ . The model using a Repeated Measures Design is written as follows.

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \quad \text{Equation 6-2}$$

$i = 1, 2, \dots, p$  and  $j = 1, 2, \dots, r$

Where:  $\mu$  = the grand mean for all 1,422 data values  
 $\alpha_i$  = the fixed effect factor identifying the method of measuring speed,  $\sum \alpha_i = 0$   
 $\beta_j$  = the random effects component identifying the car,  $\beta_j \sim N(0, \sigma_\beta^2)$   
 $\varepsilon_{ij}$  = the random error term, distributed independently and identically,  $\varepsilon_{ij} \sim N(0, \sigma_e^2)$

The Repeated Measures Design analysis of variance procedure is summarized in Table 6-2.

**Table 6-2. ANOVA table for the general repeated measures designs**

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	Ratio
Subjects	$r - 1$	$SS_{Subj}$		
Treatment	$p - 1$	$SS_{Treat}$	$MS_{Treat} = \frac{SS_{Treat}}{(p - 1)}$	$\frac{MS_{Tr}}{MSE}$
Error	$(p - 1)(r - 1)$	$SSE$	$MSE = \frac{SSE}{(p - 1)(r - 1)}$	
Total		$SST$		
<b>Equations</b>				
$SS_{Subj} = p \sum_{j=1}^r (\bar{y}_{.j} - \bar{y}_{..})^2 = \sum_{j=1}^r \frac{y_{.j}^2}{p} - \frac{y_{..}^2}{n}$ $SS_{Treat} = r \sum_{i=1}^p (\bar{y}_{i.} - \bar{y}_{..})^2 = \sum_{i=1}^p \frac{y_{i.}^2}{r} - \frac{y_{..}^2}{n}$ $SST = \sum_{i=1}^p \sum_{j=1}^r (y_{ij} - \bar{y}_{..})^2 = \sum_{i=1}^p \sum_{j=1}^r y_{ij}^2 - \frac{y_{..}^2}{n}$ $SSE = SST - SS_{Subj} - SS_{Treat}$				

Table 6-3 shows the results calculated from the 474 observations, where the  $p$ -values were less than 0.05. Therefore, the mean speed of each device was significantly different from the others, with a level of significance of 0.05.

**Table 6-3. Analysis of variance for speed**

Source	Degrees of Freedom	Sum of Squares	Mean Square	F-Value	P-Value
Device	2	1734.62	867.31	1008.12	0.0000
Time/Vehicle	473	24791.17	52.41	60.92	0.0000
Error	946	813.86	0.86		
Total	1421	27339.65			

### *Least Significant Difference*



The analysis of variance *F*-test was used to test the null hypothesis that all mean speeds were equal. The rejection of this hypothesis suggested that there were differences in mean speeds. However, it did not indicate which pair of mean speeds was different. To identify the pair of mean speeds that was different, the least significant difference test (LSD) for all pair-wise comparisons was applied in the study.

For any pair of mean speeds,  $\bar{y}_i$  and  $\bar{y}_{i'}$ , the least significant difference is calculated from the following equation.

$$LSD(\alpha) = t_{\frac{\alpha}{2}, \gamma} \sqrt{\frac{2(MSE)}{r}} \quad \text{Equation 6-3}$$

The null hypothesis is  $H_0: \mu_i = \mu_{i'}$  is rejected if  $|\bar{y}_i - \bar{y}_{i'}| > LSD(\alpha)$

$$LSD(0.05) = t_{0.025, (946)} \sqrt{\frac{2(0.86)}{474}} = 0.118 \quad \text{Equation 6-4}$$

Table 6-4 shows the results of the LSD test on differences between the mean speeds for the three devices.

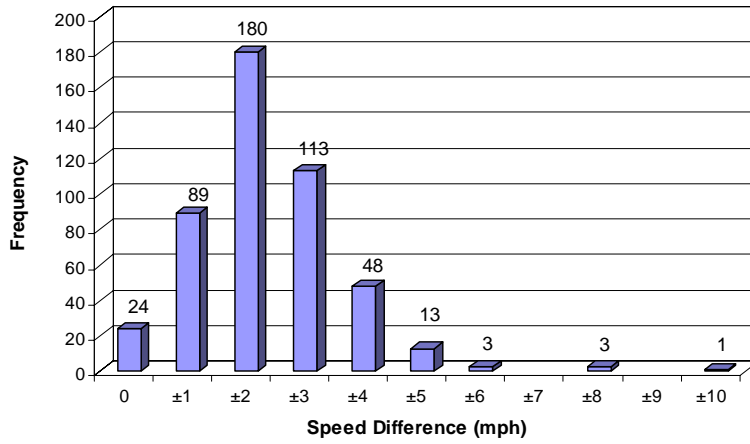
**Table 6-4. Mean speed differences between each pair of devices**

Device	Mean Speed	Device		
		Radar gun	Autoscope	PTS system
Radar gun	22.3		0.3	2.5
Autoscope	22.6			2.2
PTS system	24.8			

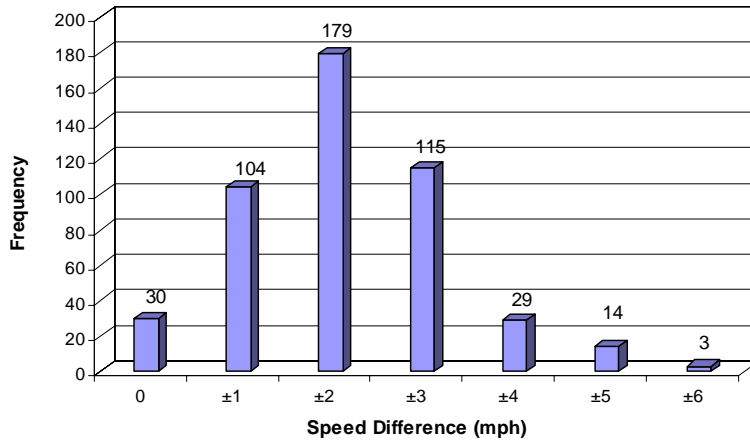
The LSD analysis indicated that the mean speeds from each pair of devices were significantly different from the others, as shown in Table 6-4. The frequency distributions of speed difference for each pair of devices are shown in Figure 6-4.

When compared to the other two devices, most vehicles had speed differences of  $\pm 2$  mph for the PTS detector,  $\pm 1$  mph for the Autoscope, and  $\pm 1$  mph for the radar gun. Moreover, 96 percent of the speed differences were within  $\pm 4$  mph for PTS detector and the other devices, and 97 percent were within  $\pm 3$  mph for the Autoscope and the radar gun. These speed differences were examined to evaluate the effects of speed errors in detecting red light violations.

(a) RLR System Versus Autoscope



(b) RLR System Versus Radar Gun



(c) Autoscope Versus Radar Gun

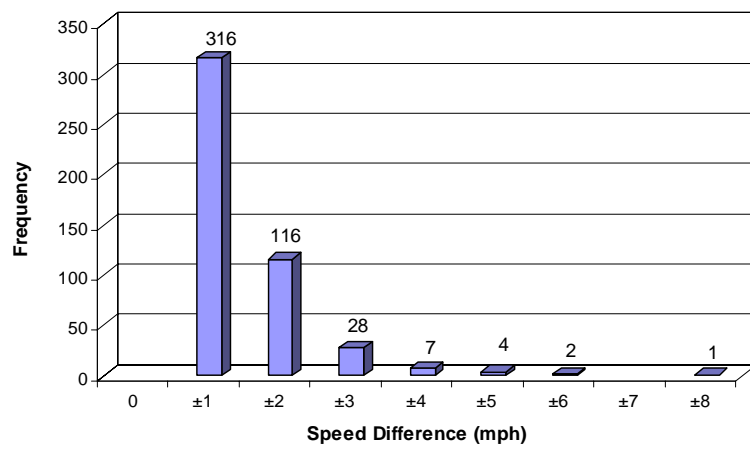
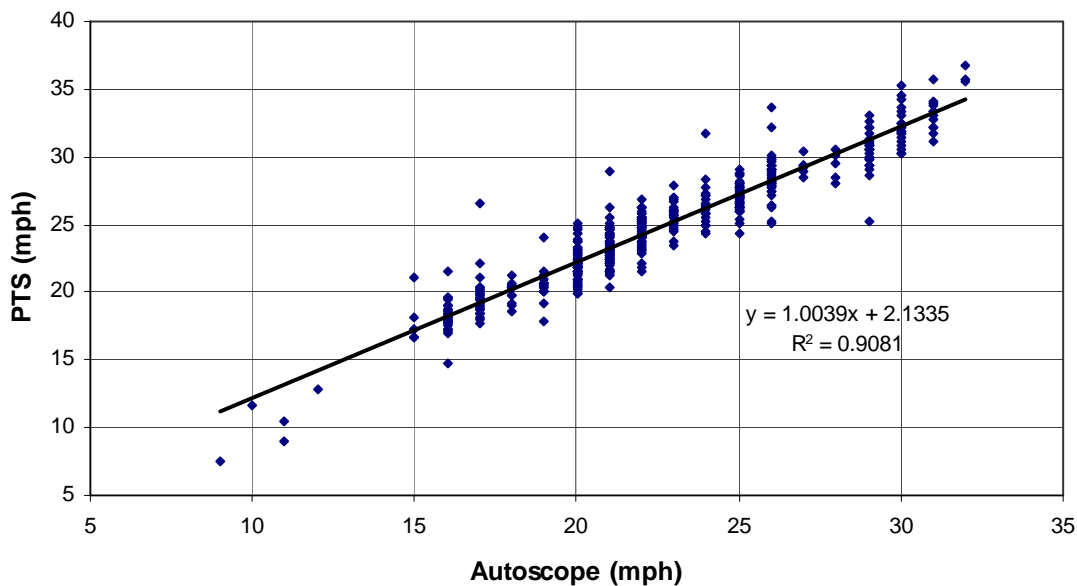


Figure 6-4. Frequency distributions of speed difference for (a) RLR system vs. Autoscope, (b) RLR system vs. radar gun, and (c) Autoscope vs. radar gun

### ***Simple Linear Regression/Correlation***

The PTS red light running system employed inductive loops for speed detection. To operate the system, the inductive loops have to be buried under the pavement. At an intersection where the inductive loops have not already been installed, one might think that the Autoscope could serve as an alternative to the inductive loops to detect vehicle speeds, considering the ease of installation and flexibility in mounting locations. A regression analysis was conducted to determine the correlation and relationship between PTS inductive loops and the Autoscope.

The speeds detected by PTS and Autoscope are plotted in Figure 6-5, along with the best fit of a least-squares regression. The correlation coefficient is 0.953, indicating a very strong correlation between the inductive loops and the Autoscope. Even though the LSD test showed that the mean speeds measured by the PTS detector and the Autoscope were significantly different, the regression equation showed that the speeds from the PTS detector and the Autoscope had a positive correlation. The relative change in the PTS detector due to the Autoscope was 1.004, which was not significantly different than 1.00.



**Figure 6-5. Regression of PTS against Autoscope speed measurements**

### **Analysis of Differences in Speed Measurements**

As discussed before, the RLR system monitors the traffic signal and triggers the camera to photograph the license plates of vehicles entering the intersection after the light has turned red. Two pictures are taken of each “violating” vehicle; one before the vehicle crosses the stop line and a second when the vehicle is in the intersection. Example photographs were shown previously in Figures 6-1.

Each inductive loop detects the presence of the vehicle passing over the loop. Then the difference of time that the vehicle is detected at each loop and the known distance between two loops is used to determine speed. Figure 6-2 showed the two inductive loops at this study site. The lengths of detection between two loops are compared to determine if the vehicle is accelerating or decelerating. However, only the speed is used to trigger the camera to take the photographs. The RLR system uses the speed measured by Loops 1 and 2, and the distance between Loop 2 and the stop bar to calculate the times to take the photographs.

The PTS system is extremely fast. The key loop (2) is very close to the stop bar. The system “senses” the vehicle, calculates the speed, determines whether the vehicle is a violator, calculates the time to take the photographs, and triggers the camera while the vehicle travels about six feet. At 40 mph the elapsed time is about a tenth of a second.

If the system miscalculates the speed, and the first photograph is taken after the vehicle passes the stop bar, this is not considered a red light violation because it can not be proved that the light was red before the vehicle broke the plane of the stop bar. This situation happens when the calculated speed is less than the actual speed. In that case, the red light running system triggers the camera later than it should. On the other hand, if the calculated speed is higher than the actual speed, the RLR system will trigger the camera too early. However, the latter case is not a problem for issuing citations because the first photograph shows that the signal is red before the vehicle crosses the stop bar.

The effect of any error in detected speed was analyzed by considering how the error affected the location of the vehicle when the first photograph was taken. Multiple speeds were used in the analysis. All calculations assumed that drivers maintained constant speed through the intersection.

At the tested site, the distance from the front of Loop 2 to the beginning of the stop bar was six feet and two inches. Consider a vehicle traveling 60 mph (88 feet/second) and that the vehicle will run the red light. The system will calculate that 0.07 seconds are needed to cover the loop-stop bar distance, so the camera uses that time to trigger the photograph. If the red light running system detected a speed of 55 mph (5 mph error), the system will wait 0.08 seconds before triggering the camera. The difference of 0.01 seconds for a 5 mph error will place the vehicle 0.6 feet (7 inches) into the stop bar. However, the stop bar is two feet wide. Even though the vehicle was photographed at 0.6 ft into the stop bar, it is still a red light runner because it had not completely crossed the stop bar before on-set of red.

This type of analysis was applied to various speeds to determine how much error it would take for the RLR system to mistakenly identify a compliant vehicle as a violator (or vice versa). Maximum errors for various speeds are presented in Table 6-5.

The “maximum error” was found to be 24.5 percent, regardless of a vehicle’s speed. For example, if a vehicle was traveling at 60 mph but the system detected a speed of 45.3 mph, the first photograph would still show the vehicle within the stop bar. Only if the error was greater than 24.5 percent (i.e., speed was less than 45.3 mph) would the vehicle cross the stop bar and enter the intersection before having the initial photograph taken.

**Table 6-5 Max error for various speeds**

Speed (mph)	Maximum Allowable Error (mph)
20	4.9
30	7.3
40	9.8
50	12.2
60	14.7
70	17.1

In effect, the detection occurs so close to the stop bar that great accuracy is not required. At the TDOT location in this project, speed detection by the PTS system was quite good, especially considering the rapidity with which the speed is acquired and used to trigger the camera. Certainly, it was sufficient to ensure accuracy of citations that could have been issued with the system.

There is an additional consideration. For this pilot study, a “grace period” of 0.2 seconds was used prior to identifying a RLR violation. This cushion is far greater than any inaccuracy in speed measurement.

### ***Manual Examination of Photographs***

Yet another consideration involved examination of more than a thousand RLR violation photographs by the researchers during the project. These confirmed the successful operation of the system.

### **Sources of Variation in Speed Estimation**

There were several potential sources of variation during the test. Considerations that affect the interpretation of test results are described below.

There were several potential sources of variation during the test. These included possible misalignment during installation of the inductive loops and the Autoscope, traffic pattern differences, characteristics of the radar gun (i.e., takes time to reset between readings, identifies speed of largest vehicle in field-not the closest vehicle, must be aimed accurately), human error in recording values, and differences in data reporting among the three measurement devices (significant digits, round off, round down, etc.) by the separate devices. Some of these potential sources, such as installation of the loops and Autoscope, could be investigated and dismissed. Others could be investigated and quantified, such as the differences in data reporting. But, some could not be precisely quantified - human recording error is a good example.

### ***Effect of Variation***

Undoubtedly, these sources of variation exerted some effect upon the results of this study. It is possible that they could account for the statistically significant differences in the speed measurements of the three methods.

However, the major finding of the speed study – importance of proximity of the inductance loops to the stop bar – overwhelmed the influence that these variations might have had on the purpose of the study. Simply stated, the proximity allowed errors of up to 24.5 percent in speed measurement before incorrectly identifying the RLR situation. This value is much greater than any realistic variation that could have been created by all of the above sources.

### **Summary**

Comparisons of speed measurements by a PTS system, Autoscope, and radar gun were used to evaluate speed estimation by the PTS system. At a 95 percent confidence level, the speed measurements of the three devices were significantly different. Even with these differences, 96 percent of the observed vehicles had speed differences within only  $\pm 4$  mph for the PTS detector and the other devices. Several factors were identified as potential sources of variance during the test. Although they could have influenced the findings, it was not necessary to analyze these factors.

The primary finding of this study was that the speed detection inductance loops for the PTS system were so close to the stop bar that the system was relatively insensitive to any errors in speed measurement. The statistically significant difference between the three speed measurement devices was inconsequential to the red light system's ability to properly detect and photograph violators. The finding was so strong that researchers concluded that it was not necessary to isolate and analyze the exact degree of influence of several potential sources of variability in the test.

A comparison of PTS system speeds to Autoscope speeds through a regression analysis suggested that the two sets of measurements were very close (i.e., a nearly unitary slope was observed along with a high R-squared value). The results indicated that Autoscope yields speed data of comparable quality to the PTS system, and that Autoscope can be used as an alternative to inductive loops for RLR automated enforcement purposes.

Automated RLR enforcement equipment is proprietary, and the methodologies, software and hardware vary from vendor to vendor. Detectors for the PTS equipment used in this study were located very close to the stop bar, so the study findings are limited to the PTS system, and to systems employing similar methodologies.

A second major conclusion from this part of the study came from the researchers' review of thousands of RLR photographs generated by the PTS system. The involved researchers developed a high degree of confidence in the system, and complete respect for its ability to identify RLR violators. This confirmed the accuracy of the PTS speed measurement system.

## **Section 7**

### **Analysis of Tuscaloosa Red Light Violations**

#### **Overview**

One objective of this project was to determine the extent and characteristics of red light running in Alabama, and to provide a better understanding of the situation so that efficient prevention programs could be devised. This section of the report describes the data analysis and findings directed toward this objective.

#### **Data Collection**

Red light violation data and traffic data were collected by the PTS equipment, and stored in a database at the PTS home office. For each violation, the data record included items like the location, approach direction, violation date and time, speed and time-since-red of the violating vehicle, two digital photographs, and other items. PTS created a Web site for TDOT that displayed routine time plots of traffic volumes, speeds of violators, times-since-red of violators, etc., in ten-minute increments. When needed for this project, the research team requested additional data plots, additional features, and raw data (in several specific formats). PTS was responsive, thorough, and prompt in meeting these requests.

This portion of the research was directed at only violation rates and characteristics. No attempt was made to evaluate the effectiveness of the red light camera in reducing violations or RLR-related crashes, because it was not possible to give citations during the demonstration period. (The potential reduction is estimated in a later section of the report).

The three study sites provided a good variety of speed limits, traffic volumes, traffic flow patterns, street functional classifications, and intersection geometry. Descriptions of the test intersections and equipment installation diagrams may be found in Section 4 and Appendix D. Primary data items were obtained through the PTS system, which used Microloops for speed detection at Site 3 and inductive loops at the other two sites. Data were collected and recorded 24 hours per day at each site. The PTS equipment was available for slightly more than a year. It was operational about 80 percent of the time, including time lost in rotating it from site to site and additional time devoted strictly to research tests.

#### **General Observations**

Key information about the sites and the data collection is summarized in Table 7-1. Two key observations are readily apparent in the table. First, large volumes of traffic and violations were observed: 2.7 million vehicles and over 13,000 violators. Second, the violation rates showed extreme variation between the three sites.

The violations shown in this table are raw data. About 7.2 percent of the violations fell within the 0.2 second grace period, and would not have received a citation under the criteria applied during this study.

**Table 7-1. Summary of site locations and data collection**

Site	Intersection Approach	Observation Period	Vehicle Passages	*Number Violations
1	Two through lanes southbound on Highway 69 at Skyland Boulevard	May 6 to July 8, 2002	586,947	2,270
2	Three through lanes southbound on Lurleen Wallace Boulevard South at Stillman Boulevard	August 1, '02 to Jan 2, '03	1,858,998	1,019
3	One through lane and one shared (right + through) lane westbound on Hargrove Road at McFarland Boulevard	Feb 28 to May 17, 2003	280,116	10,358
Totals	All three sites	May 6, '02 to May 17, '03	<b>2,726,061</b>	<b>13,647</b>

\*Violations are raw data; no grace period was applied.

The camera was in place for different parts of the year and for different lengths of time for the three sites, which complicated comparative analysis. For further analysis, the research team selected representative data sets covering 28-day periods for each intersection. This provided 84 days of data, with more than 4,600 violations observed.

As the next step in the analysis, RLR rates per 1,000 vehicle passages were computed for each study approach. This volume-based rate has been used in many studies, as discussed in the literature review. Next, various tabulations and graphs were prepared to examine factors associated with red light running (time of day, day of week, speeds of violators, time-into-red, etc.) to help identify RLR characteristics and patterns. Examples of the graphs developed during this analysis may be found in Appendix E. Table 7-2 summarizes the number of violations, number of observed vehicles, and violation rates for each site, based upon the 28-day day samples.

**Table 7-2. RLR rates at study sites (28 day duration)**

Site	Number of Violations	Total Observations	Violations per 1,000 vehicles
Site 1	1,030	282,930	3.6
Site 2	223	473,046	0.47
Site 3	3,392	116,046	29.0
Total/Average	4,645	872,022	5.3

There was extreme variability in RLR rates. They were as low as 0.47 violations per 1,000 vehicles (Site 2, progressive signal system, moderate speed, much platoon flow), and as high as 29.0 (Site 3, moderate flow, minor arterial crossing high flow primary arterial, high right turn volume). This variability is not unusual. The literature review identified research at thirteen intersections in Iowa with RLR rates ranging from 0.45 to 38.50 violations per 1,000 vehicles (Kamyab, et al. 2000). The Iowa findings were very similar to the findings of this study.

The speeds of violating vehicles are shown in Table 7-3. It is interesting that at two of the sites, all violators in the 28-day samples entered the intersections below the speed limit. This was not anticipated. At the site with the lowest speed limit, the maximum violation was almost 20 mph above the speed limit.



**Table 7-3. Summary of violators' speeds, in mph (28 day duration)**

Site	Number	Mean	Median	Std Dev	Minimum	Maximum	Speed Limit
Site 1	1,030	31.68	34.4	10.17	6.7	54.1	55
Site 2	223	23.86	16.1	13.04	12.1	62.3	45
Site 3	3,293	10.54	9.7	3.57	7.8	39.7	40

### **Analysis of Individual Sites**

Many conclusions were drawn from on-site observations, examination of tabulations and graphs prepared during the analysis, and review of photographs of violations. Representative conclusions are listed for each site in the following paragraphs.

#### ***Site 1 – Highway 69 and Skyland Boulevard***

The intersection approach is characterized as high volume, high speed (55 mph speed limit) multilane primary arterial, with drivers transitioning from Interstate highways. The approach is slightly downhill with a long sight distance.

- A total of 282,930 vehicles and 1,030 violations were observed in 28 days. This equates to an average of 3.6 violations per 1,000 vehicles or 1.5 violations per hour.
- The violation rate is similar to those in other cities, as shown by the literature review (Table 2-3).
- When a 0.2 second grace period is used, only 74 percent of the violators (759 vehicles) would have received a citation.
- When a 0.2 second grace period is applied, the average violation rates drop to 2.7 per 1,000 vehicles or 1.1 per hour.
- The afternoon was the highest violation period (noon through 7:00 p.m.).
- About 83 percent of violators entered during the all-red interval (first 1.5 seconds of red indication on their approach).
- About 17 percent of violators entered the intersection after the all-red interval had ended. At this point, the conflicting traffic flow is starting and the probability of a collision is much higher.
- Most of the blatant RLR violations (more than ten seconds into red) occurred during the noon hour and in late afternoon (2:00 - 4:00 pm).

- Even though this is a high-speed approach and drivers had just left Interstate highways, only 6.2 percent of traffic (and no red light violators) entered the intersection above the limit. This is a surprising but positive finding.

### ***Site 2 – Lurleen Wallace Boulevard South and Stillman Boulevard***

The intersection approach is characterized as one-way, urban multilane, very high volume, moderate speed (45 mph speed limit), with a high degree of platoon flow in a progressive signal system.

- Overall, 473,046 vehicles and 223 violations were observed in 28 days. This equates to an average of 0.47 violations per 1,000 vehicles or 0.34 violations per hour.
- The violation rate is very low, but a few similar locations were identified by the literature review (Table 2-3).
- When a 0.2 second grace period is used, about 92 percent of the violators (206 vehicles) would have received a citation.
- When a 0.2 second grace period is applied, the average violation rates drop to 0.44 per 1,000 vehicles or 0.3 per hour.
- The afternoon was the highest RLR violation period (2:00 - 6:00 p.m.).
- For violators entering the intersection three or more seconds into red, the great majority were traveling at or below 20 mph. Almost all speeds faster than 20 mph were emergency vehicles or very-high-speed violators.
- Most violators were traveling between 13 and 16 mph.
- Of the three test sites, this was the only one with any violators above the speed limit.
- Speeds are controlled by signal system progression, but 31.8 percent of violators and 95.2 percent of all traffic had speeds above the speed limit.

### ***Site 3 – Hargrove Road and McFarland Boulevard***

The intersection approach is characterized as urban, multilane, minor arterial, with moderate speed (40 mph speed limit), joining a major arterial in a popular commercial shopping location.

- A total of 116,916 vehicles and 3,392 violations were observed in 28 days. This equates to an average of 29.0 violations per 1,000 vehicles or 5.0 violations per hour.
- The violation rate was extremely high, but similar rates have been reported in the literature (Table 2-3).

- When a 0.2 second grace period is used, 96 percent of the violators (3,259 vehicles) would have received a citation.
- When a 0.2 second grace period is applied, the average violation rates drop to 28.1 per 1,000 vehicles or 4.8 per hour.
- There were no sharp daily peaks in violations at this site. The greatest number of violations occurred between 10:00 a.m. and 7:00 p.m. This might possibly be related to the commercial nature of the location.
- Most violators were in the 8 to 14 mph speed range.
- As indicated previously, no violating vehicle entered the intersection above the speed limit.
- Two unusual characteristics were noted: (1) some violations occurred with extremely high time-since-red values (100 or more seconds), and (2) this intersection approach experienced a very high right-turn-on-red (RTOR) volume.
- Virtually all violations with extreme time-into-red values occurred during late night, and most of them had speeds less than 15 mph.
- The research team determined that the extreme time-into-red values were a function of the signalization. McFarland Boulevard utilizes a “time of day” signalization plan with signal progression (120 second cycle) between 6:30 a.m. and 10:00 p.m. For the remaining portion of the night, it operates in a fully actuated mode. In the absence of traffic on Hargrove Road, the green indication “rests” on McFarland Boulevard. During late night it is possible that no vehicles used the study approach for several minutes. A vehicle that executed a RTOR without stopping would be recorded as a violation with an extreme time-into-red value.
- A very high percentage of vehicles were executing RTOR maneuvers, and right-turn violations far outnumbered through-vehicle violations. 98 percent of all violations were RTOR.
- The characteristics of this site encouraged RTOR without stopping: intersection geometry (30-foot curb return); good sight distance; the commercial nature of the site, with many commercial driveways and associated congestion; and driving pressure due to the large traffic volume carried by McFarland Boulevard.

### **Comparison of RLR from Site to Site**

In planning this study, the research team anticipated that a comparative analysis of the three sites would identify quantifiable characteristics associated with RLR. Knowledge of such

characteristics would be useful in targeting enforcement activities, selecting traffic operations improvements, and conducting public awareness campaigns. Toward that end, tabulations and plots were prepared for a wide range of parameters from the three sites. A sample is shown below in Figure 7-1, and additional examples are included in Appendix E.

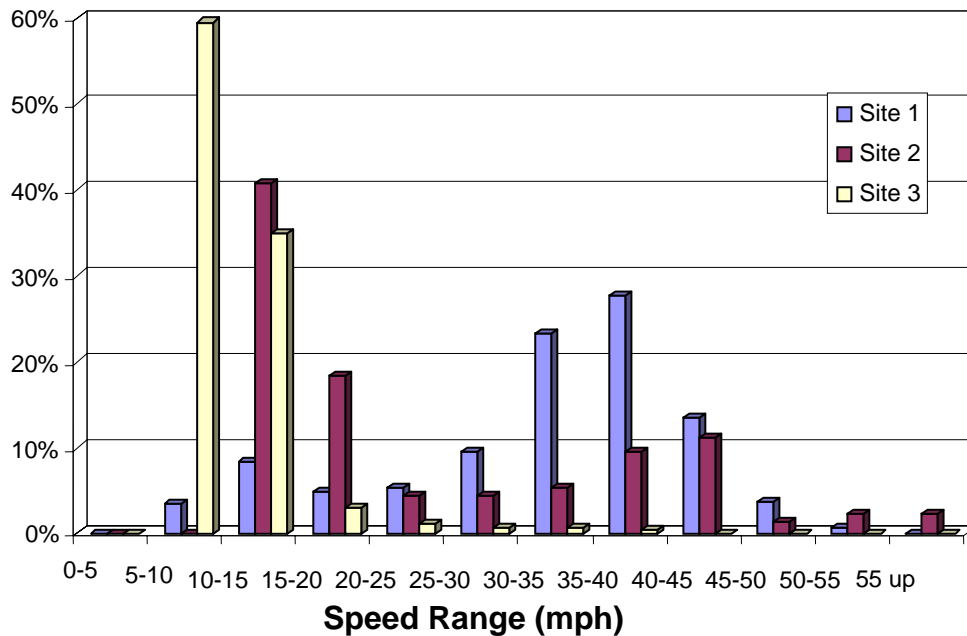


Figure 7-1 Three site comparison of violation speeds

It is easy to note from the figure that there is no strong common speed characteristic for the three sites. The same conclusion was drawn from investigation of many additional parameters. The research team concluded that it was not possible to identify and quantify characteristics associated with RLR from the data generated by this study. That means that either RLR is location dependent (i.e., a function of each specific site), or a much larger database is needed to generate statistically significant characteristics of RLR.

### Right Turn on Red Analysis

Automated RLR enforcement systems typically have difficulty handling right-turn-on-red vehicles on a multilane approach. The outside lane used by a RTOR vehicle is at the extreme edge of the camera field. The violator might be completely out of the field for the second photo (intended to show the violating vehicle clearly in the intersection during the red phase). It is especially difficult to photograph a vehicle executing a RTOR at high speed, and the higher the speed, the more likely the vehicle will be involved in a traffic crash.

The literature review found that RTOR vehicles are often excluded from automated RLR enforcement programs. This is due to the difficulty noted in the last paragraph and fact that the RTOR is a merge movement (minor conflict) with cross street traffic. Minor conflicts are less

likely to cause crashes than major conflict maneuvers (crossings or left-turns) through cross street traffic.

As noted in Section 2 of this report during the discussion of the Alabama Code, right turning vehicles entering an intersection on red without stopping at the stop bar are considered red light violators. The research team decided to investigate Site 3 to determine if it was feasible to cite RTOR violators.

One important capability of the PTS system is that it can be programmed to evaluate RTOR vehicles and to treat them separately from through vehicles. Section 6 of this report noted that some jurisdictions allow RLR vehicles below some low (threshold) speed to enter the intersection without being cited (e.g., 15 mph in Oxnard, California and Fairfax, Virginia). The 15 mph criterion was used to eliminate false detections from emergency vehicles and RTOR vehicles.

A total of 34 days of PTS data for Site 3 were analyzed to determine if two photographs were available for each vehicle executing a right-turn-on-red maneuver. Overall, 2,925 RTOR vehicles were identified, and a speed profile was prepared to find an appropriate speed threshold for this site (Figure 7-2).

The PTS system allows an interested traffic engineer or local law enforcement official to determine a site-specific speed threshold for citing violators. The photos also allow law enforcement officials to disregard violations by emergency vehicles. In this case, the researchers determined that RTOR vehicles entering the intersection at speeds above 12 mph would be identified as red light violators. About 88.5 percent of the RTOR vehicles would have been discarded from the database (no citation). No matter what speed threshold is used to discard RTOR vehicles, some legitimate red light violations will also be discarded. However, the main concern with automated red light enforcement is not citing every violator; it is improving safety. Reducing the number of high-speed RLR violators and far-into-red violators is the key to safety, so the research staff felt that there was no need to select a threshold speed any lower than 12 mph for this site.

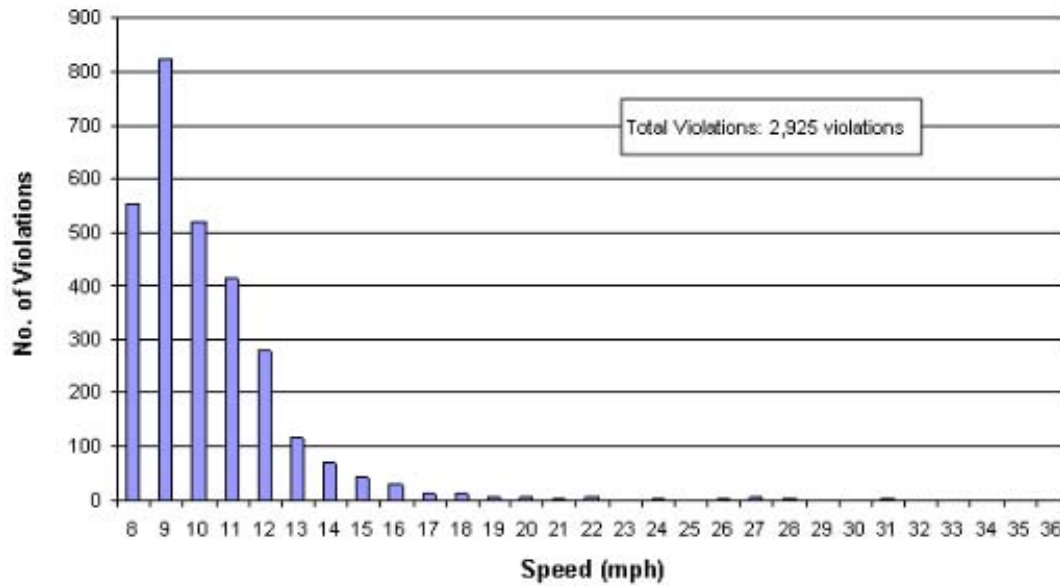


Figure 7-2. Speeds of RLR violators executing right-turn-on-red at Site 3

### Analysis of Change Interval and Clearance Interval

The technical literature indicated that RLR is affected by signal timing, especially by the length of yellow time and all-red time on signal approaches. The yellow interval provides a legal option for drivers who are too close to the intersection to stop when yellow begins. The interval should be long enough to allow drivers to make an appropriate driving decision (stop, or continue through the intersection before red) and to execute that driving maneuver. The all-red interval provides a safety factor by allowing RLR vehicles to pass through the conflict zone before cross street traffic enters the intersection.

Longer change intervals allow drivers more time to make the go-no go decision and generally increases safety. However, there can also be an unintended “catch 22” effect that diminishes safety. Drivers that use the intersection repeatedly recognize that the yellow phase is long and are more likely to try to squeeze through on yellow. For example, a very safe driver may make a sudden stop when yellow first appears, then sit at the long yellow while cars in the adjacent lane pass safely through the intersection. The very safe driver is apt to keep going the next time that yellow appears and violate the red.

Bonneson, et al. (2002) conducted a before-after study in five Texas cities to determine the effect of increasing the length of the yellow change interval as a RLR countermeasure. His study found that a properly timed yellow change interval could decrease the frequency of RLR violations by at least 50 percent. He also confirmed that over time drivers adapted to the increase in yellow change interval.

Green (2000) looked at RLR caused by deliberate driver action, by poor driver estimates of speed/distance, and by distracted drivers. She concluded that extending the all-red clearance

interval might not be a reasonable countermeasure for all types of red light running. At her study sites, drivers appeared to know the length of current all-red clearance intervals and used them as an extra opportunity to get through the intersection.

*The Urban Transportation Monitor* (2001) performed a nationwide survey of the opinions of city traffic engineers about all-red clearance intervals. Survey respondents felt that more and more drivers were using the yellow change interval as part of the green interval. They also felt that after drivers became accustomed to the all-red interval, they used it as an extension of the yellow change interval. Driver expectancy was that the all-red clearance interval would protect them.

The Institute of Transportation Engineers (ITE) and others recommend that the change interval length be tied to the approach speed, and that the maximum change interval be limited. The *Manual on Uniform Traffic Control Devices* (MUTCD) recommends a range of three to six seconds for the yellow change interval. However, five seconds is used in some jurisdictions as a practical maximum for the yellow change interval (Roess, et al, 1998). There is guidance in the MUTCD and in publications like the *ITE Traffic Engineering Handbook*, but there is no national standard practice for determining the duration of change or clearance intervals. The ITE formula for calculating the sum of change plus clearance intervals is given in Equation 7-1.

$$Y = t + \frac{S_o}{2a + 64.4g} + \frac{w + L}{S_o} \quad \text{Equation 7-1}$$

where,

- $t$  = driver reaction time, sec (1.0 second)
- $S_o$  = initial approach speed of vehicle, fps
- $a$  = deceleration rate of vehicles, fps<sup>2</sup> (10 fps<sup>2</sup>)
- $g$  = grade of approach, expressed as a decimal

The characteristics of the three study sites were used to calculate change and clearance intervals. The results of the computations are presented in Table 7-4, which shows that the sums of the intervals for the ITE method were longer 5,29, and 53 percent longer than the intervals used at the TDOT sites. This does not mean that the existing TDOT settings are not appropriate or not safe. The ITE formula is a general guide, and practitioners often modify it to fit specific local site conditions.

**Table 7-4. Analysis of change and clearance intervals**

	Site 1	Site 2	Site 3
Average Speed (mph)	28.0	41.6	17.5
Speed Limit (mph)	55	45	40
Grade of approach	- 3%	0%	0%
Current change interval at study approach (sec)	4.0	3.5	4.0
Current clearance interval at study approach (sec)	1.5	1.0	1.0
Current change + clearance intervals (sec)	5.5	4.5	5.0
ITE formula, change + clearance intervals (sec)	5.8	5.8	7.6
Ratio: ITE to TDOT (change + clearance intervals)	105%	129%	152%

For one thing, the ITE clearance interval is sensitive to slow traffic crossing wide intersections (i.e., it takes a long time for a slow vehicle to “clear” an intersection by driving across six or

eight lanes). That is why the ITE recommendation for Site 3 is so large. It is also why traffic engineers evaluate each site prior to selecting signal parameters.

Adopting the ITE values usually results in less violations; however, there is a price to pay. Extending the yellow and all-red times reduces the amount of green time available to carry traffic (i.e., capacity is lowered). McFarland Boulevard is a very busy arterial carrying a very large volume of traffic. Adopting the ITE value at Site 3 could reduce the signal green time for both streets, so that about five seconds of green would be lost during each cycle. Although this does not sound like much, it means that several hundred additional vehicles will be stopped by the signal during the peak hour and that average delay will increase significantly. Although longer yellow and all-red phases may be a good way to help reduce violations, traffic engineers must make discretionary decisions about the levels of congestion and safety at individual intersections before lengthening the yellow and all-red intervals.

## **Summary**

This section documented the analysis of red light running at three sites in Tuscaloosa, Alabama. RLR violations were found to exist at a substantial level, with a high degree of variability from site to site. No common RLR characteristics were identified that could be used to predict violation rates.

Two interesting side studies were conducted. Researchers noted that 98 percent of violators at Site 3 were executing right-turn-on-red maneuvers. Photographs of about 3000 violators were examined, and a plot of violation speeds was used to select a “grace cushion” speed below which vehicles would not be cited. The second side issue involved the lengths of yellow and all-red signal phases at the three test sites. The literature review indicated that increasing yellow discouraged RLR violations, but that the effect diminished over time as local drivers became used to the longer phases. The lengths of yellow and all-red phases at the Site 3 fell considerably below the phase time recommendations of ITE, but an investigation found that the moderate approach speeds and wide intersection made the ITE recommendation impractical. This reinforced the need for local traffic engineers to use discretion in modifying yellow and all-red phases to address RLR problems.



## Section 8

### Adoption of a RLR Camera System

#### Planning and Implementing a RLR Camera Program

A RLR camera system is one of many countermeasures that can be applied to mitigate red light safety problems. Cameras are effective, in the right situations, but should not be installed until the problem location has been studied and other countermeasures have been considered.

Installation of RLR cameras should be accomplished through a careful sequence of actions. Tables 8-1 through 8-3 illustrate that point. They are similar even though different researchers and different organizations prepared them. The recommended work steps cover the same general topics even though the level of detail is different.

The University of North Carolina began conducting extensive RLR research in late 1998, and concluded in 2001 that, “We have found that red light cameras are indeed an effective tool in certain situations, when properly implemented” (Milazzo, Hummer and Prothe, 2001). They noted that the program in Charlotte was a good role model for both North Carolina and the nation. The North Carolina researchers suggested that camera enforcement should not be the initial response to a RLR problem, and recommended an eight-stage process for implementing red light running countermeasures (Table 8-1).

The ITE recommendations in Table 8-2 were taken from a publication that overviewed several types of automated enforcement, including red light running, speeding, highway-railroad grade crossing, and high-occupancy vehicle and bus lane violations (ITE, 1999). It addressed development of a successful program, legal issues, public acceptance, and experiences of agencies that have used automated enforcement.

The information in Table 8-3 was taken from a recent FHWA state-of-the-practice web publication (FHWA and NHTSA, 2003). It is the most comprehensive of the three publications used to develop this section of the UTCA report.

#### First Steps in Implementation

A RLR camera program typically begins when an informed individual decides that intersection safety is important and needs to be improved, and begins to build consensus about addressing the problem. Typically, this involves documenting the problem (developing and using safety data that clearly illustrate the safety problem), encouraging other safety officials to join the effort, building public awareness, and planning a program. Once some agency commits personnel and funds toward a RLR project, there are three initial steps:

- Establish an advisory or oversight committee
- Establish objectives
- Determine legal requirements

**Table 8-1 RLR system Implementation**  
(Milazzo, Hummer and Prothe, 2001)

Verify existence, extent, and causes of problems
Implement traffic engineering countermeasures
Consider implementation of traditional enforcement measures
If above steps are unsuccessful or unfeasible, select appropriate red light-camera locations
Choose financing arrangement that ensures that public safety remains the primary goal
Conduct a detailed, perpetual public information and education program
Put cameras at intersections with the highest potential for crash reduction benefits
Monitor progress over time

**Table 8-2 Steps to adopt an automated enforcement program (ITE, 1999)**

Document the problem
Establish institutional partnerships
Clearly enumerate program objectives
Pass enabling legislation
Involve the local judiciary
Educate the public
Pay attention to details

**Table 8-3 RLR camera implementation**  
(FHWA and NHTSA, 2003)

<u>Early planning and startup</u>
Oversight committee of stakeholder groups
Program objectives
Legal requirements
Encourage adoption of enabling state code
Municipal ordinances
System procurement alternatives
Public awareness and information campaign
<u>System planning</u>
Violations processing procedure
Site selection
Warning signs
Traffic signal yellow times
System selection and technologies
Camera unit
Intersection Lighting
Camera housing and supporting structure
Vehicle detection
Communications
Warning signs
<u>Engineering design of red light camera systems</u>
<u>RLR camera system installation</u>
<u>Operation and maintenance</u>
Citation data processing
System maintenance
Problem identification and analysis
<u>On-going public information and education</u>

Advisory Committee Many agencies must cooperate to develop and operate a RLR program. Often, support for the program is developed through an advisory committee of stakeholder groups and interested individuals. In Alabama this would include agencies like the Department of Public Safety, Department of Transportation, Department of Economic and Community Affairs, Administration Office of Courts, city and county representatives, the judiciary, legislators, the media, safety groups and concerned citizens.

Advisory committee members should receive an overview briefing to familiarize them with the situation, including records of citations issued for RLR and safety statistics on the situation, and other data that can be used in the decision making process. The purpose is to bring them to a state-of-practice level of knowledge so that they can guide the development of the program.

Program Objectives One of the first duties of the advisory committee is to establish the objectives of the program. They can be used to guide the long and systematic process of enabling, designing, installing and operating the system. A good start can be obtained by reviewing the objectives used in other states.

Legal Issues This typically involves analysis of state code and municipal ordinances. In Alabama, a major challenge will be securing legislation to enable automated enforcement. UTCA Report 470-2, the legal principles discussed in Section 2 of this report (literature review), and the legislation introduced in the 2001 session of the Alabama Legislature (found in Appendix A2) provide a useful starting point. Another good source of information may be found in Appendix A1, the model law for red light cameras, developed by a national committee that deals with traffic laws and ordinances (National Committee 2000). Concerns related to invasion of privacy, the right to a speedy notice of a violation, citation distribution methods and timelines, types of penalties, and similar issues should be thoroughly discussed by the group.

### ***Intermediate Actions (Sometimes Called System Planning)***

Once a jurisdiction has the authority to establish a RLR camera program, the hard work begins. It is helpful to obtain and study references like “Guidance for using Red Light Cameras.” After a vendor has been selected, the vendor’s documentation should be obtained and studied thoroughly. Studying reports of existing programs, including successful and unsuccessful case studies, can provide much guidance.

At this point, the oversight group can begin to work through the steps of implementing the program. They are outlined in the following paragraphs.

**Identifying Procurement Alternatives** A major early effort should be devoted to determining appropriate procurement alternatives. Someone must decide whether to use a private contractor, to purchase equipment and software and perform all activities in house, or to use some combination of private vendor/public agency. This decision is largely driven by cost effectiveness, state legislation, and capabilities of the local jurisdiction in which the camera is installed. Alternative methods for obtaining equipment and operating the program are discussed later in this Section.

Designing a Public Awareness and Education Program Public understanding and support of the RLR program is important, and programs are rarely successful without it. The public awareness and information campaign should be carefully planned and conducted to convey the primary message - red light cameras reduce the number of crashes and the severity of crashes. The campaign should start early and continue as long as the cameras are in use. Jurisdictions that have already implemented camera programs have used posters, mail, handouts (brochures), the media, billboards, warning signs, press releases, slogans, bumper stickers, and similar methods to spread the word.

An excellent technique is to train members of the advisory committee to make presentations to professional organizations including traffic judges, mayors, county administrators, police fraternities, traffic engineering organizations, civic and social organizations, and others. These provide excellent forums to present facts and explanations about the program, and to answer questions. It is a good way to build support among those individuals and groups that are crucial to the successful operation of the program.

The public awareness program should be simple, clear and repetitive. The components of the program should be described in non-technical terms, and should include topics like the following:

- The program objectives (safety, safety, safety),
- How the red light camera system works,
- The advantages of an automated system as compared to law enforcement officers,
- Other safety improvements at intersections, and whether or not they provided the desired results, and
- An explanation of how RLR camera revenues will be used.

Seat belt emphasis programs, like “Click it or Ticket it,” have been very successful in conducting Alabama public awareness campaigns. They have provided multiple means for citizens to contact the campaign organizers, including a 1-800-telephone number for individuals to report safety problems or to ask questions about the program, widely publicized surface mail and email addresses for correspondence, and outreach efforts to schools, community and social groups and others. These increase community involvement, provide a sense of ownership of the program, and increase the chances of success.

In some cities, the public awareness program has been conducted continuously. They were used to inform the public why the program was needed and what the outcome would probably be. Statistics were periodically released about the number of citations issued and the number of crashes prevented. Public support was strong in this situation.

Adopting a Warning Sign Policy Warning signs are considered to be part of the public information campaign. Previous camera programs have typically used warning signs to alert drivers that a RLR camera program was being operated. Sometimes this was required by the enabling legislation. The signs should be clearly visible to drivers and should conform to the requirements of the MUTCD. They are typically placed in advance of photo-enforced intersections, at the intersections, and on all approaches into the area where cameras are being used for enforcement.

Establishing Violation Processing Procedures It is important to determine the steps that will be used to process violations, to establish the parameters that will govern it, and to assign responsibilities. The following are examples of decisions that must be made:

- The “cushion” or “ grace period” for issuing citations,
- The minimum speed threshold for issuing citations,
- Whether violations will be recorded 24 hours per day, or just during the peak traffic period; whether violations will be recorded seven days per week, or only on certain days,
- Which agency will process and mail the citations,
- Which law enforcement agency will review the photographs prior to mailing the citation,
- The maximum time allowed between the violation date and the date the citation is mailed,
- The number of days allowed between mailing the citation and the official response from the registered owner of the violating vehicle,
- Whether citations will be mailed when the violator was driving a rental vehicle, and

- Specifications for the photographs (visibility of the red signal, date, time, seconds since on-set of red, clarity of photograph, etc.).

It is usually best if these decisions can be made by a group of informed officials representing several involved stakeholder organizations. The advisory board may be the appropriate group to conduct this work step.

**Selecting Candidate Sites** The selection of sites for installation of cameras is usually based on consideration of crash data, citation data, citizen complaints, and opinions of local law enforcement officers and traffic engineers. RLR cameras are not installed until other appropriate counter measures have been tried at the intersections that are candidates for cameras.

**Selecting the System/Technologies** Technical decisions must be made about how the system will operate, and acceptable ranges of activities. These include the types of camera units that are acceptable (wet film, digital, video, etc.), whether the intersection will require lighting, the types of associated hardware (like the camera housing and traffic hardware cabinet) that will be used, how vehicles will be detected, how data will be communicated to the central office, how the unit will be monitored, and the duration of operation of individual cameras. These decisions are not absolute, and can be modified during negotiations with vendors.

**Paying Attention to the Details** ITE points out the importance of the “details” in the systems planning or engineering design stages of RLR cameras implementation (ITE, 1999). Similar advice is given in “Guidance for Using Red Light Cameras” (FHWA and NHTSA 2003). This includes designing warning signs and establishing appropriate locations for them, establishing appropriate lengths of signal yellow intervals and all-red intervals to minimize red light running, ensuring that the geometry of candidate intersections is suitable for RLR cameras, examining adequacy of existing street lighting for night photographs, investigating whether the host agency’s signal hardware and communications infrastructure are compatible with the vendor’s equipment, and similar topics.

### ***The RLR Camera Installation***

**Engineering Design** The red light camera installation should be treated the same as any other traffic control device. It should be based on a careful engineering study, input from informed specialists, legal considerations, and other important factors. After a vendor has been selected, that company’s technical support staff usually handles the detailed design of hardware to fit the local intersection geometry and traffic characteristics. This design must be integrated with the host agency’s signalization scheme, and (often ) the host agency’s communication system.

The detailed design will include the following:

- Camera,
- Camera housing and support,
- Vehicle detectors,
- Detection signal processing,
- Communications equipment,
- Equipment cabinet,

- Conduit runs, and
- Electrical service.

If a vendor will operate or maintain the system, or handle citation processing, the installation specifications should require the vendor to address concerns as they arise, and to issue periodic reports to the host jurisdiction.

Installation, Operation, and Maintenance Installation should be conducted jointly by the host agency and the vendor. Preparation and review of the plans, testing and fine-tuning of the equipment, delivery of as-built drawings, and other steps are necessary to ensure proper operation. The contract should spell out which organization is responsible for the individual steps in the process.

Once the installation and testing are completed, the RLR camera system should be operated consistent with the manufacturer's instructions. A log should be kept of activities, sufficient to identify unusual events, modifications to the system, and other noteworthy actions that occur.

Violation records should be collected and stored in a secure manner. Data processing should ensure that confidentiality and security are maintained, whether the system uses wet film or digital imagery. The following steps are used to issue citations and operate the program:

- The vehicle's registered owner is identified.
- The photographs in each record are reviewed to confirm that a violation occurred. A law enforcement officer performs this step.
- A draft citation is prepared, reviewed, and approved.
- The citation is mailed to the vehicle's registered owner.
- A telephone number is established and published so that individuals can obtain answers to their questions.
- Regular times are scheduled for violator appointments to discuss citations.
- Vehicle registered owner certifications are processed.
- Information is provided to the court system as requested, and support is provided at court hearings.
- Statistics are compiled and periodic progress reports are prepared.

Programs are more likely to be successful when thorough guidelines are prepared and applied for issuing citations. Definitions need to be very specific about what constitutes a red light running violation. The guidelines should define review-and-approval authority, including extraordinary circumstances like shortened review times, situations where traffic officers are not available for review, and when the number of citations is larger than anticipated. All successful programs have quality assurance procedures and quality assurance audits.

### ***Summary of RLR Implementation***

This portion of the report has briefly outlined the orderly steps necessary to implement a RLR camera program. This narrative should be considered as a good starting place for acquiring information, not as a complete set of instructions on the topic.

## **Cost Estimates for a RLR Camera Program**

This section of the report describes the costs for installing and operating a RLR camera program in general terms. It is not possible to provide detailed and specific cost estimates, because each program is tailored to a specific jurisdiction and to specific sites. For example, some cities prefer to purchase the equipment and software and conduct the program themselves. Others prefer to outsource the program because of limited capital funds.

Some jurisdictions require that all citation processing be performed locally while others allow the data to be exported to a remote site (i.e., out of state) where it can be processed more efficiently and less expensively. Local citation processing by a vendor involves significant costs, including office space, utilities, phones, networking, computing equipment, and staff. Using city staff and equipment or relying on a remote processing facility with a local mailing operation will substantially reduce cost.

The size and type of local installation is a key cost factor, and economies of scale are important. Installing multiple cameras instead of a single camera reduces the cost per intersection, because of efficiencies in installing and servicing the equipment, and in processing the citations. Somewhere around 20 cameras in a jurisdiction, it typically becomes cost effective for the vendor to station a technician in the host city.

RLR systems are sometimes maintained under contract. Contracts for such services typically require 24 to 48 hour response and repair times. This seems to be based on an organizational culture of rapid repair of traffic control equipment (which is good practice because it involves safety considerations). A RLR camera system repair time requirement of 72 hours, instead of 24, would not jeopardize safety and it would significantly reduce maintenance costs. It is expensive to handle repairs on an emergency basis.

The degree of support provided by the host city has a strong influence on cost. For example, the traffic engineering department may install the sensors, poles, cabinets, and other hardware, and pull the wires. Some locations use video detection (instead of pavement loops) to reduce installation expense. Local governments sometimes use their communications systems to transmit data from the RLR system.

Finally, the pricing policy of an agency is sometimes constrained by political reality. Discussions with vendors identified situations where cities paid per-citation costs of more than 95% of the citation fine (so citizens would not perceive the cities as greedy for revenue), but this is not the normal situation. In another state, cities use a de facto (unstated) \$200,000 upper limit on system purchase prices because that is the amount of grant money they receive when they install a RLR system.

Vendors are usually willing to work with government agencies to minimize overall cost while meeting the safety goals. Vendors have suggested the following techniques to reduce host agencies' costs:

- Use longer term contracts so vendors can recover initial investments,
- Include a large number of intersections to spread the cost of a citation processing investment,
- Include a purchase option in the contract; if the program is economically viable, it may be more economical to purchase the equipment,
- Allow remote citation processing so vendors can handle multiple contracts from a single location,
- Use city staff for citation review and processing (e.g., add the red light citation processing to the parking or utility operation),
- Use web based reporting and citation processing applications (use existing PCs and existing network),
- Focus on technologies that allow use of existing infrastructure,
- Use city communications infrastructure,
- Use existing power, cabinets, networking, and
- Where contract maintenance is used, allow reasonable response and repair times.

***Estimates of Vendor Costs***

Vendors price their equipment and services to recover their initial costs. As private sector companies, they must ensure profitability to remain in business. As a rule, vendors are very aggressive about pricing in new markets or for large (many intersections) or long-term (more than three years) contracts.

There are several methods for financing automated enforcement programs. A good overview is given in *Guidance for Using Red Light Cameras* (FHWA and NHTSA, 2003), and is shown below in Table 8-4:

**Table 8-4 Financial options for red light camera systems**

Payment Option	Equipment	Equipment Installation	Equipment Maintenance	Citation Data Processing
<b>Contractor owned and operated red light camera systems</b>				
Initial fixed price payment	X	X		
Initial fixed price payment and fixed monthly payments	X	X	X	X
Fixed monthly payments	X	X	X	X
Initial fixed price payment and per citation payments				
Per citation payments				
Initial fixed price payment and fixed monthly payment schedule, depending on pre-determined low/high number of citations issued	X	X	X	X
Fixed monthly payment schedule, depending on pre-determined low/high number of citations issued	X	X	X	X
Time worked and materials used			X	X
<b>Agency owned, contractor operated red light camera systems</b>				
Fixed monthly payments			X	X
Fixed monthly/per citation payments			X	X
Per citation payments				
Fixed monthly payment schedule, depending on pre determined low/high number of citations issued			X	X
Time worked and materials used			X	X



The financing techniques that appear to be most appropriate for Alabama are discussed in the next several paragraphs. The narrative is based upon the literature review and discussions with several RLR vendors.

(1) Per Citation Fees This is a form of out-sourcing, and the vendor is reimbursed for either the number of citations issued or the number of citations paid. This method was initially very popular, because the vendor bears all costs of installing and operating the equipment and processing the citations. The host jurisdiction has very little direct cost, and receives income from fines associated with RLR citations (after the vendor's fee has been paid).

Opponents of RLR camera programs claim that this system can become a "cash cow" that generates substantial cash flows for the host city. Cities can be tempted to operate their programs to the extreme and to pursue every violator, no matter how minor, for more income. The negative publicity associated with this payment method has made this type of program less attractive, especially after the San Diego program was halted following a judge's decision that supported such claims. Fortunately, the San Diego program is now back in operation following revisions to its structure.

The minimum/maximum known payments per-citation are \$27/\$90, but most programs seem to operate at about \$35 to \$55 per (civil) citation, based upon the number of cameras in operation and other factors. The payment jumps to the \$200 level for criminal citations. Vendors usually offer discounts based on volume, especially once the up-front capital expenses and installation costs have been recovered. A small program in Tuscaloosa (one camera, about 30-40 citations/day) could probably be conducted for about \$50 per citation.

Most per-citation program pricing is inclusive, i.e., the program is completely outsourced. However, a few programs (such as Howard County, Maryland) have separate pricing for camera operation (\$12 - \$19) and for citation processing (no cost estimate available).

2) Monthly Fee This is the most popular current form of financing. In this arrangement, the RLR program is all-inclusive (lease of equipment plus processing of citations). The vendor is paid at a monthly rate for the life of the contract regardless of the number of citations issued.

These programs range from \$4,000 to \$10,000 per month. For a large, fully outsourced program, the cost is approximately \$5,000 to \$6,500 per month. A small program is typically \$6,000 to \$8,500 per month. Tuscaloosa would probably pay \$6,000 to \$7,000 per month.

(3) Combination of Lease and Per-Citation Fee: Another option is to charge a fixed monthly price for the equipment, plus a per-citation fee. This provides a surer way for the vendor to recover cost and eliminate extreme risk, and can provide the lowest total cost to the agency in the right circumstances. One vendor has noted that a moderate sized program could be conducted for \$2,000 to \$4,000 per month, plus a per citation charge of \$15 to \$25.

(4) Outright Purchase: It is rare that a jurisdiction purchases its own system, because the hardware and software evolve so quickly that a purchased camera may soon be obsolete. Also, cities typically need specialized maintenance on the system and software, which can cost

\$10,000 to \$30,000 per year. One vendor with over 60 RLR system installations indicated that less than five percent of these clients had purchased the system.

Depending on configuration, a standalone red light camera system will cost from \$40,000 to \$60,000, with installation adding another \$10,000 to \$20,000. It is realistic to estimate that Tuscaloosa would spend \$50,000 for the system and another \$10,000 in installation costs, assuming that TDOT would do much of the installation work. Since TDOT has an aggressive maintenance program, an on-call maintenance contract with the vendor would probably cost only \$10,000 to \$20,000 per year.

(5) Other Costs Regardless of the financing method, citation-processing software is typically included in the price (either as a portion of the citation fee or monthly fee, or embedded in the cost of the system). As more citation processing packages become available, this is likely to change. A good estimate is that the initial price for citation software will be in the range of \$10,000 per intersection, with significant discounts for volume.

### ***Host City Costs***

TDOT handled the RLR equipment installation and servicing very efficiently. For the pilot project, their material and labor records indicated the following costs:

Site 1 Installation	\$4,400
Site 2 Installation	\$3,700
Site 3 Installation	<u>\$3,500</u>
Total	\$11,600

The installations were temporary in nature, and the materials would have been more expensive for permanent installations. Also, these figures do not reflect employee fringe benefits and similar costs. For the cost-effectiveness scenario later in this section, the above values were expanded by one-third to reflect permanent installations and full costs. They were still very reasonable and below the costs reported in the literature.

TDOT provided the communications infrastructure for the pilot project. There was no charge for this, since the TDOT fiber optic cable system was available and had plenty of capacity.

If a RLR system was fully operational, there would be at least three additional costs. First, some level of supervision, quality control and reporting would be required. Second, the camera would be rotated from site to site, perhaps as often as monthly. Third, a law enforcement officer would have to review the photographs and the draft citations to approve them. These costs are included in the cost effectiveness study discussed in the next paragraphs of this section.

### **Cost Effectiveness Investigation**

A cost-effectiveness study was conducted for a potential RLR program in Alabama, using data generated during the Tuscaloosa pilot study and cost information provided by vendors. There

were too many financing and operating options for a complete analysis. For purposes of this study, a single application was examined to obtain a feel for the situation.

### ***Background Information for Analysis***

The scenario was based upon a single camera, since this is the most expensive technique (on a per citation basis) to acquire and operate a RLR system. Other pertinent facts and assumptions are listed below:

- One camera is utilized, rotated from site to site.
- The system registers citations 24 hours per day, seven days per week.
- The camera is operational 80% of the time (conservative estimate).
- A grace period of 0.2 seconds is used.
- No minimum speed threshold is used.
- Initially, violations occur at the level experienced during the Tuscaloosa pilot study (about 12,600 per year, using the above assumptions).
- Violations decline after installation of the camera. Assume that typical (vendor provided) rates will apply in Tuscaloosa:
  - 6 months – drops to 75% of initial rate
  - 12 months – drops to 60% of initial rate
  - 18 months – drops to 50% of initial rate

The rate of decline is not linear; over time the rate of decline slows. In reality, after the rate drops a significant amount, the camera is usually rotated to a new location.

- The RLR fine is \$100, based on the fine in the 2001 House Bill in the Alabama Legislature.
- The distribution schedule will provide 80 percent of the collected fines to the City of Tuscaloosa, based on the same 2001 legislation.
- 90% of fines will be collected (this is conservative, as collection rates for camera citations are initially extremely high, certainly higher than for officer citation fines).
- The life of the program will be five years, since technology advancements might make the current system obsolete by that time.
- A discount rate of 4% will be used, which is typical for highway agency studies in 2003.

### ***Scenario – All Inclusive, Monthly Lease (vendor provides and operates system)***

This is the most popular current method for financing RLR camera systems. It is also the quickest and easiest to put into operation, since there are no capital costs and only limited operational costs for TDOT. The camera, software, citation processing, system maintenance, reporting, and all other normal RLR camera system activities are included in the lease. The details are described as follows:

- Installation
  - TDOT provides and installs supporting hardware (detection loops, mounting pole, signal cabinet, electricity, communications, etc.).
  - TDOT, advisory committee, and vendor jointly conduct the public awareness campaign.

- Vendor provides, installs and aligns the camera, tests the system and adjusts it as needed.
- Maintenance
  - Vendor maintains camera, software, and citation processing equipment.
  - TDOT maintains loops, street hardware, communications system, etc.
- Operation
  - Vendor operates system, processes violation data, and prepares and mails citation.
  - Vendor issues periodic reports to TDOT.
  - TDOT oversees the operation, and performs quality control audits.
  - A Tuscaloosa Police Department (TPD) officer reviews the evidence, verifies that the citations are valid, and signs them.
- Crash Reduction Savings
  - Preventing a traffic crash saves money for the public. National Safety Council estimates of such savings were applied to this project.
  - Crash reduction procedures and estimates in NCRHP Report 310 were applied to this project. This provided a very conservative analysis using only rear-end and RLR right-angle crashes that occurred on the camera approach to the intersection.
  - Crash reports provided by TDOT were examined for each site, and were analyzed using standard crash analysis procedures to prepare Table 8-5.
  - Site 2 had the largest crash savings (\$212,280 per year), because it had a history of severe crashes. The second largest savings was for Site 1 at \$116,979 per year.

**Table 8-5 Site 2 crash reduction savings**

Year	PDO Crashes	Injury Crashes	Fatal Crashes	Total Crashes
2000	4	1		5
2001	2	0	1	3
2002	1	2	1	4
Total	7	3	2	12
Ave/yr	2.3	1.0	0.7	4.0
Reduced Crashes/yr*	0.24	0.10	0.07	0.41
Cost/crash**	\$2,300	\$63,000	\$3,000,000	
Saved/yr	\$556	\$6,530	\$207,309	<b>\$214,395</b>

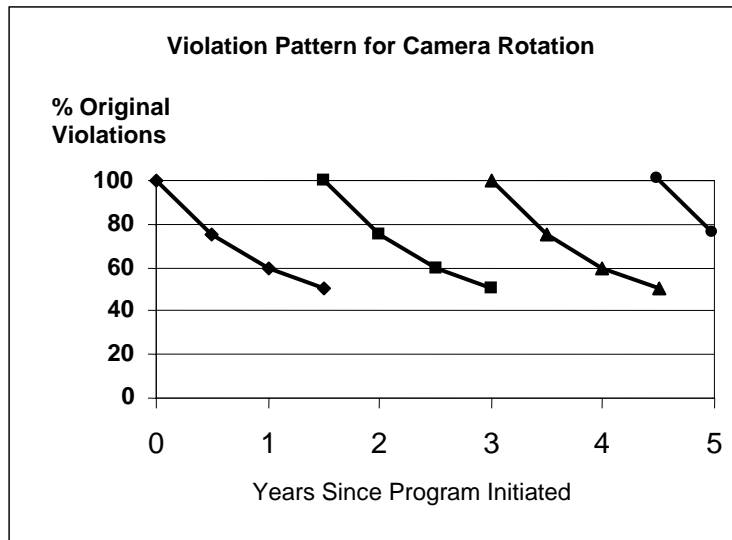
\*Based on average 26% reduction in 30.4 months, only rear-end and RLR right-angle crashes on camera approach (NCHRP Report 310)

\*\*National Safety Council estimate for 2002

- Revenues
  - Violations are estimated to decrease as outlined previously.
  - Table 8-6 and Figure 8-1 illustrate the decline in violations at an intersection, followed by relocation of the camera to a new intersection. It was assumed that the camera would be rotated after violations had fallen to 50 percent of the initial level (1.5 years).

**Table 8-6 Estimated violation reduction as camera is moved**

Years Since Start	Violation rate at signal (% or original value)				Average Rate for Year
	Signal 1	Signal 2	Signal 3	Signal 4	
0	100%				
0.5	75%				77%
1	60%				
1.5	50%...	...100%			71%
2		75%			
2.5		60%			61%
3		50%...	...100%		
3.5			75%		77%
4			60%		
4.5			50%...	...100%	71%
5				75%	



**Figure 8-1 Decline in violations at four successive intersections**

- The number of citations varies with time at each intersection. The approximate number was calculated for each year and applied to the TDOT pilot data to yield the following estimates of violations.

- Year 1 = 9,550
- Year 2 = 8,800
- Year 3 = 7,550
- Year 4 = 9,550
- Year 5 = 8,800

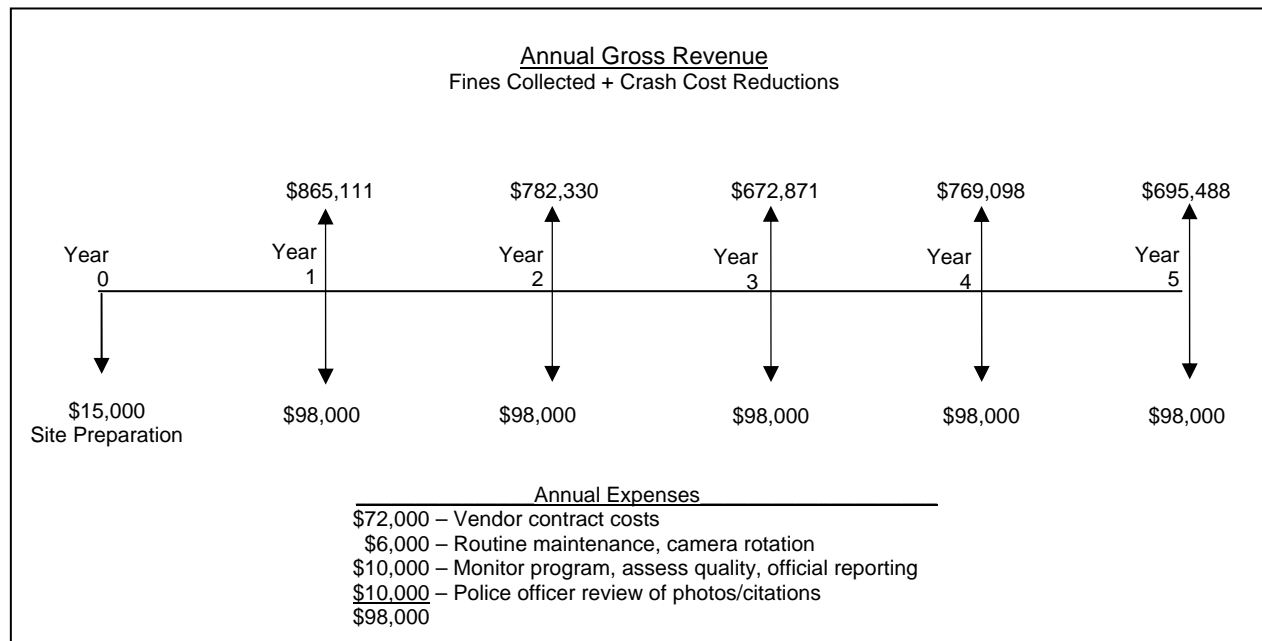
The pertinent expenses for the scenario were introduced in the previous paragraphs, and are outlined below:

- Vendor contract costs (inclusive, all services): \$6,000 per month
- TDOT in-house expenses:

- Site preparation at three intersections: \$15,000 one time cost
- Communicate data (TDOT fiber optic network) no cost
- Routine maintenance, rotate camera to next site (6 times/year) \$6,000 per year.
- Monitor program, assess quality, official reporting: \$10,000 per year.
- TPD officer reviews approximately 50 photos/citations/day: \$10,000 per year.
- Gross revenue, at \$80 net per citation and 90% collection rate:
  - Year 1 = \$687,500
  - Year 2 = \$633,900
  - Year 3 = \$544,600
  - Year 4 = \$687,500
  - Year 5 = \$633,900

Cost Effectiveness of Scenario These expenses and revenues were subjected to a Net Present Value analysis over a five-year period. Both expenses and revenues were examined, using standard financial equations. The cash flow diagram is shown in Figure 8-2, and the results of this conservative analysis are presented in Table 8-7.

General Conclusions from Scenario It is obvious that this scenario is cost-beneficial, even with the conservative nature of the analysis. For example, if safety benefits had been included the scenarios would have generated higher cost effectiveness. Also, additional cameras could be added to the system to generate higher net present values. Because of the extremely beneficial nature of these findings, in spite of the conservative nature of the analysis, the research staff concluded that there was no need to conduct further scenarios.



**Figure 8-2 Cash flow diagram over time for scenario**

**Table 8-7 Cost-benefit analysis of scenario**

Analysis Category	Present Value
<b>Expenses:</b>	
Vendor contract costs (inclusive, all services, \$6,000/month):	(\$325,794)
TDOT in-house expenses:	
Site preparation at three intersections (one-time cost)	(\$15,000)
Communicate data (TDOT fiber optic network)	No cost
Routine maintenance, rotate camera to next site (6 times/year)	(\$26,711)
Monitor program, assess quality, official reporting	(\$44,518)
TPD expenses for officer review of citations	<u>(\$44,518)</u>
Total Expenses:	(\$456,542)
<b>Revenues:</b>	
Gross revenue, \$80 net per citation, 90% collection rate, decreasing over time:	
Year 1 =	\$661,015
Year 2 =	\$586,065
Year 3 =	\$484,155
Year 4 =	\$587,640
Year 5 =	<u>\$521,010</u>
Total Revenues:	\$2,839,885
Crash reduction, NSC cost estimates, NCHRP 300 procedures	
Year 1 =	\$204,115
Year 2 =	\$196,265
Year 3 =	\$188,716
Year 4 =	\$181,458
Year 5 =	<u>\$174,479</u>
Total Savings:	\$945,033
<b>Revenue plus crash reductions, less expenses:</b>	
Net Present Value:	\$3,328,376

Sensitivity Analysis The effects of some of the analysis assumptions were investigated, such as rate of return, percentage of fines collected, decline in violations per year, etc. The results of these investigations are shown in Table 8-8. The investigation showed that few of the assumptions had a pronounced effect on the analysis.

**Table 8-8 Sensitivity of Several Assumptions on Cost Effectiveness**

Assumption	Initial Assumption	Additional Values Tested	Net 5-year Revenue
Rate of Return	4%	2%, 6%	\$3,526,390; \$3,147,498
Percent Fines Collected	90%	70%, 100%	\$2,697,290; \$3,643,919
Camera Operational Time	80%	50%, 100%	\$2,251,968; \$4,003,994
Violations Fine	\$100	\$70, \$85	\$2,263,418; \$2,795,898
Grace Cushion	0.2 seconds	0.3 sec, 0.5 sec	\$3,225,316; \$3,053,548
Threshold Speed	None	10 mph, 12 mph, 15 mph	\$1,988,592; \$1,427,485; \$1,118,304
Operate Workdays, Weekdays	24/7	Workdays, Weekdays	\$1,896,982; \$2,710,014

Note: Initial Assumption Revenue = \$3,328,376

Workdays = 7:00 a.m. - 6:00 p.m., Monday-Friday, and Weekdays = 12:00 a.m. Monday - 12:00 p.m. Friday

- Increasing or decreasing the rate of return by 50 percent has an effect of only five to six percent on the net present value. So the analysis is insensitive to rate of return.

- Percent-fines-collected was sensitive to changes, but interviews with vendors and the literature review indicated that 90% is a reasonable estimate. The existence of photos showing the violation provides a strong inducement to for the violator to pay the fine.
- The amount of time that the camera is in service did have pronounced effects. But even if the camera was inoperable half of the time (doomsday analysis), the net present value over five years would still be over \$2.2 million. The performance record of these systems is very high, and the 50 percent scenario is unlikely.
- The most prevalent grace periods for existing programs are 0.2 and 0.3 seconds. The research staff used 0.2 seconds in accumulating data during the pilot project. If 0.3 had been used, the net present value over five years would have decreased only three percent.
- If a threshold speed is applied to the TDOT application, some vehicles that previously were labeled as RLR would not longer have to pay citations. For the TDOT pilot data, speed thresholds could have significant effects. Threshold values of 10 mph, 12 mph and 15 mph reduce the net present value by 40, 67, and 66 percent, respectively. Prior to adopting a threshold speed value, additional analyses should be conducted to determine how adoption a speed threshold will effect safety.
- If less revenue is one of the operational goals, then reducing the number of hours in operation is an effective method to obtain the goal. The two options shown in Table 8-8 provided 43 percent and 19 percent reductions. But if this method is adopted, the hours of operation should be controlled by the potential to increase safety (i.e., operate when there is the best probability of issuing citations to high speed and far-into-red violators). This would be difficult in Tuscaloosa, because there was no dominant pattern from site to site in the collected RLR data.

The sensitivity analysis was useful in that it helped to understand the effects of various assumptions in the cost-effectiveness analysis. This information could be useful to local officials and vendors in planning a program and setting parameters for an Alabama city. But, the bottom line is that the huge number of violations during the pilot study in Tuscaloosa generated a huge cash flow. If this is typical for Alabama, any host city can carefully analyze purchase/lease and all-inclusive/shared-costs options, and select an attractive financing arrangement.

Program Not Revenue Driven There is one important point to consider. Cash flow is not the main purpose of the program; in some instances large cash flows have jeopardized RLR camera programs. These systems should be implemented to improve safety, not generate revenues. If the situation arises when total cash flow and large revenues jeopardize the system purpose, the research staff offers the following suggestions:

- Modify the program to eliminate a portion of the violations.
  - Raise the value of the “grace period.”
  - Establish a speed “threshold” below which citations are not issued.
  - Operate the camera only during time periods known to have high incidences of violations and crashes.
- Dispel the notion that the RLR camera program is being operated to generate cash, rather than to improve safety.
  - Conduct a vigorous public relations program to publish RLR crash rates before and after the program was initiated, and to otherwise point out how the program is generating safety benefits for the public.



- Reduce the fine associated with camera citations to reduce cash flow.
- Designate that all revenue beyond the cost of operating the program be devoted to street safety improvements in the host city.
- Designate that all revenue beyond the cost of operating the program be distributed to the same groups that receive revenues from officer-citation fines (City, Municipal Court, Municipal Corrections, and State).

### **Summary**

This section has presented an overview of the systematic steps that can be used to implement a red light running camera program in Alabama. This overview material can be expanded, as needed, by reviewing several references cited in this section.

Financing options and costs associated with RLR programs were reviewed in this chapter, and a limited cost effectiveness analysis was conducted. That analysis showed that RLR programs can be cost beneficial, and can generate large cash flows. For that reason, suggestions were made to emphasize the purpose of RLR systems (safety), and for de-emphasizing the revenue aspect.

## **Section 9**

### **Summary and Recommendations**

This report documents a pilot project for the installation of a red light running camera enforcement system. The system was used to gather data, but no citations were issued. The research project was conducted by the University Transportation Center for Alabama for the Alabama Department of Transportation. The partners in this effort were the Tuscaloosa Department of Transportation and Precision Traffic Systems, Inc. The most significant conclusions and recommendations resulting from the project are outlined in the remainder of this section.

#### **Project Summary and Key Findings**

RLR Crashes The current technical literature indicates that red light running is a serious problem in the U.S, including the State of Alabama, as illustrated by the following facts:

- The number of RLR crashes in the U.S. approaches 200,000 annually, producing approximately 1,000 deaths per year.
- The Insurance Institute for Highway Safety found that Alabama had the fifth worst RLR fatality rate among all states. Birmingham had the sixth worst RLR fatality rate among U.S. cities.
- During 1993-2001 there were 47,501 RLR crashes in Alabama, an average of 5,278 per year. There were 16,306 RLR injuries and fatalities, an average of 1,812 per year.
- Europe has been using automated RLR camera enforcement for 30 years.
- A decade ago, there were virtually no RLR cameras used for enforcement in the U.S. By 2003, RLR camera programs were operational in 68 jurisdictions in 15 states and the District of Columbia.
- There have been many studies documenting that red light cameras reduce violations, crashes, injuries and fatalities.
- A recent NCHRP study noted that RLR cameras do cause decreases in crash rates, but that the absolute decrease could not be established because previous studies lacked scientific design and statistical rigor. NCHRP used the best available data to estimate a 26% reduction in angle crashes and rear end crashes, but cautioned that the study was based on limited data.
- A telephone survey of 2,181 drivers in ten cities in Virginia, North Carolina, California, Arizona, Florida, and Texas found strong acceptance of camera enforcement systems (72 to 84 percent of respondents in the various cities). A survey conducted in Alabama in 2002 found 73 percent of respondents favored red light camera enforcement systems.

Legal Issues Legal issues involving RLR cameras were investigated in this project. Enabling legislation must be enacted before RLR cameras can be used for enforcement in Alabama. For that reason, a copy of the “model law” developed by a national committee has been included as

Appendix A1 of this report, and a copy of the RLR camera legislation introduced in the 2001 Alabama Legislature has been included as Appendix A2.

When a RLR camera program is contemplated legal issues arise, like the driver's right to privacy, the driver's right to prompt notice of a violation, the driver's right to form a defense, the possibility that a city could operate a RLR program to maximize profit, and similar topics. However, these issues rarely go to trial today, because the courts have long ago settled them.

Design and Operation of a RLR Camera in Tuscaloosa The project team devised a field test in Tuscaloosa. Three intersections were selected for study, based upon their RLR crash and violation histories. A PTS camera was rotated between the three sites for a year. It took two photographs of each violating vehicle at the stop bar and near the middle of the intersection. In both photos the signal face was red. During the pilot test, the research team examined the camera system's data collection and processing procedures. The study included evaluation of vehicular speed measurement by the camera system and examination of thousands of photograph pairs that showed RLR vehicles. The researchers concluded that the system was highly accurate, and that the speed measurement system, software and camera functioned as advertised by the vendor.

Red Light Violations in Tuscaloosa The RLR camera was operated about 80 percent of the time for a year. It detected 13,647 red light violations out of 2,726,061 vehicles that passed through the system (about one out of every 200 vehicles). The following were the major findings:

- If a "grace period" 0.2 seconds had been used, 7.2 percent of the violators would have avoided a citation.
- There was pronounced variation from site to site. No dominant common characteristics associated with RLR (violation rate, time of day pattern, day of week pattern, speed patterns, etc.) were noted.
- Site three experienced a high volume of right-turn-on-red vehicles that did not stop prior to turning (a violation of Alabama law). UTCA researchers examined 2,929 pairs of photographs of RTOR vehicles that made the turn at 5 to 31 mph. A speed analysis was jointly conducted by UTCA, TDOT and the vendor to determine the effect of using a threshold speed for citations. The vendor's camera could be programmed to analyze RTOR vehicles while simultaneously monitoring through-vehicles.
- The research team analyzed signal yellow phases and all-red phases at the three test sites, since the lengths of these phases can deter RLR. The researchers reviewed advantages (less RLR violations, etc.) and disadvantages (decreased signal green time and increased congestion) of lengthening the yellow and all-red phases, and noted that phase lengths are individual decisions based upon the factors at each signal location.

Implementation Guidelines UTCA researchers reviewed several professional publications to identify steps required to implement of a RLR automated enforcement program. The typical steps include the following:

- RLR cameras are implemented through a series of orderly steps.
- The preliminary steps include formation of an oversight committee, selection of program objectives and analysis of legal issues.

- System planning occurs next. This involves identification of procurement alternatives, design and implementation of a public awareness program, establishment of guidelines for processing violations, selection of candidate sites, securing a vendor, and working out the details of the program.
- The third phase is installation, which includes a thorough engineering design to fit local sites, installing and testing the system, training operators, starting and operating the system, maintaining and updating it, and routinely reporting the results.

Financial Issues An analysis of RLR camera system cost was conducted through a literature review, discussions with FHWA officials, discussions with other cities, and interviews with several vendors.

- Financial options for securing RLR systems include purchase, monthly lease, a per-citation fee, all inclusive operation (contractor does everything), and various combinations. Vendors provided typical price ranges for these options, using typical system sizes (i.e., number of intersections involved).
- The literature and the vendors provided a wealth of suggestions for conducting a program efficiently, and for minimizing a city's costs in conducting a program.
- A typical scenario (monthly lease, vendor inclusive service) was subjected to a cost-effectiveness analysis. Cost data was provided by TDOT and vendors, and revenue was estimated from the violation data captured during the pilot project.
- The cost-effectiveness analysis indicated that the program was feasible, and would operate in a net-revenue status.
- A sensitivity analysis was conducted on the various assumptions used in the cost-effectiveness study. It indicated that the assumptions were reasonable and within normal expected ranges. This analysis also provided a better understanding of the various parameters (length of grace period, speed threshold, etc.) that must be established to place a camera system in operation in Alabama.

## **Recommendations**

This study found that red light running cameras are effective safety devices for reducing crashes. In 2002, they were being used by approximately 70 cities in the U.S., and their use was expanding. The research team analyzed this and much other information, including the results of the Tuscaloosa pilot project, and makes the following recommendations:

- An oversight committee should be formed to encourage adoption of RLR camera programs in Alabama.
- Legislation should be pursued in Alabama to enable automated enforcement of RLR. This legislation should be modeled after the national law, tailored to fit Alabama situations.
- The primary purpose of a RLR camera system should be to improve safety.
- In selecting sites for RLR cameras, the primary criteria should be crash history or potential for crashes. Additional criteria include violation history, opinions of local traffic engineers and law enforcement officials, and other factors.

- Individual sites should be investigated to ensure that they are suitable for camera coverage prior to camera installation.
- When installing a RLR camera, cities should use a series or orderly steps to increase the likelihood of success in reducing violations and crashes.
- Each red light camera installation should be tailored to fit the local situation.
- Where grace periods are adopted by local officials, 0.2 or 0.3 seconds are appropriate for routine situations, but longer periods may be needed in some situations.
- Financial arrangements will vary from city to city, but should be robust enough to ensure proper operation of the system. RLR camera systems should generate enough revenue to offset the major costs of the systems.
- Fine revenues collected from RLR camera citations should be distributed according to the provisions in Alabama House bill 683, introduced in the 2001 Legislature.
- Where excess revenues (beyond the cost of acquiring and operating the RLR camera program) are generated, they should be dedicated to safety and road projects in the host city.

## **Conclusion**

This research project investigated red light running camera systems. The project included a literature review, conversations with cities that have implemented RLR camera, conversations with national FHWA experts, and a year long pilot installation of a RLR camera in Tuscaloosa, Alabama. All findings pointed to a strong conclusion. These cameras are legal, accepted by the public, and effective in reducing violations, crashes, injuries and fatalities.

The research staff strongly encourages the adoption of automated enforcement of red light running in Alabama, as a safety countermeasure to mitigate the approximately 5,278 RLR collisions that occur each year, and to reduce the approximately 1,812 Alabama citizens injured and killed each year in these collisions.

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## **Appendices**

- A - Sample Red Light Running Camera Legislation
  - (A1) Automated Traffic Law Enforcement Model Law
  - (A2) Alabama House Bill 683 (2001), The Red Light Safety Act of 2001
- B - A description of the CARE software and its capabilities
- C - PTS Intersection Installation and Maintenance Guide
- D - PTS Enforcement Unit Details and Installation Diagrams
- E - Red Light Violation Figures

## **Appendix A1**

### **Automated Traffic Law Enforcement Model Law**

(Reformatted for this UTCA report)

### **Automated Traffic Law Enforcement Model Law**

Prepared by the National Committee on Uniform Traffic Laws and Ordinances  
[www.ncutlo.org/autoenforce622.htm](http://www.ncutlo.org/autoenforce622.htm)

The objective of automated traffic law enforcement is reduced traffic crashes and improved adherence to traffic laws through the use of photographic and electronic technology as a supplement for traditional traffic law enforcement. This type of enforcement should be used at high crash sites, at other high-risk locations, or in situations where traffic law enforcement personnel cannot be utilized, either due to the pressing needs of other law enforcement activities or where inherent on-site problems make traditional law enforcement difficult.

Automated traffic law enforcement is not intended to replace traditional law enforcement personnel nor to mitigate safety problems caused by deficient road design, construction or maintenance. Rather, it provides enforcement at times and locations when police manpower is unavailable or its use raises safety concerns.

The model law imposes only a civil fine for traffic law violations enforced via an automated traffic law enforcement system and relies on an initial presumption of guilt. This approach is not new as it is typically utilized for the enforcement of parking law violations. As with parking violations, traffic law violations resulting from automated traffic law enforcement are not recorded in drivers' licensing files for possible point assessment or licensing action. Indeed, any attempt to unfavorably influence persons' driving privileges, through the use of this system, could raise due process of law concerns.

This model law contains provisions to insure that automated traffic law enforcement is not used as a revenue generator. Compensation paid for an automated traffic law system is to be based only on the value of the equipment or the services provided. Compensation for services or equipment is not to be based on the revenue generated by the system. To help further this goal and improve highway safety, this model law provides that revenue derived from automated traffic law enforcement may be utilized solely to fund highway safety functions.

## **Automated Traffic Law Enforcement Model Law**

### **§ 1 Legislative Purpose**

This legislation authorizes automated traffic law enforcement at high crash or other high-risk locations where on-site traffic law enforcement personnel cannot be utilized, either because of insufficient manpower or inherent on-site difficulties with enforcement by police officers. The objective of automated traffic law enforcement is reduced traffic crashes resulting from improved adherence to traffic laws achieved by effective deterrence of potential violators which could not be achieved by traditional law enforcement methods.

Automated traffic law enforcement is not intended to replace traditional law enforcement personnel, nor is it intended to mitigate problems caused by deficient road design, construction or maintenance. Rather, it provides enforcement at times and locations when police manpower is unavailable, difficult to utilize safely, or needed for other priorities.

### **§ 2 Applicability of law**

The State, a county, or a municipality may utilize an automated traffic law enforcement system to detect traffic violations under State or local law, subject to the conditions and limitations specified in this Act.

### **§ 3 Limitations on Use of Automated Enforcement**

Automated traffic law enforcement systems may be utilized only at locations with high incidences of violations or with high crash rates due to violations, where it is impractical or unsafe to utilize traditional enforcement, or where traditional enforcement has failed to deter violators. In determining deployment of automated traffic law enforcement systems, the judgment of the administering agency, when using due diligence in evaluating the suitability of potential deployment sites, including consideration of site violations and crash data, shall be controlling on where and when to install automatic traffic law enforcement systems.

Before issuing citations based on surveillance by an automated traffic law enforcement system, a traffic engineering analysis of the proposed site shall be conducted to verify that the location meets highway safety standards. An automated traffic law system may not be used as a means of combating deficiencies in roadway design or environment.

### **§ 4 Citation and Warning Notice**

(a) Pursuant to this section, an agency shall mail to the owner a citation, which shall include:

- (1) The name and address of the registered owner of the vehicle;
- (2) The registration number of the motor vehicle involved in the violation;
- (3) The violation charged;
- (4) The location where the violation occurred;
- (5) The date and time of the violation;
- (6) A copy of the recorded images;
- (7) The amount of the civil penalty imposed and the date by which the civil penalty should be paid;
- (8) A signed statement by a technician employed by the agency that, based on inspection of recorded images, the motor vehicle was being operated in violation of a traffic control device;
- (9) A statement that recorded images are evidence of a violation of a traffic control device;
- (10) Information advising the person alleged to be liable under this Act:
  - (A) Of the manner, time, and place in which liability as alleged in the citation may be contested; and
  - (B) Warning that failure to pay the civil penalty or to contest liability in a timely manner is an admission of liability and may result in denial of renewal of vehicle registration.
  - (C) Except as provided in §7(f)(2), a citation issued under this section shall be mailed no later than 2 weeks after the alleged violation.

(b) An owner who receives a citation pursuant to the provisions of this Act may:

- (1) Pay the civil penalty;
- (2) Elect to stand trial for the alleged violation; or
- (3) Specify the person who was operating the vehicle at the time of the violation, including the operator's name and current address.

### **§ 5 Violations**

Unless the driver of the motor vehicle received a citation from a police officer at the time of the violation, the motor vehicle owner, or the driver if subsection 7 (f) (2) is applicable, is subject to a civil penalty not exceeding \$(\_\_\_\_) if the motor vehicle is recorded by an automated traffic law enforcement system. A violation for which a civil penalty is imposed under this Act is not a moving violation for the purpose of assessing points and may not be recorded on the driving record of the owner or driver of the vehicle.

#### **§ 6 Failure to Pay Penalty or Contest Violation**

If a person charged with a traffic violation as a result of automated traffic law enforcement does not pay the civil penalty resulting from that violation, the department of motor vehicles may refuse to reregister any motor vehicles owned by that person.

#### **§ 7 Rules of Evidence and Defenses**

- a) (1) Based on inspection of recorded images produced by an automated traffic law enforcement system, a citation or copy thereof alleging that the violation occurred and signed by a duly authorized agent of the agency shall be evidence of the facts contained therein and shall be admissible in any proceeding alleging a violation under this section.
- (2) Adjudication of liability shall be based on a preponderance of evidence.
- (b) The court may consider in defense of a violation:
  - (1) That the motor vehicle or registration plates of the motor vehicle were stolen before the violation occurred and not under the control of or in the possession of the owner at the time of the violation;
  - (2) Evidence satisfactory to the Court that the person named in the citation was not operating the vehicle at the time of the violation;
  - (3) With respect to an alleged red light violation, evidence that the driver of the vehicle passed through the intersection when the light was red:
    - (A) In order to yield the right-of-way to an emergency vehicle; or
    - (B) As part of a funeral procession;
    - (C) The vehicle had not illegally crossed the required stopping point.
  - (4) Any other evidence or issues that the Court deems pertinent.
- (c) In order to demonstrate that the motor vehicle or the registration plates were stolen before the violation occurred and were not under the control or possession of the owner at the time of the violation, the owner must submit proof that a police report concerning the stolen motor vehicle or registration plates was filed in a timely manner.
- (d) In order to demonstrate that the person named in the citation was not the violator, the person so named in the citation shall provide evidence satisfactory to the Court, specifying the person who was operating the vehicle at the time of the violation, including the operator's name and current address.
- (e) If the person named in the citation is an owner of a commercial vehicle with a registered gross weight of 10,000 pounds or more, a tractor vehicle, a trailer operated in combination with a tractor vehicle or a passenger bus, in order to demonstrate that he or she was not the violator, that person shall, in a letter mailed to the Court by certified mail return receipt requested:
  - (A) Swear that the person named in the citation was not operating the vehicle at the time of the violation; and
  - (B) Provide the name, address, and driver's license identification number of the person who was operating the vehicle at the time of the violation.
- (f) (1) If the court finds that the person named in the citation was not operating the vehicle at the time of the violation or receives evidence identifying the person who was driving the vehicle at the time of the violation, the clerk of the court shall provide to the agency issuing the citation a copy of the evidence identifying who was operating the vehicle at the time of the violation.
- (2) Upon receipt of evidence from the court that a person other than the one initially charged was operating the vehicle at the time of the violation, an agency may issue a citation to that other person so identified. A citation issued under this paragraph shall be mailed no later than 2 weeks after receipt of the evidence from the court.

#### **§ 8 Public information**

A public information campaign must precede the issuance of citations using an automated traffic law enforcement system. An integral part of an automated traffic law enforcement program is a community-wide information campaign to inform the driving public. This public information campaign shall continue throughout the life of automated traffic law enforcement program and may be funded from revenues derived from the program. The goal of the automated traffic law enforcement program is reduced traffic crashes achieved by deterrence of violations, not the issuance of citations or the generation of revenues.

#### **§ 9 Payment for Automated Traffic Enforcement System**

The compensation paid for an automated traffic law system shall be based on the value of the equipment or the services provided. It may not be based on the revenue generated by the system.

#### **§ 10 Use of Revenues Derived from Automated Enforcement**

No portion of any fine collected through the use of automated traffic law system may be utilized as general revenue of the implementing jurisdiction. Revenue derived from automated traffic law enforcement shall be utilized solely to fund highway safety functions and projects, which may include the cost of automated enforcement programs. Automated enforcement program costs that may be funded by revenues derived from citation fines are limited to equipment acquisition, installation and replacement, program administration, public information campaigns and education, and periodic program evaluations of compliance, public awareness and impacts on highway safety.

**§ 11 Adoption of Implementing Procedures**

In consultation with local governments, the chief judge of the (insert name of the appropriate state, county or municipal court) shall adopt procedures for the issuance of citations, the trial of civil violations, and the collection of civil penalties under this Act. Thresholds established for determining violations and protocols for establishing acceptable evidence of committed violations shall be established and documented by the public agency responsible for administering the automated enforcement program. This authority may not be delegated to equipment vendors, service providers or other private sector institutions or employees.

**§12 Program Evaluation**

Within three years of the establishment of an automated traffic law enforcement program, the implementing jurisdiction shall initiate a formal evaluation of the program to determine the program's impact on highway safety. That evaluation shall be completed within (one year).

**§13 Definitions**

"Agency" means any public organization of the State or a political subdivision that is authorized to issue citations for a violation of State vehicle law or of local traffic laws or regulations.

"Automated traffic law enforcement system," means a device with one or more sensors working in conjunction with:

- (1) A red light signal to produce recorded images of motor vehicles entering an intersection against a red signal indication; or
- (2) A speed measuring device to produce recorded images of motor vehicles traveling at a prohibited rate of speed; or
- (3) A device to produce recorded images of motor vehicles violating railroad grade crossing signals; or
- (4) Any other traffic control device if the failure to comply with it constitutes (Insert appropriate language from the state code which enumerates safety-related moving violations).

"Automated traffic law enforcement program" means the utilization of one or more automated traffic law enforcement systems to issue citations for civil violations of traffic law.

The "Manual on Uniform Traffic Control Devices" means the national standard for all traffic control devices installed on any street, highway or bicycle trail open to public travel in accordance with 23 U.S.C. 109(d) and 402(a).

"Owner" means the registered owner of a motor vehicle or a lessee of a motor vehicle under a lease of 6 month or more.

"Recorded images" means images recorded by an automated traffic law enforcement system on:

- (1) Two or more photographs;
- (2) Two or more microphotographs;
- (3) Two or more electronic images; or
- (4) A videotape;

Showing the motor vehicle, and on at least one image or portion of tape, clearly identifying the registration plate number of the motor vehicle.

A "traffic control device" means any sign, signal, marking, channelizing and other device in conformance with the Manual on Uniform Traffic Control Devices and used to regulate, warn or guide traffic, placed on, over, or adjacent to a street, highway, roadway, pedestrian facility, or bicycle path by authority of a public body or official having jurisdiction.

## **Appendix A2**

### **Alabama House Bill 683 (2001) The Red Light Safety Act of 2001**

(Reformatted for this UTCA report)



1 HB683  
2 34694-2  
3 By Representatives Haney, Gipson, Thigpen, Sanderford, Hall  
4 (L), Beasley, Hamilton, Ford (J), Boothe, Bridges, Clouse,  
5 Laird, Greene, Barton, McMillan and Newton (D)  
6 RFD: Ways and Means General Fund  
7 First Read: 22-MAR-2001

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1 34694-2:G:03/22/2001:LD/abm LRS2001-13724R1  
2  
3  
4  
5  
6  
7

8 SYNOPSIS: This bill would create a pilot project that  
9 would authorize the governing body in any Class 1,  
10 2, or 3 municipality to enact an ordinance,  
11 provided it meets certain requirements, that  
12 permits the use of traffic infraction detectors.

13 This bill would define a traffic infraction  
14 detector as a device that uses a vehicle sensor  
15 installed to work in conjunction with a traffic  
16 control signal and a camera synchronized to  
17 automatically record photographs or images when a  
18 vehicle fails to stop at a red light.

19 This bill would provide that civil penalties  
20 may be imposed for a violation of the act.

21 This bill would provide that the registered  
22 owner of a vehicle would be held liable for  
23 violating the act unless the owner can establish  
24 that he or she ran a red light to yield  
25 right-of-way to an emergency vehicle, that he or  
26 she ran the red light at the direction of a police  
27 officer, that the vehicle was not in his or her

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1 care, custody, or control, or any other reason the  
2 court deems justifiable.

3 This bill would provide that any fees  
4 collected pursuant to the act shall be divided  
5 between the general fund of the municipality, the  
6 Law Enforcement Traffic Safety Division of the  
7 Department of Economic and Community Affairs, the  
8 Administrative Office of Courts, and the General  
9 Fund of the State of Alabama.

10 This bill would require a participating  
11 municipality to submit an annual report to the Law  
12 Enforcement Traffic Safety Division of the  
13 Department of Economic and Community Affairs, and a

14 summary report to the President of the Senate, the  
15 President Pro Tern of the Senate, the Speaker of the  
16 House of Representatives, and the Governor.

17 This bill would require any traffic control  
18 device to be approved by the Department of  
19 Transportation and any traffic infraction detector  
20 must meet the requirements established by the  
21 Department of Transportation.

22  
23 A BILL  
24 TO BE ENTITLED  
25 AN ACT  
26

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1 Relating to uniform traffic control; creating "The  
2 Red Light Safety Act of 2001"; amending Section 32-1-1.1, Code  
3 of Alabama 1975, to add a definition; amending Section  
4 32-5A-30, Code of Alabama 1975, to include additional  
5 subsections, which would provide that traffic control devices  
6 and traffic infraction detectors must meet the requirements  
7 established by the Department of Transportation; creating a  
8 pilot project for Class 1, 2, and 3 municipalities to be  
9 administered by the Law Enforcement Traffic Safety Division of  
10 the Department of Economic and Community Affairs; authorizing  
11 municipalities that desire to participate in the pilot project  
12 to enact ordinances permitting the use of traffic infraction  
13 detectors; providing for the expiration of the pilot project  
14 after a specified period of time unless the Legislature  
15 extends the project by resolution; and providing for penalties  
16 for violations detected by the traffic infraction detectors.  
17 BE IT ENACTED BY THE LEGISLATURE OF ALABAMA:

18 Section 1. (a) The Legislature finds and declares  
19 the following:

20 (1) Motor vehicle drivers who run red lights are a  
21 serious concern to law enforcement, traffic safety, and health  
22 officials in this state.

23 (2) By disregarding red lights, motor vehicle  
24 drivers put themselves, other drivers, and pedestrians in  
25 jeopardy by creating situations that cause automobile crashes  
26 and, consequently, result in death, serious injury, or costly  
27 property damage.

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1 (3) The number of fatal crashes continues to  
2 increase as a result of motor vehicle drivers who run red  
3 lights at intersections.

4 (4) Injuries received in automobile crashes due to  
5 drivers who run red lights result in significant health care  
6 costs.

7 (5) Due to the manpower shortages and budget  
8 constraints, law enforcement agencies in Alabama are not able  
9 to adequately enforce the violations that occur from running

10 red lights. Therefore, it is the intent of the Legislature to  
11 assist law enforcement agencies by providing every available  
12 tool or innovative approach to curb the ever increasing  
13 crashes that result from running red lights.

14 (b) Accordingly, one approach to assisting law  
15 enforcement is this proposed bill that creates "The Red Light  
16 Safety Act of 2001."

17 Section 2. Sections 32-1-1.1 and 32-5A-30, Code of  
18 Alabama 1975, are amended to read as follows:

19 "§32-1-1.1.

20 "The following words and phrases when used in this  
21 title shall, for the purpose of this title, have meanings  
22 respectively ascribed to them in this section, except when the  
23 context otherwise requires:

24 "(1) ALLEY. A street or highway intended to provide  
25 access to the rear or side of lots or buildings in urban  
26 districts and not intended for the purpose of through  
27 vehicular traffic.

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1 "(2) ARTERIAL STREET. Any United States or state  
2 numbered route, controlled-access highway, or other major  
3 radial or circumferential street or highway designated by  
4 local authorities within their respective jurisdictions as  
5 part of a major arterial system of streets or highways.

6 "(3) AUTHORIZED EMERGENCY VEHICLE. Such fire  
7 department vehicles, police vehicles and ambulances as are  
8 publicly owned, and such other publicly or privately owned  
9 vehicles as are designated by the Director of Public Safety or  
10 the chief of police of an incorporated city.

11 "(4) BICYCLE. Every device propelled by human power  
12 upon which any person may ride, having two tandem wheels  
13 either of which is more than 14 inches in diameter.

14 "(5) BUS. Every motor vehicle designed for carrying  
15 more than 10 passengers and used for the transportation of  
16 persons; and every motor vehicle other than a taxicab,  
17 designed and used for the transportation of persons for  
18 compensation.

19 "(6) BUSINESS DISTRICT. The territory contiguous to  
20 and including a highway when within any 600 feet along such  
21 highway there are buildings in use for business or industrial  
22 purposes, including but not limited to hotels, banks or office  
23 buildings, railroad stations and public buildings which occupy  
24 at least 300 feet of frontage on one side or 300 feet  
25 collectively on both sides of the highway.

26 "(7) CANCELLATION OF DRIVER'S LICENSE. The annulment  
27 or termination by formal action of the Director of Public

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1 Safety of a person's driver's license because of some error or  
2 defect in the license or because the licensee is no longer  
3 entitled to such license, but the cancellation of a license is  
4 without prejudice and application for a new license may be

5 made at any time after such cancellation.  
6 "(8) CONTROLLED-ACCESS HIGHWAY. Every highway,  
7 street or roadway in respect to which owners or occupants of  
8 abutting lands and other persons have no legal right of access  
9 to or from the same except at such points only and in such  
10 manner as may be determined by the public authority having  
11 jurisdiction over such highway, street or roadway.  
12 "(9) CROSSWALK.  
13 "a. That part of a roadway at an intersection  
14 included within the connections of the lateral lines of the  
15 sidewalks on opposite sides of the highway measured from the  
16 curbs or, in the absence of curbs, from the edges of the  
17 traversable roadway;  
18 "b. Any portion of a roadway at an intersection or  
19 elsewhere distinctly indicated for pedestrian crossing by  
20 lines or other markings on the surface.  
21 "(10) DEALER. Every person engaged in the business  
22 of buying, selling or exchanging vehicles who has an  
23 established place of business for such purpose in this state  
24 and to whom current dealer registration plates have been  
25 issued by the Department of Revenue.

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1 "(11) DEPARTMENT. The Department of Public Safety of  
2 this state acting directly or through its duly authorized  
3 officers and agents.  
4 "(12) DIRECTOR. The Director of Public Safety of  
5 Alabama.  
6 "(13) DRIVEAWAY-TOWAWAY OPERATION. Any operation in  
7 which any motor vehicle, trailer or semitrailer, singly or in  
8 combination, new or used, constitutes the commodity being  
9 transported, when one set or more of wheels of any such  
10 vehicle are on the roadway during the course of  
11 transportation, whether or not any such vehicle furnishes the  
12 motive power.  
13 "(14) DRIVER. Every person who drives or is in  
14 actual physical control of a vehicle.  
15 "(15) DRIVER'S LICENSE. Any license to operate a  
16 motor vehicle issued under the laws of this state.  
17 "(16) ESSENTIAL PARTS. All integral and body parts  
18 of a vehicle of a type required to be registered hereunder,  
19 the removal, alteration or substitution of which would tend to  
20 conceal the identity of the vehicle or substantially alter its  
21 appearance, model, type or mode of operation.  
22 "(17) ESTABLISHED PLACE OF BUSINESS. The place  
23 actually occupied either continuously or at regular periods by  
24 a dealer or manufacturer where his books and records are kept  
25 and a large share of his business is transacted.  
26 "(18) EXPLOSIVES. Any chemical compound or  
27 mechanical mixture that is commonly used or intended for the

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1 purpose of producing an explosion and which contains any

2 oxidizing and combustive units or other ingredients in such  
3 proportions, quantities or packing that an ignition by fire,  
4 by friction, by concussion, by percussion or by detonator of  
5 any part of the compound or mixture may cause such a sudden  
6 generation of highly heated gases that the resultant gaseous  
7 pressures are capable of producing destructive effects on  
8 contiguous objects or of destroying life or limb.  
9 "(19) FARM TRACTOR. Every motor vehicle designed and  
10 used primarily as a farm implement, for drawing plows, mowing  
11 machines and other implements of husbandry.  
12 "(20) FLAMMABLE LIQUID. Any liquid which has a flash  
13 point of 70; F., or less as determined by a fagliabue or  
14 equivalent closed-cup test device.  
15 "(21) FOREIGN VEHICLE. Every vehicle of a type  
16 required to be registered hereunder brought into this state  
17 from another state, territory or country other than in the  
18 ordinary course of business by or through a manufacturer or  
19 dealer and not registered in this state.  
20 "(22) GROSS WEIGHT. The weight of a vehicle without  
21 load plus the weight of any load thereon.  
22 "(23) HIGHWAY. The entire width between the boundary  
23 lines of every way publicly maintained when any part thereof  
24 is open to the use of the public for purposes of vehicular  
25 travel.  
26 "(24) HOUSE TRAILER.

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1 "a. A trailer or semitrailer which is designed,  
2 constructed and equipped as a dwelling place, living abode or  
3 sleeping place (either permanently or temporarily) and is  
4 equipped for use as a conveyance on streets and highways; or  
5 "b. A trailer or semitrailer whose chassis and  
6 exterior shell is designed and constructed for use as a house  
7 trailer, as defined in paragraph a., but which is used instead  
8 permanently or temporarily for the advertising, sales, display  
9 or promotion of merchandise or services, or for any other  
10 commercial purpose except the transportation of property for  
11 hire or the transportation of property for distribution by a  
12 private carrier.  
13 "(25) IMPLEMENT OF HUSBANDRY. Every vehicle designed  
14 and adapted exclusively for agricultural, horticultural or  
15 livestock raising operations or for lifting or carrying an  
16 implement of husbandry and in either case not subject to  
17 registration if used upon the highways.  
18 "(26) INTERSECTION.  
19 "a. The area embraced within the prolongation or  
20 connection of the lateral curb lines, or, if none, then the  
21 lateral boundary lines of the roadways of two highways which  
22 join one another at, or approximately at, right angles, or the  
23 area within which vehicles traveling upon different highways  
24 joining at any other angle may come in conflict.  
25 "b. Where a highway includes two roadways 30 feet or  
26 more apart, then every crossing of each roadway of such  
27 divided highway by an intersecting highway shall be regarded

1 as a separate intersection. In the event such intersecting  
2 highway also includes two roadways 30 feet or more apart, then  
3 every crossing of two roadways of such highways shall be  
4 regarded as a separate intersection.

5 "c. The junction of an alley with a street or  
6 highway shall not constitute an intersection.

7 "(27) LANED ROADWAY. A roadway which is divided into  
8 two or more clearly marked lanes for vehicular traffic.

9 "(28) LICENSE or LICENSE TO OPERATE A MOTOR VEHICLE.  
10 Any driver's license or any other license or permit to operate  
11 a motor vehicle issued by the director under the laws of this  
12 state, including any nonresident's operating privilege as  
13 defined herein.

14 "(29) LOCAL AUTHORITIES.

15 "a. Every county commission; and

16 "b. Every municipal and other local board or body  
17 having authority to enact laws relating to traffic under the  
18 constitution and laws of this state.

19 "(30) MAIL. To deposit in the United States mail  
20 properly addressed and with postage prepaid.

21 "(31) METAL TIRE. Every tire the surface of which in  
22 contact with the highway is wholly or partly of metal or other  
23 hard, non-resilient material.

24 "(32) MOTOR VEHICLE. Every vehicle which is  
25 self-propelled and every vehicle which is propelled by  
26 electric power obtained from overhead trolley wires, but not  
27 operated upon rails.

1 "(33) MOTORCYCLE. Every motor vehicle having a seat  
2 or saddle for the use of the rider and designed to travel on  
3 not more than three wheels in contact with the ground, but  
4 excluding a tractor.

5 "(34) MOTOR-DRIVEN CYCLE. Every motorcycle,  
6 including every motor scooter, with a motor which produces not  
7 to exceed five brake horsepower nor to exceed 150 cubic  
8 centimeter engine displacement, and weighs less than 200  
9 pounds fully equipped, and every bicycle with motor attached.

10 "(35) NONRESIDENT. Every person who is not a  
11 resident of this state.

12 "(36) NONRESIDENT'S OPERATING PRIVILEGE. The  
13 privilege conferred upon a nonresident by the laws of this  
14 state pertaining to the operation by such person of a motor  
15 vehicle, or the use of a vehicle owned by such person, in this  
16 state.

17 "(37) OFFICIAL TRAFFIC-CONTROL DEVICES. All signs,  
18 signals, markings and devices not inconsistent with this title  
19 placed or erected by authority of a public body or official  
20 having jurisdiction, for the purpose of regulating, warning or  
21 guiding traffic.

22 "(38) OWNER. A person, other than a lien-holder,  
23 having the property in or title to a vehicle. The term

24 includes a person entitled to the use and possession of a  
25 vehicle subject to a security interest in another person, but  
26 excludes a lessee under a lease not intended as security.

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1 "(39) PARK or PARKING. The standing of a vehicle,  
2 whether occupied or not, otherwise than temporarily for the  
3 purpose of and while actually engaged in loading or unloading  
4 merchandise or passengers.

5 "(40) PASSENGER CAR. Every motor vehicle, except  
6 motorcycles and motor-driven cycles, designed for carrying 10  
7 passengers or less and used for the transportation of persons.

8 "(41) PEDESTRIAN. Any person afoot.

9 "(42) PERSON. Every natural person, firm,  
10 copartnership, association or corporation.

11 "(43) PNEUMATIC TIRE. Every tire in which compressed  
12 air is designed to support the load.

13 "(44) POLE TRAILER. Every vehicle without motive  
14 power designed to be drawn by another vehicle and attached to  
15 the towing vehicle by means of a reach or pole, or by being  
16 boomed or otherwise secured to the towing vehicle, and  
17 ordinarily used for transporting long or irregularly shaped  
18 loads such as poles, pipes or structural members capable,  
19 generally, of sustaining themselves as beams between the  
20 supporting connections.

21 "(45) POLICE OFFICER. Every officer authorized to  
22 direct or regulate traffic or to make arrests for violations  
23 of traffic regulations.

24 "(46) PRIVATE ROAD or DRIVEWAY. Every way or place  
25 in private ownership and used for vehicular travel by the  
26 owner and those having express or implied permission from the  
27 owner, but not by other persons.

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1 "(47) RAILROAD. A carrier of persons or property  
2 upon cars other than street cars, operated upon stationary  
3 rails.

4 "(48) RAILROAD SIGN or SIGNAL. Any sign, signal or  
5 device erected by authority of a public body or official or by  
6 a railroad and intended to give notice of the presence of  
7 railroad tracks or the approach of a railroad train.

8 "(49) RAILROAD TRAIN. A steam engine, electric or  
9 other motor, with or without cars coupled thereto, operated  
10 upon rails.

11 "(50) RECONSTRUCTED VEHICLE. Every vehicle of a type  
12 required to be registered hereunder materially altered from  
13 its original construction by the removal, addition or  
14 substitution of essential parts, new or used.

15 "(51) REGISTRATION. The registration certificate or  
16 certificates and registration plates issued under the laws of  
17 this state pertaining to the registration of vehicles.

18 "(52) RESIDENCE DISTRICT. The territory contiguous  
19 to and including a highway not comprising a business district

20 when the property on such highway for a distance of 300 feet  
21 or more is in the main improved with residences or residences  
22 and buildings in use for business.  
23 "(53) REVOCATION OF DRIVER'S LICENSE. The  
24 termination by formal action of the director of a person's  
25 license or privilege to operate a motor vehicle on the public  
26 highways, which termination shall not be subject to renewal or  
27 restoration except that an application for a new license may

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1 be presented and acted upon by the director after the  
2 expiration of the applicable period of time prescribed in this  
3 title.

4 "(54) RIGHT-OF-WAY. The right of one vehicle or  
5 pedestrian to proceed in a lawful manner in preference to  
6 another vehicle or pedestrian approaching under such  
7 circumstances of direction, speed and proximity as to give  
8 rise to danger of collision unless one grants precedence to  
9 the other.

10 "(55) ROAD TRACTOR. Every motor vehicle designed and  
11 used for drawing other vehicles and not so constructed as to  
12 carry any load thereon either independently or any part of the  
13 weight of a vehicle or load so drawn.

14 "(56) ROADWAY. That portion of a highway improved,  
15 designed or ordinarily used for vehicular travel, exclusive of  
16 the berm or shoulder. In the event a highway includes two or  
17 more separate roadways the term "roadway" as used herein shall  
18 refer to any such roadway separately but not to all such  
19 roadways collectively.

20 "(57) SAFETY ZONE. The area or space officially set  
21 apart within a roadway for the exclusive use of pedestrians  
22 and which is protected or is so marked or indicated by  
23 adequate signs as to be plainly visible at all times while set  
24 apart as a safety zone.

25 "(58) SCHOOL BUS. Every motor vehicle that complies  
26 with the color and identification requirements set forth by  
27 statute or regulation and is used to transport children to or

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1 from school or in connection with school activities, but not  
2 including buses operated by common carriers in urban  
3 transportation of school children.

4 "(59) SECURITY AGREEMENT. A written agreement which  
5 reserves or creates a security interest.

6 "(60) SECURITY INTEREST. An interest in a vehicle  
7 reserved or created by agreement and which secures payment or  
8 performance of an obligation. The term includes the interest  
9 of a lessor under a lease intended as security. A security  
10 interest is perfected when it is valid against third parties  
11 generally, subject only to specific statutory exceptions.

12 "(61) SEMITRAILER. Every vehicle with or without  
13 motive power, other than a pole trailer, designed for carrying  
14 persons or property and for being drawn by a motor vehicle and



15 so constructed that some part of its weight and that of its  
16 load rests upon or is carried by another vehicle.  
17 "(62) SIDEWALK. That portion of a street between the  
18 curb lines, or the lateral lines of a roadway, and the  
19 adjacent property lines, intended for use by pedestrians.  
20 "(63) SOLID TIRE. Every tire of rubber or other  
21 resilient material which does not depend upon compressed air  
22 for the support of the load.  
23 "(64) SPECIAL MOBILE EQUIPMENT. Every vehicle not  
24 designed or used primarily for the transportation of persons  
25 or property and only incidentally operated or moved over a  
26 highway, including but not limited to: ditch digging  
27 apparatus, well boring apparatus and road construction and

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1 maintenance machinery such as asphalt spreaders, bituminous  
2 mixers, bucket loaders, tractors other than truck tractors,  
3 ditchers, leveling graders, finishing machines, motor  
4 graders, road rollers, scarifiers, earth moving carry-alls and  
5 scrapers, power shovels and drag lines, and self-propelled  
6 cranes and earth moving equipment. The term does not include  
7 house trailers, dump trucks, truck mounted transit mixers,  
8 cranes or shovels, or other vehicles designed for the  
9 transportation of persons or property to which machinery has  
10 been attached.  
11 "(65) SPECIALLY CONSTRUCTED VEHICLE. Every vehicle  
12 of a type required to be registered hereunder not originally  
13 constructed under a distinctive name, make, model or type by a  
14 generally recognized manufacturer of vehicles and not  
15 materially altered from its original construction.  
16 "(66) STAND or STANDING. The halting of a vehicle,  
17 whether occupied or not, otherwise than temporarily for the  
18 purpose of and while actually engaged in receiving or  
19 discharging passengers.  
20 "(67) STATE. A state, territory or possession of the  
21 United States, the District of Columbia, the Commonwealth of  
22 Puerto Rico or a province of Canada.  
23 "(68) STOP. When required, means complete cessation  
24 from movement.  
25 "(69) STOP or STOPPING. When prohibited means any  
26 halting even momentarily of a vehicle, whether occupied or  
27 not, except when necessary to avoid conflict with other

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1 traffic or in compliance with the directions of a police  
2 officer or traffic-control sign or signal.  
3 "(70) STREET. The entire width between boundary  
4 lines of every way publicly maintained when any part thereof  
5 is open to the use of the public for purposes of vehicular  
6 travel.  
7 "(71) SUSPENSION OF DRIVER'S LICENSE. The temporary  
8 withdrawal by formal action of the Director of Public Safety  
9 of a person's license or privilege to operate a motor vehicle

10 on the public highways, which temporary withdrawal shall be  
11 for a period specifically designated by the director.  
12 "(72) THROUGH HIGHWAY. Every highway or portion  
13 thereof on which vehicular traffic is given preferential  
14 right-of-way, and at the entrances to which vehicular traffic  
15 from intersecting highways is required by law to yield the  
16 right-of-way to vehicles on such through highway in obedience  
17 to a stop sign, yield sign, or other official traffic-control  
18 device, when such signs or devices are erected as provided in  
19 this title.  
20 "(73) TRACKLESS TROLLEY COACH. Every motor vehicle  
21 which is propelled by electric power obtained from overhead  
22 trolley wires but not operated upon rails.  
23 "(74) TRAFFIC. Pedestrians, ridden or herded  
24 animals, vehicles, streetcars and other conveyances either  
25 singly or together while using any highway for purposes of  
26 travel.

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1 "(75) TRAFFIC-CONTROL SIGNAL. Any device, whether  
2 manually, electrically or mechanically operated, by which  
3 traffic is alternately directed to stop and permitted to  
4 proceed.  
5 "(76) TRAFFIC INFRACTION DETECTOR. A device that  
6 uses a vehicle sensor installed to work in conjunction with a  
7 traffic control signal and a camera synchronized to  
8 automatically record two or more sequenced photographs.  
9 microphotographs. or electronic images. utilizing wet film.  
10 digital imaging. or full motion streaming video. of only the  
11 rear of a motor vehicle at the time the vehicle fails to stop  
12 when facing a steady red traffic control signal.  
13 "~~(76)~~ (77) TRAILER. Every vehicle with or without  
14 motive power, other than a pole trailer, designed for carrying  
15 persons or property and for being drawn by a motor vehicle and  
16 so constructed that no part of its weight rests upon the  
17 towing vehicle.  
18 "~~(77)~~ (78) TRANSPORTER. Every person engaged in the  
19 business of delivering vehicles of a type required to be  
20 registered hereunder from a manufacturing, assembling or  
21 distributing plant to dealers or sales agents of a  
22 manufacturer.  
23 "~~(78)~~ (79) TRUCK. Every motor vehicle designed, used  
24 or maintained primarily for the transportation of property.  
25 "~~(79)~~ (80) TRUCK TRACTOR. Every motor vehicle  
26 designed and used primarily for drawing other vehicles and not

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1 so constructed as to carry a load other than a part of the  
2 weight of the vehicle and load so drawn.  
3 "~~(80)~~ (81) URBAN DISTRICT. The territory contiguous  
4 to and including any street which is built up with structures  
5 devoted to business, industry or dwelling houses situated at  
6 intervals of less than 100 feet for a distance of a quarter of  
7 a mile or more.

8           "~~(81)~~ (82) VEHICLE. Every device in, upon or by  
9           which any person or property is or may be transported or drawn  
10          upon a highway, excepting devices moved by human power or used  
11          exclusively upon stationary rails or tracks; provided, that  
12          for the purposes of this title, a bicycle or a ridden animal  
13          shall be deemed a vehicle, except those provisions of this  
14          title, which by their very nature can have no application.

15           "§32-5A-30.

16           "(a) The Department of Transportation is authorized  
17          to classify, designate, and mark both interstate and  
18          intrastate highways lying within the boundaries of this state.

19           "(b) The Department of Transportation shall adopt a  
20          manual and specifications for a uniform system of  
21          traffic-control devices consistent with the provisions of this  
22          chapter and other state laws for use upon highways within this  
23          state. Such uniform system shall correlate with and so far as  
24          possible conform to the system set forth in the most recent  
25          edition of the Manual on Uniform Traffic-Control Devices for  
26          Streets and Highways and other standards issued or endorsed by  
27          the federal highway administrator.

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1           "(c) No local authority shall place or maintain any  
2          traffic-control device upon any highway under the jurisdiction  
3          of the Department of Transportation except by the latter's  
4          permission.

5           "(d) Any system of traffic control devices  
6          controlled and operated from a remote location by electronic  
7          computers or similar devices shall meet all the requirements  
8          established for the uniform system, and, if the system affects  
9          the movement of traffic on state roads, the design of the  
10         system shall be reviewed and approved by the Department of  
11         Transportation.

12          "(e) Any traffic infraction detector deployed on the  
13         streets and highways of the state shall meet the requirements  
14         established by the Department of Transportation and shall be  
15         tested according to procedures at regular intervals as  
16         prescribed by the department."

17           Section 3. (a) This act shall be known as and may be  
18          cited as "The Red Light Safety Act of 2001."

19           (b) There is created a pilot project on the  
20          operation of traffic infraction detectors for Class 1, 2, and  
21          3 municipalities only. The pilot project shall be administered  
22          by the Law Enforcement Traffic Safety Division of the  
23          Department of Economic and Community Affairs. The project  
24          shall include the following provisions:

25           (1) Participation in the pilot program shall be  
26          voluntary and the municipality shall bear all cost associated  
27          with the project.

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1           (2) In order to utilize a traffic infraction  
2          detector, a municipality shall enact an ordinance that

3 provides for the use of a traffic infraction detector to  
4 enforce Sections 32-5A-31 and 32-5A-32, Code of Alabama 1975,  
5 which require the driver of a vehicle to stop the vehicle when  
6 facing a steady red traffic control signal on the streets and  
7 highways under the jurisdiction of the municipality. Any  
8 municipality that operates a traffic infraction detector may  
9 by ordinance authorize a law enforcement officer to issue a  
10 ticket for violations of Sections 32-5A-31 and 32-5A-32, Code  
11 of Alabama 1975, and to enforce the payment of tickets for the  
12 violation. Any citation issued by the utilization of a traffic  
13 infraction detector shall include a photograph showing both  
14 the license tag of the offending vehicle and the traffic  
15 control device being violated in the same frame.

16 (3) The ordinance enacted shall meet the following  
17 requirements:

18 a. The ordinance shall require that a sign be posted  
19 at key entry points to the municipality and other conspicuous  
20 locations within the municipality to provide motorist with  
21 notification that a traffic infraction detector is in use. The  
22 sign shall conform to the standards and requirements adopted  
23 by the Department of Transportation under Section 32-5A-30,  
24 Code of Alabama 1975.

25 b. The ordinance shall require that the municipality  
26 make a public announcement and conduct a public awareness

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1 campaign of the proposed use of traffic infraction detectors  
2 at least 30 days before commencing the enforcement program.

3 c. The ordinance shall establish a schedule of fines  
4 to be assessed against the registered owner of a motor vehicle  
5 whose vehicle fails to stop when facing a steady red traffic  
6 control signal, as determined through the use of a traffic  
7 infraction detector. However, any civil penalty imposed by  
8 ordinance may not exceed one hundred dollars (\$100). Any other  
9 provision of law to the contrary notwithstanding, any  
10 additional surcharge, fee, or cost may not be added to the  
11 civil penalty authorized by this act.

12 (4) For purposes of this act, "owner" does not  
13 include a motor vehicle rental or leasing company.

14 (5) When responding to an emergency call, an  
15 emergency vehicle is exempt from any ordinance enacted  
16 pursuant to this act.

17 (c) (1) A municipality within the pilot project may  
18 adopt an ordinance that provides for the use of a traffic  
19 infraction detector in order to impose a civil penalty on the  
20 registered owner of a motor vehicle for a violation of an  
21 ordinance enacted under the provisions of this act. Any  
22 conviction under an ordinance enacted pursuant to the  
23 provisions of this act is not a conviction of the operator,  
24 may not be made a part of the driving record of the operator,  
25 and may not be used for purposes of setting motor vehicle  
26 insurance rates. Points may not be assessed based upon a  
27 violation.

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1           (2) The procedures set forth in Sections 32-5-152  
2 and 32-5-152.1, Code of Alabama 1975, apply to a violation of  
3 an ordinance enacted under this act and Section 32-5-1(d) ,  
4 Code of Alabama 1975, except that the ticket shall contain the  
5 name and address of the person alleged to be liable as the  
6 registered owner or operator of the motor vehicle involved in  
7 the violation, the license tag number of the vehicle, the  
8 violation charged, the location where the violation occurred,  
9 the date and time of the violation, information that  
10 identifies the device that recorded the violation and a signed  
11 statement by a technician employed by the agency stating that,  
12 based on inspection of recorded images, the motor vehicle was  
13 being operated in violation of Section 32-5A-32(3) .The ticket  
14 shall advise the registered owner of the motor vehicle  
15 responsible for the violation of the amount of the civil  
16 penalty, the date by which the fine is required to be paid,  
17 and the procedure for contesting the violation alleged in the  
18 ticket. The ticket shall contain a warning that failure to  
19 contest the violation in the manner and time provided is  
20 deemed an admission of the liability and that default may be  
21 entered thereon. The violation shall be processed by the  
22 municipality that has jurisdiction over the street or highway  
23 where the violation occurred or by any entity authorized by  
24 the municipality to prepare and mail the ticket.

25           (3) A certificate sworn to or affirmed by a person  
26 authorized under this act and Section 32-5-1(d) , Code of  
27 Alabama 1975, who is employed by or under contract with the

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1           municipality where the violation occurred, or a facsimile  
2 thereof which is based upon inspection of photographs or other  
3 recorded images produced by a traffic infraction detector, is  
4 prima facie evidence of the facts contained in the  
5 certificate. A photograph or other recorded image evidencing a  
6 violation shall be available for inspection in any proceeding  
7 to adjudicate liability for violation of an ordinance enacted  
8 under this act and Section 32-5-1(d) , Code of Alabama 1975.

9           (4) The uniform traffic citation prepared by the  
10 department under Section 12-12-53, Code of Alabama 1975, may  
11 not be issued for any violation for which a ticket is issued  
12 as provided in this section.

13           (5) In any municipality in which tickets are issued  
14 as provided in this section, the names of persons who have one  
15 or more outstanding violations shall be adjudicated by the  
16 municipal court in accordance with Section 12-14-10, Code of  
17 Alabama 1975. Any adjudication under this section that results  
18 in a suspension of driving privileges will not preclude any  
19 reinstatement fees required by law.

20           (d) The registered owner of the motor vehicle  
21 involved in a violation is responsible and liable for payment  
22 of the fine assessed under this act, unless the owner can  
23 establish one of the following:

24           (1) That the vehicle passed through the intersection

25 in order to yield right-of-way to an emergency vehicle or as a  
26 part of a funeral procession.

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1 (2) That the vehicle passed through the intersection  
2 at the direction of a police officer, subject to the  
3 exceptions granted the driver of an authorized emergency  
4 vehicle in Title 32, Chapter 5A of the Code of Alabama 1975.

5 (3) That the vehicle was, at the time of the  
6 violation, in the care, custody, or control of another person.

7 (4) Any other reason deemed justifiable by the court  
8 having jurisdiction.

9 (e) The registered owner shall, within 20 days after  
10 receipt of notification of the alleged violation, furnish the  
11 municipality with an affidavit stating that the registered  
12 owner meets one of the provisions of subsection (d) (1) through  
13 (4) above. Upon receipt of an affidavit, the person designated  
14 as having had care, custody, or control of the motor vehicle  
15 at the time of the violation may be issued a ticket. The  
16 affidavit is admissible in a proceeding pursuant to this  
17 section for the purpose of proving that the person identified  
18 in the affidavit was not in actual care, custody, or control  
19 of the motor vehicle. If the registered owner seeks to  
20 establish by affidavit that he or she was not in the care,  
21 custody, or control of the motor vehicle, the affidavit shall  
22 provide one of the following:

23 (1) The name, address, and if known, the driver's  
24 license number of the person who leased, rented or otherwise  
25 had care, custody, or control of the motor vehicle at the time  
26 of the alleged violations.

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1 (2) A statement that the vehicle was stolen with a  
2 copy of the police report attached to the affidavit,  
3 indicating that the vehicle was stolen at the time of the  
4 alleged violation.

5 (f) A person may elect to contest the determination  
6 that he or she failed to stop when faced with a steady red  
7 traffic control signal as evidenced by a traffic infraction  
8 detector by electing to appear before the municipal court of  
9 the municipality that adjudicates traffic infractions. Any  
10 person who elects to appear before the court to present  
11 evidence is deemed to have waived the limitation of civil  
12 penalties imposed for the violation. The court, after a  
13 hearing, shall determine whether the violation was committed  
14 and may impose a civil penalty not to exceed one hundred  
15 dollars (\$100) plus costs. The court may take appropriate  
16 measures to enforce collection of any penalty not paid within  
17 the time permitted by the court.

18 (g) The distribution of civil penalties collected  
19 under this section shall be as follows:

20 (1) The general fund of the municipality conducting  
21 the pilot project shall receive 80 percent of the civil

22 penalties collected.  
23 (2) The Law Enforcement Traffic Safety Division of  
24 the Department of Economic and Community Affairs shall receive  
25 10 percent of the civil penalties collected.  
26 (3) The Administrative Office of Courts shall  
27 receive 5 percent of the civil penalties collected.

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1 (4) The General Fund of the State of Alabama shall  
2 receive 5 percent of the civil penalties collected.  
3 (h) From the funds received due to civil penalties  
4 imposed under this act and Section 32-5-1(d) , Code of Alabama  
5 1975, municipalities that operate a traffic infraction  
6 detector under the pilot project shall submit a base line  
7 accident and violation report annually to the Law Enforcement  
8 Traffic Safety Division of the Department of Economic and  
9 Community Affairs. The report shall detail the results of  
10 using the traffic infraction detector and the procedures for  
11 enforcement and shall include:  
12 (1) A description of the location where  
13 traffic-control signal monitoring devices were used.  
14 (2) The number of violations recorded at each  
15 location and in the aggregate on a monthly basis.  
16 (3) The total number of citations issued.  
17 (4) The number of civil penalties and the total  
18 amount paid after citation without contest.  
19 (5) The number of violations adjudicated and results  
20 of the adjudication, including breakdowns of dispositions  
21 made.  
22 (6) The total amount of civil penalties paid.  
23 (7) The quality of the adjudication process and its  
24 results.  
25 (i) The Law Enforcement Traffic Safety Division of  
26 the Department of Economic and Community Affairs shall provide  
27 a summary report to the President of the Senate, the President

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1 Pro Tern of the Senate, the Speaker of the House of  
2 Representatives, and the Governor regarding the use and  
3 operation of traffic infraction detectors under this act and  
4 Section 32-5-1(d), Code of Alabama 1975. The summary report  
5 shall include a review of the information the municipality  
6 submitted to the department and shall describe the enhancement  
7 of the traffic safety and enforcement programs. The department  
8 shall report its recommendations on or before December of each  
9 year to the President of the Senate, the President Pro Tern of  
10 the Senate, the Speaker of the House of Representatives, and  
11 the Governor. The report shall include any recommendation  
12 regarding legislation in the event that the department  
13 determines that the pilot project would be beneficial for  
14 application on a statewide basis.  
15 (j) This section shall be repealed effective  
16 December 1, 2004, unless extended by resolution of the

17 Legislature.  
18 Section 4. This act shall become effective on the  
19 first day of the third month following its passage and  
20 approval by the Governor, or its otherwise becoming law.

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## **Appendix B**

**A description of the CARE software and its capabilities**

## Overview of CARE

Critical Analysis Reporting Environment (CARE) is a software system developed by faculty members and students of the Department of Computer Science at the University of Alabama. CARE has been implemented by state highway agencies in Alabama, Michigan, North Carolina, Tennessee, Iowa, and Delaware. It is one of the most sophisticated and versatile analytical tools specifically developed to provide crash and incident information to decision-makers in the fields of traffic and aviation safety. An example of a CARE work screen is showed in Figure B-1.

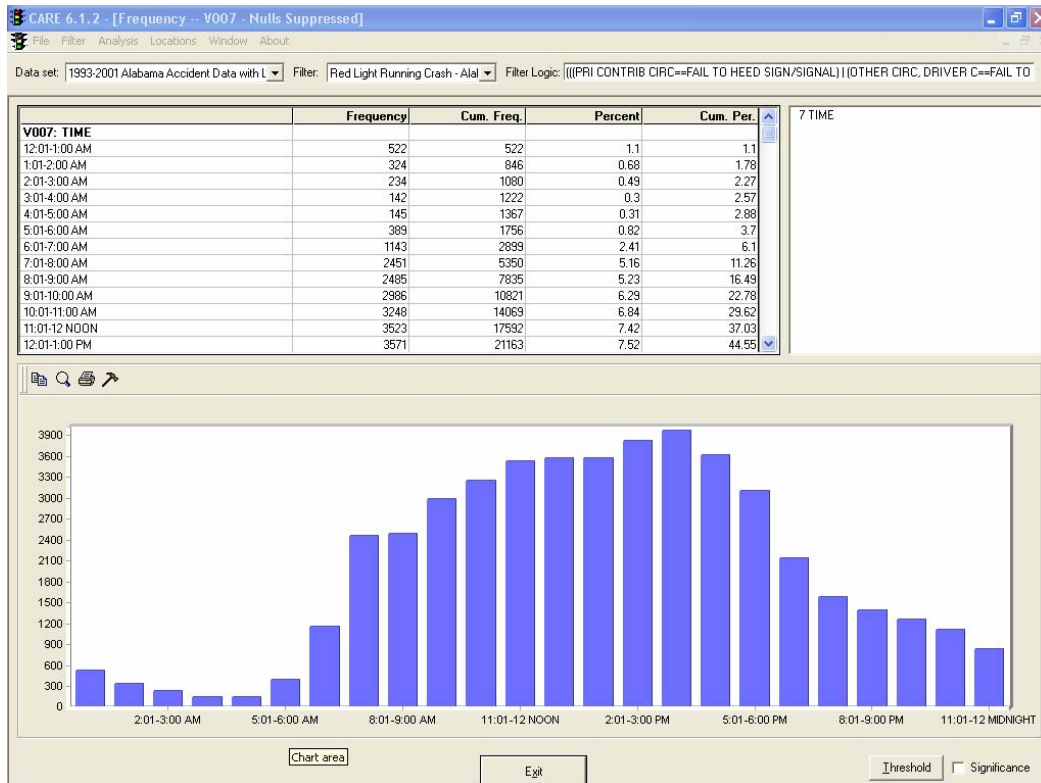


Figure B-1. An example CARE work screen listing RLR crashes in Alabama

## Basic Operation of CARE

The CARE software is designed to operate on a desktop computer under all recent versions of Windows. A web version of CARE (<http://care.cs.ua.edu>) is also available. CARE is normally used for problem identification and countermeasure development.

CARE works on a query system. The user defines a data set of any combination of roadway system types, geographic locations, accident report data items, and combination of data items. Then CARE analyzes the data set and provides graphs, tabulations, and other output. The software can review and report virtually any crash information available in the database (Brown and Turner, 2000).

## Capabilities of CARE

CARE capabilities are extensible. CARE can provide summaries and analyses of virtually any crash information that exists within safety databases. However, there are some special studies that require more complicated statistical procedures. The following CARE capabilities were used during this project.

- **Database selection.** The user is guided through the database selection process, from which crash information will be obtained. The database used in this project consisted of crash data from 1993-2001 for the State of Alabama.
  - **Filter Selection.** This is the ability to limit the CARE analysis to a specific subset of data that meets the criteria the user created (e.g., those occurring during the night). The user constructs a filter from a predefined list of variables (such as alcohol related, over speed limit, motorcycle, rural, work zone, etc).
  - **Filter Combination.** In addition to selecting predefined filters, the user can create combinations of predefined filters with standard Boolean AND and OR operations (e.g., the user can indicate that only speeding-related crashes that occurred in the nighttime will be analyzed). However, this option limits users to only combinations of two filters.
  - **Filter Creation.** To create more sophisticated filters from those already created, the user can use this option. This can be achieved through the selection of any combination of variables and values from the database, and the use of standard logic AND, OR, and NEGATE. Variables are the crash characteristics that are under considerations within the database. When the new filter is created, it has the same status as a predefined filter.
  - **Frequency distributions.** Using this function, the user can obtain frequency distributions for any variables for the selected database. Variables are selected from a list, which includes accident severity, time, day of week, year, gender, license status, etc. The results, which are simple counts of crashes that meet the criteria, will be tabular frequency distributions and bar charts like those shown in Figure B-1.
  - **Cross-tabulations.** This option presents cross-tabulations between two variables for the user-defined filter.
  - **Information Mining Performance Attainment Control Technique (IMPACT).** This function performs systematic automated information discovery to find the key differences between any two subsets. It indicates over-represented data without the analyst having to specify the query variables. The outputs are obtained in graphical or tabular format and are prioritized in a worst-first format for each variable.

For more information regarding the CARE system, please refer to its website (<http://care.cs.ua.edu>).

## **Appendix C**

### **PTS Intersection Installation and Maintenance Guide Tuscaloosa Red-Light Intersection Safety Project**

(Provided by Precision Traffic Systems, Austin, Texas)

## **The Product**

Precision Traffic Systems provides an automated red light camera enforcement system that includes the following:

1. Cameras and computer systems for capturing violation images, relevant incident data, and traffic data at intersections specified by the city,
2. High speed Internet connections for uploading violation information from the intersection,
3. Database system and personnel for violation and citation processing,
4. Collection and check processing for paid citations,
5. Secure Internet access to violation and traffic statistic reports,
6. Ongoing system test and maintenance, and
7. System training for city users.

### ***Red Light Camera Systems***

Each installation includes a digital camera controlled by an onsite computer. The system is connected to traffic signal output (to determine signal status – red, amber, green), and to road sensor loops (to identify the presence of a vehicle and calculate its speed). The camera is active only when the signal is red, and captures two images per violation – the vehicle immediately before entering the intersection and the vehicle fully into the intersection. Both images include the vehicle and the signal (which is clearly red). The images are stored locally and then forwarded, along with relevant incident data, via a high speed Internet connection to Precision Traffic's Back Office database server.

### ***Reporting System***

Precision Traffic provides an on-line Internet browser based reporting system with password protected access to city designated users. The reports include violation and traffic statistics information for all intersections being monitored by the Precision Traffic Systems cameras.

### ***Training and System Maintenance***

Precision Traffic provides ongoing system tests and maintenance for all equipment provided by Precision Traffic to the city for the red light camera enforcement program. If desired, training of city personnel in the operation and installation of the systems (including feature enhancements and new releases) will be provided by Precision Traffic.

## Intersection Selection

*City police and traffic engineering departments are encouraged to use accident and other statistical information to determine which intersections are the best candidates for system installations. Candidate intersections should be examined by the city and PTS to make sure that the intersections do not have characteristics that facilitate violations, like an amber time less than recommended or a blocked view of the signal.*

## Installation Issues

The remainder of this appendix deals with system components and installation issues. A system installation drawing is shown in Figure C-1. All issues described below must be suitable for PTS system. In particular:

- Pole/Camera: A pole must be available or installable in or near the target region detailed below. There must be a clear view of the intersection from 25 feet behind the stop line to 40 feet after at a height of 10-15 feet at the pole location
- Loops: Each lane must be clear of existing loops at least 15' back from the stop line.
- Signal Lights: The signal control box must allow for wiring to the PTS computer box.
- Power: 110-120 VAC power must be available to be run to the PTS computer box.
- Conduits must exist or be installable for wiring from loops and the control box to the PTS computer and from the PTS computer to the pole.

### **Pole Pole placement is constrained by the following requirements:**

- The left edge of the camera field of view should contain at least the center of the left-most lane of interest 40 feet past the stop line.
- The right edge of the camera field of view should contain at least the center of the right most lane of interest 25 feet before the stop line.
- The angle between these two points should be less than or equal to 20 degrees.

For a three-lane coverage installation, the ideal pole placement zone is from 100 to 140 feet back from the stop line. In all cases, the pole should be placed within eight feet of the curb. The pole should allow camera mounting between 10-15 feet high. For a three-lane coverage installation with a pole location 145 feet back from the stop line, the camera should be mounted about 12 feet high.

**Loops All loops should be standard five feet x five feet or six feet x six feet in-road loops. For each lane of coverage, the first loop should be placed one to five feet back from the stop line. The second loop should be placed five to 15 feet back from the first loop. The ideal loop placement is the first loop 3.5 feet back from the stop line and the second loop 10 feet back from the first loop. Wires from each loop should be labeled and run to the PTS computer box location. A multi-cable wire is recommended.**

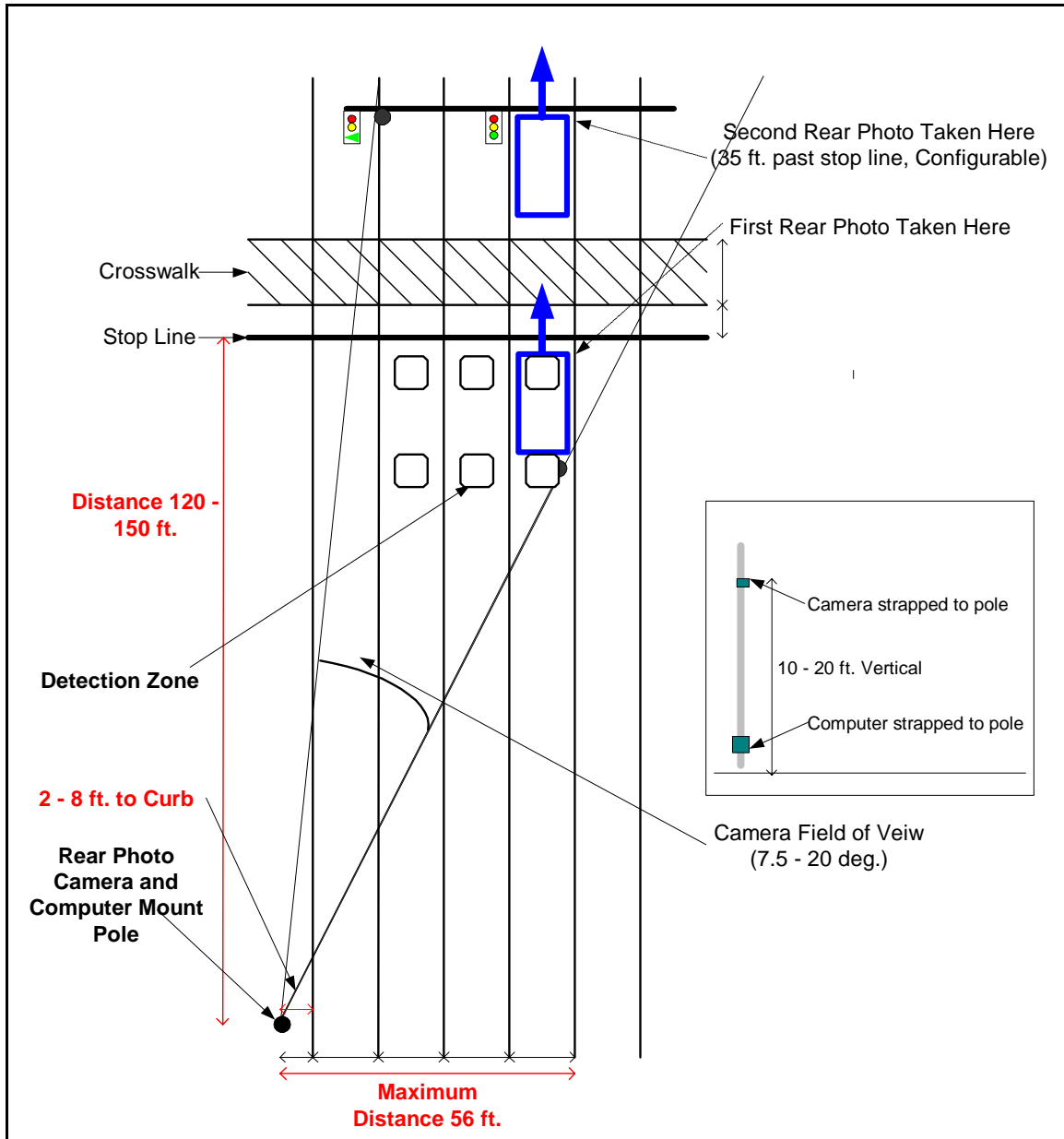


Figure C-1. Typical system installation

**Signal Interface** *Currently, the PTS system can only monitor one signal per unit. Multiple signals can be monitored with multiple units. For example, two left-turn lanes can be monitored with a unit, and four straight lanes can be monitored with a second unit. Lead wires from the red signal lamp and the amber signal lamp should be labeled and run to the PTS computer box location. The leads can be 120VAC, 12VDC, or similar.*

**Power** *The PTS system requires stable 110 – 120 VAC power. The system will draw (at most) 165 watts of power (1.5 Amps). Power can be pulled from the signal control box or directly from the power pole.*

**Network** *For this installation, PTS used the existing City of Tuscaloosa fiber optic. A fiber to Ethernet converter was installed at each location by the city crew. The lines and the network connection must be installed and confirmed before installation of the PTS equipment.*

## **PTS Equipment Installation**

**Computer** *The PTS computer enclosure is a standard National Electrical Manufacturers Association (NEMA) signal control enclosure containing the following individually-mounted components:*

- Signal Interface Module,
  - Dual-loop detectors, one per lane (for speed measurement, no crosstalk),
  - Relays for amber and red lights,
  - A/D converter,
- Computer Module,
  - Motherboard and expansion cards,
- Storage Module,
  - Magnetic media drive,
- Network Module,
  - Ethernet,
- Power Module,
  - Power conditioner,
  - 5/12VDC power converter,
- Cooling Module,
  - Fans, and
- Input/Output wiring block.

Each of these component modules can be individually replaced without disturbing other modules.

The enclosure is 1/8 inch aluminum construction, 22 inch high x 22 inch wide x 16 inch deep. Two fans are mounted inside the front door of the enclosure, and intake vents are located under the lip on the top of the box. The enclosure is locked with a standard key and a keyed padlock.

The box weighs approximately 55 pounds and can be mounted high on the camera pole, on the ground at the pole, or on the ground at a distance of as much as 60 feet from the pole.



The computer requires the following wiring in:

- One pair of wires for each loop (two pairs per lane),
- One wire from the amber signal,
- One wire from the red signal,
- Common ground for signal, and
- 110 – 120 VAC power, maximum 1.5 Amps.

The computer requires the following wiring out:

- 110 – 120 VAC power to camera, and
- Communications cable to camera.

All wiring (loops, signal, network, and power) must be complete and working before the installation can be configured.

***Camera*** *A typical PTS camera is shown in Figure C-2. The camera enclosure is a Pelco EH4718-1 enclosure with a WM2000 and AH2000 mount. The enclosure contains the following components:*

- Digital camera,
- Mechanical lens,
- Linear power supply, and
- Pelco heater/fan.

All components are individually replaceable. Modifications to the camera system require a directional configuration before the system can become operable.

***Configuration*** *Once all systems are mounted, installed, and wired into the wiring block, power can be switched on. The system will take 30-60 seconds to boot. However, during this period, the operation of several subsystems can be confirmed:*

- Within a few seconds of power on, the loop detectors and signal relays should be in operation, as indicated by standard relay lights. If the signal module components are not operating correctly, the wiring should be checked and fixed before proceeding.
- Within 20 seconds of power on, the network should become configured. The lights to confirm correct operation will vary from modem to modem.

After 60 seconds, the system should be in configuration mode. A call should then be placed to PTS. An operator in the PTS office will attempt to log on to the system. Once the system is on-line, the operator will confirm the operation of the remainder of the systems. Any problems encountered in this process can be solved jointly by PTS and the installation crew.

The final configuration step is a directional configuration of the camera. An operator will need to adjust the pointing of the camera enclosure while maintaining contact with the PTS office. Once the camera enclosure is pointing in the correct direction, the bolts should be locked down.



**Figure C-2. Pole-mounted camera**

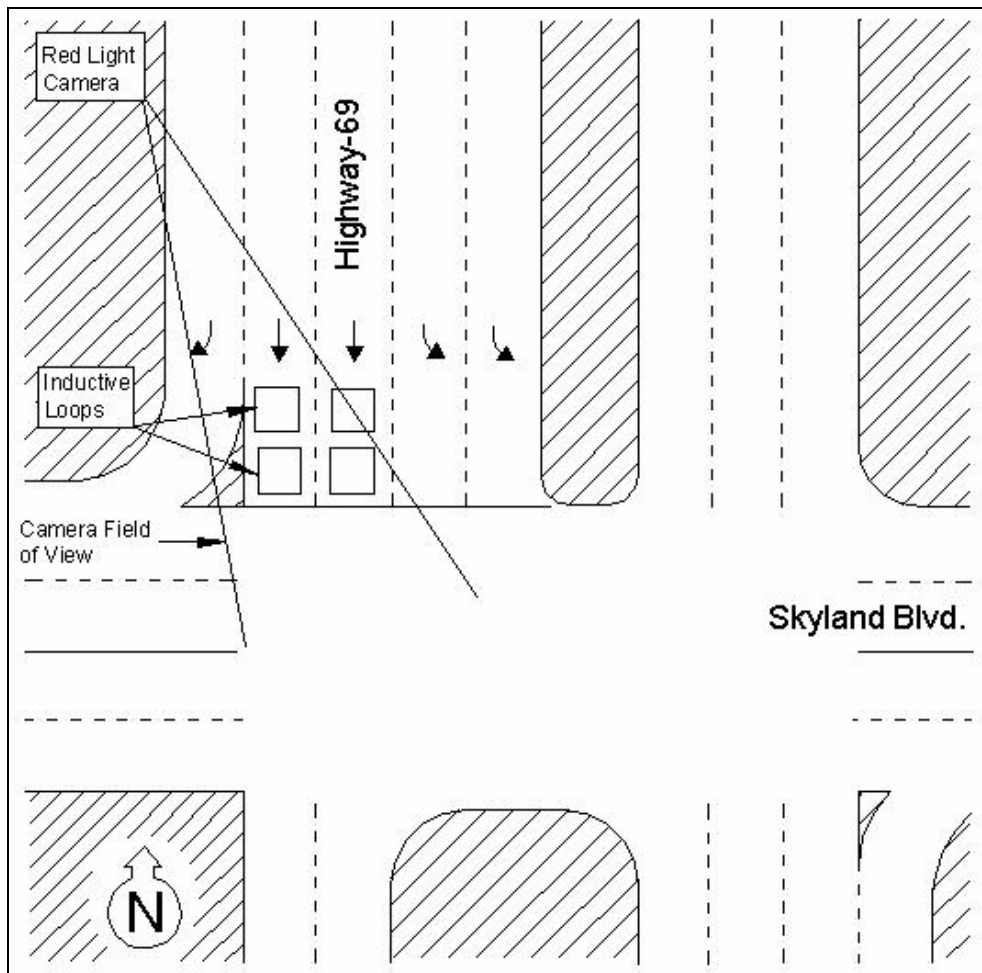
**Appendix D**

**PTS Enforcement Unit Details and Installation Diagrams  
Tuscaloosa Red-Light Intersection Safety Project**

## Tuscaloosa Site 1 – Highway-69 at Skyland Boulevard

**Table D-1. Details of the enforcement unit at Site 1**

Municipality	Tuscaloosa, AL
On Street	Highway-69 southbound
At Intersection of	Skyland Boulevard
Distance from Light	140 feet
Speed Limit	55 mph
Loop Set 1 - Left straight lane	
Spans 1 lane	Loops 10.00 feet apart
Loop Set 2 - Right straight lane	
Spans 1 lane	Loops 10.00 feet apart

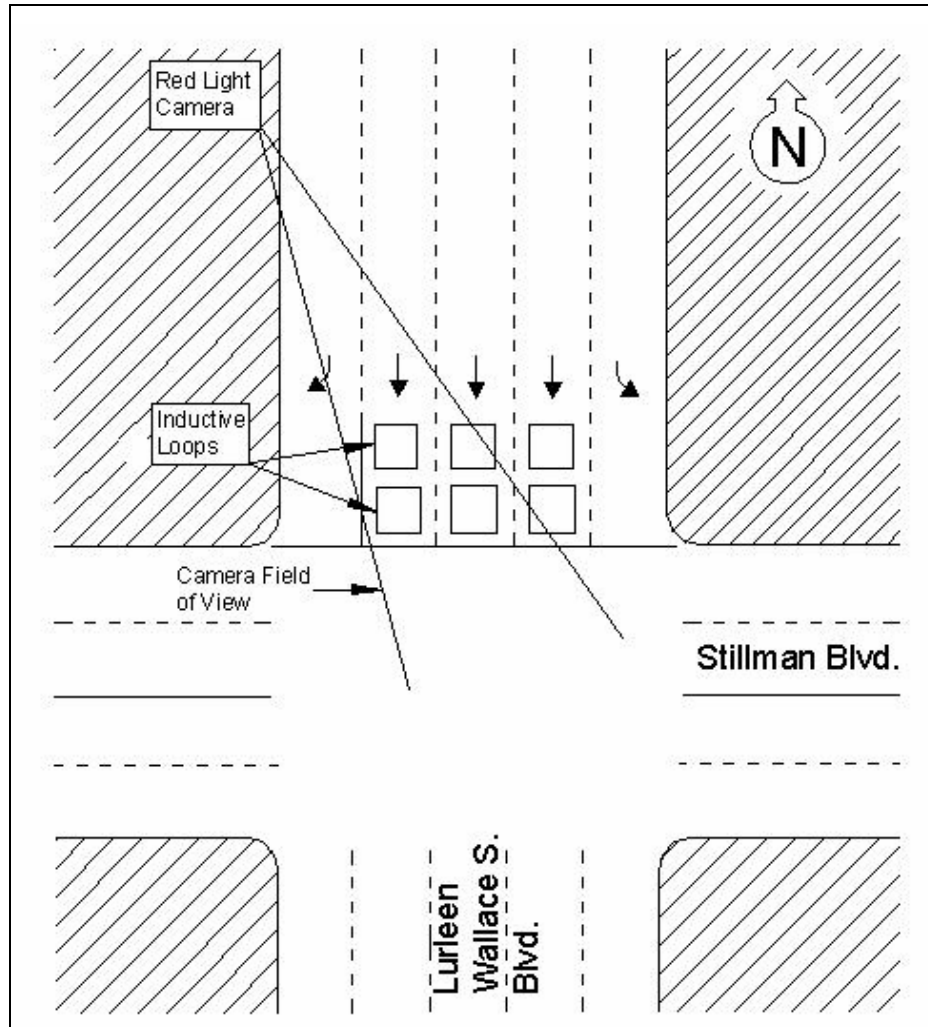


**Figure D-1. Installation diagram of Site 1**

## Tuscaloosa Site 2 – Lurleen Wallace South Boulevard at Stillman Boulevard

**Table D-2. Details of the enforcement unit at Site 2**

Municipality	Tuscaloosa, AL
On Street	Lurleen Wallace South Boulevard southbound
At Intersection of	Stillman Boulevard
Distance from Light	145 feet
Speed Limit	45 mph
Loop Set 1 - Left straight lane	
Spans 1 lane	Loops 10.00 feet apart
Loop Set 2 - Middle lane	
Spans 1 lane	Loops 10.00 feet apart
Loop Set 3 - Right straight lane	
Spans 1 lane	Loops 10.00 feet apart

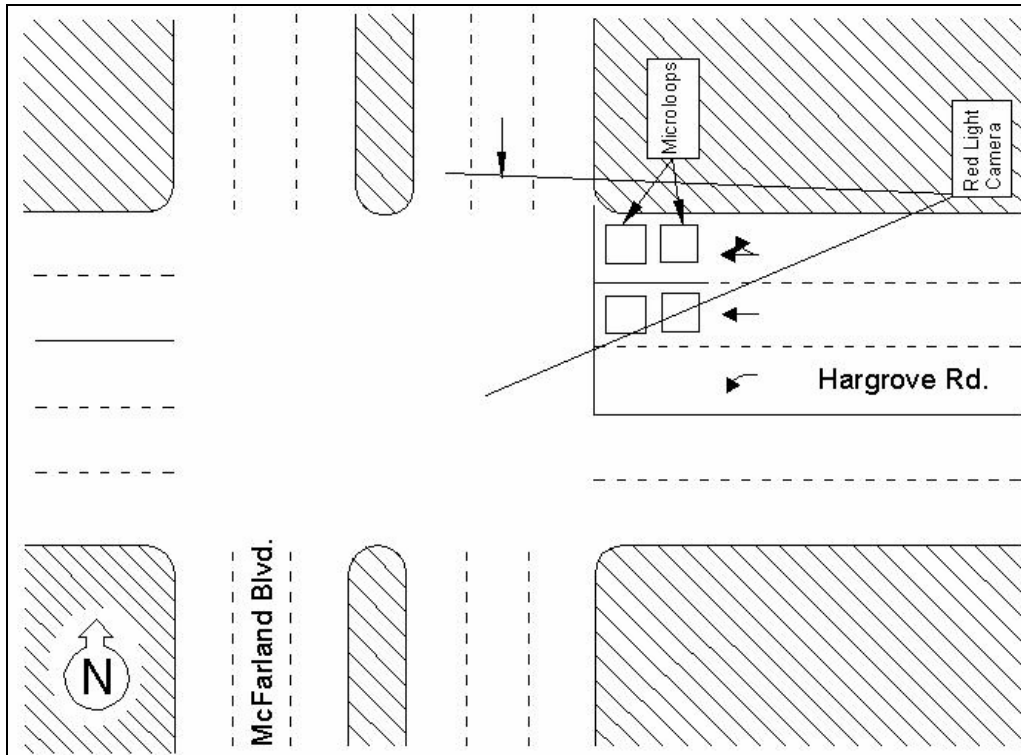


**Figure D-2. Installation diagram of Site 2**

# Tuscaloosa Site 3 – Hargrove Road at McFarland Boulevard

**Table D-3. Details of the enforcement unit at Site 3**

Municipality	Tuscaloosa, AL
On Street	Hargrove Road westbound
At Intersection of	McFarland Boulevard
Distance from Light	142 feet
Speed Limit	40 mph
Loop Set 1 - Right lane	
Spans 1 lane	Loops 13.00 feet apart
Loop Set 2 - Left lane	
Spans 1 lane	Loops 13.00 feet apart



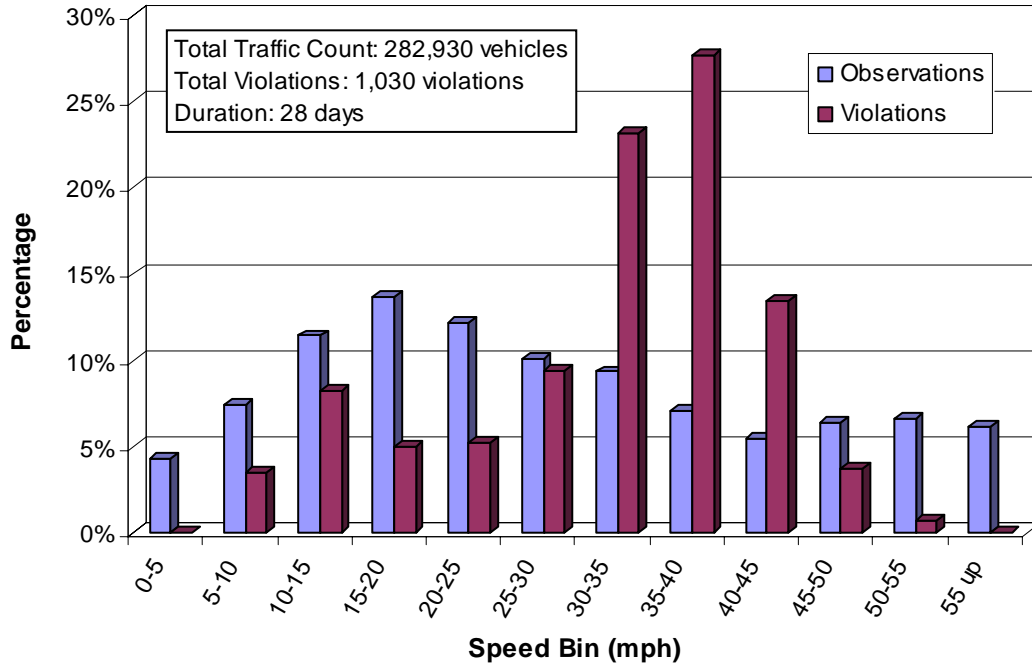
**Figure D-3. Installation diagram of Site 3**

## Appendix E

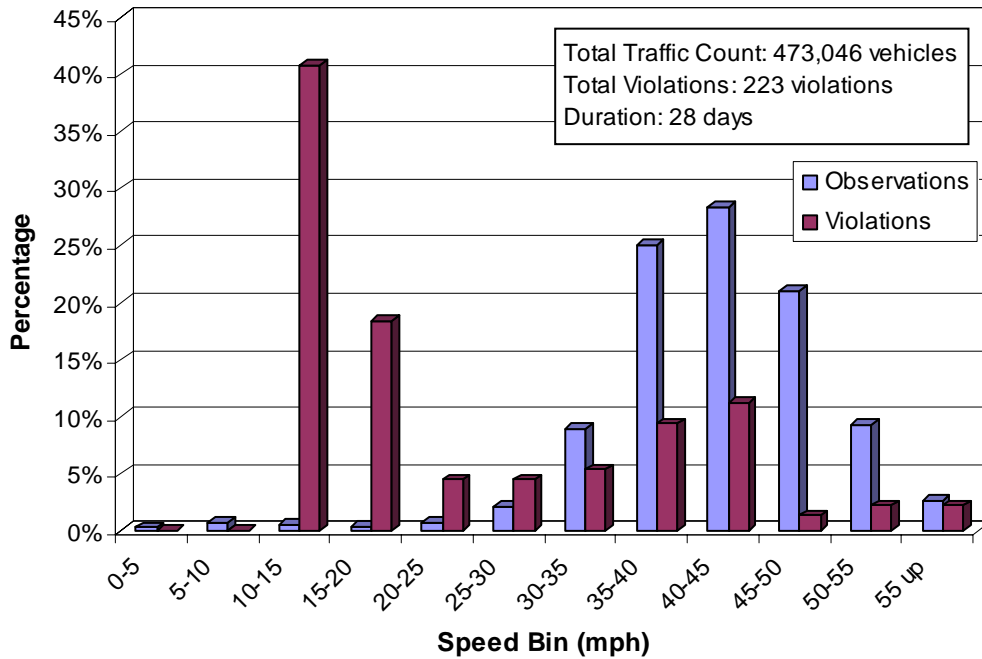
### Red Light Violation Figures

No.	Figure Caption
<b>PART I: Speed of Traffic and Violators</b>	
E-1	Site 1-speed of traffic and of violators
E-2	Site 2-speed of traffic and of violators
E-3	Site 3-speed of traffic and of violators
E-4	All sites-speeds of violators
<b>PART II: Time of Day</b>	
E-5	Site 1-violations by time of day
E-6	Site 1-violations per 1000 vehicles by time of day
E-7	Site 2-violations by time of day
E-8	Site 3-violations by time of day
E-9	All sites-violations by time of day
<b>PART III: Violations by Day of Week</b>	
E-10	Site 1-violations by day of week
E-11	Site 1-violations per 1000 vehicles by day of week
E-12	Site 2-violations by day of week
E-13	Site 3-violations by day of week
E-14	All sites-violations by day of week
<b>PART IV: Cumulative Distribution of Speed</b>	
E-15	Site 1-cumulative distribution of speed data
E-16	Site 2-cumulative distribution of speed data
E-17	Site 3-cumulative distribution of speed data
<b>PART V: Distribution of Violations by Red Interval Duration</b>	
E-18	Site 1-distribution of violations by time-into-red
E-19	Site 2-distribution of violations by time-into-red
E-20	Site 3-distribution of violations by time-into-red
<b>PART VI - Violation Speed versus Time-into-red</b>	
E-21	Site 1-speed versus time into red
E-22	Site 2-speed versus time into red
E-23	Site 3-speed versus time into red
<b>PART VII - Violation Speed versus Time of Day</b>	
E-24	Site 1-violations speed versus time of day
E-25	Site 2-violations speed versus time of day
E-26	Site 3-violations speed versus time of day

**PART I: Speed of Traffic and of Violators**



**Figure E-1. Site 1 - speed of traffic and of violations**



**Figure E-2. Site 2 - speed of traffic and of violations**



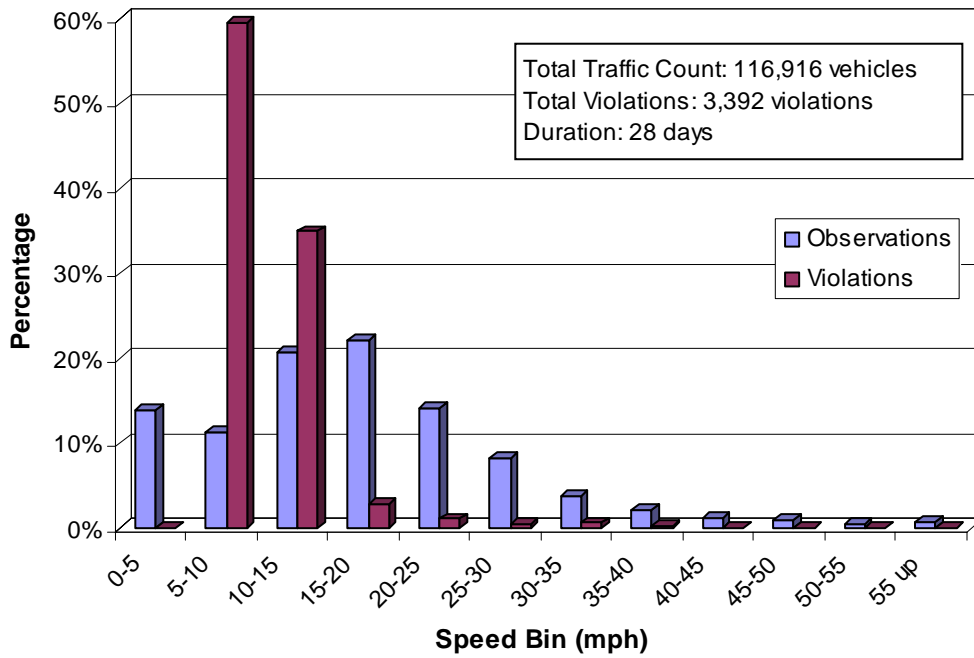


Figure E-3. Site 3 - speed of traffic and of violations

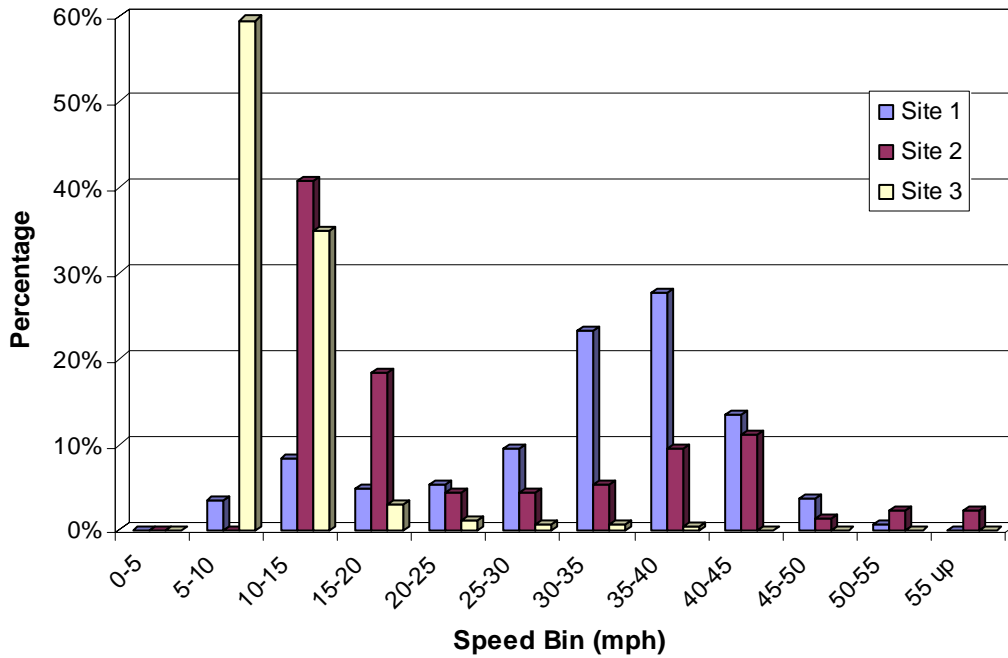
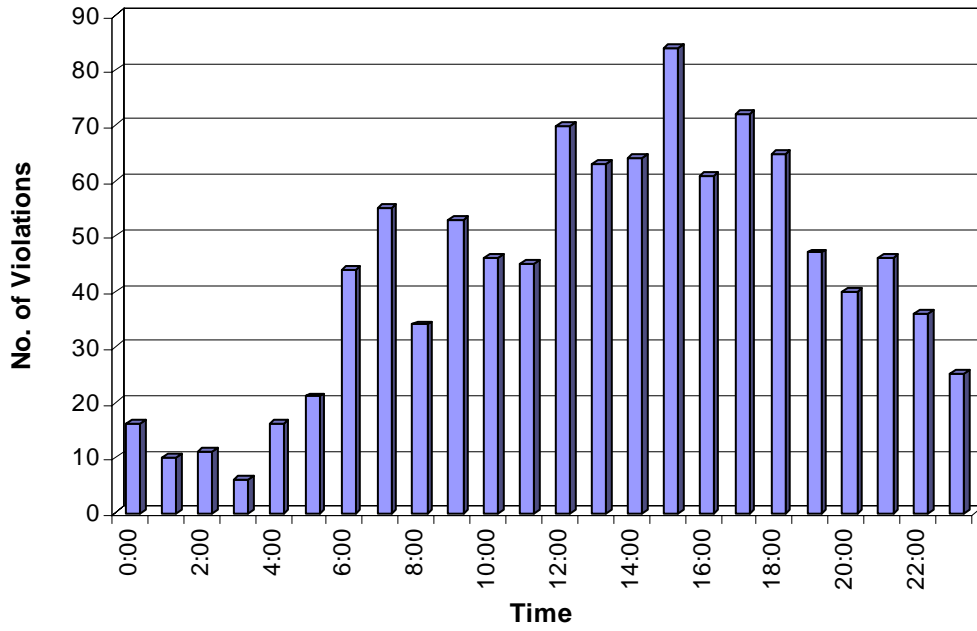
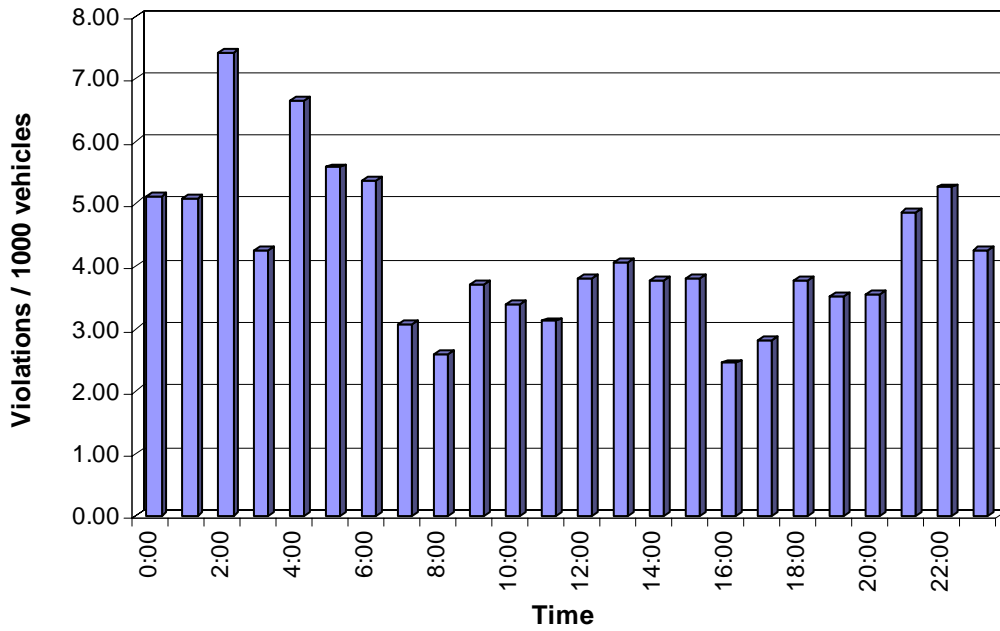


Figure E-4. All sites - speeds of violators

**PART II: Violations by Time of Day**



**Figure E-5. Site 1 - violations by time of day**



**Figure E-6. Site 1 - violations per 1000 vehicles by time of day**

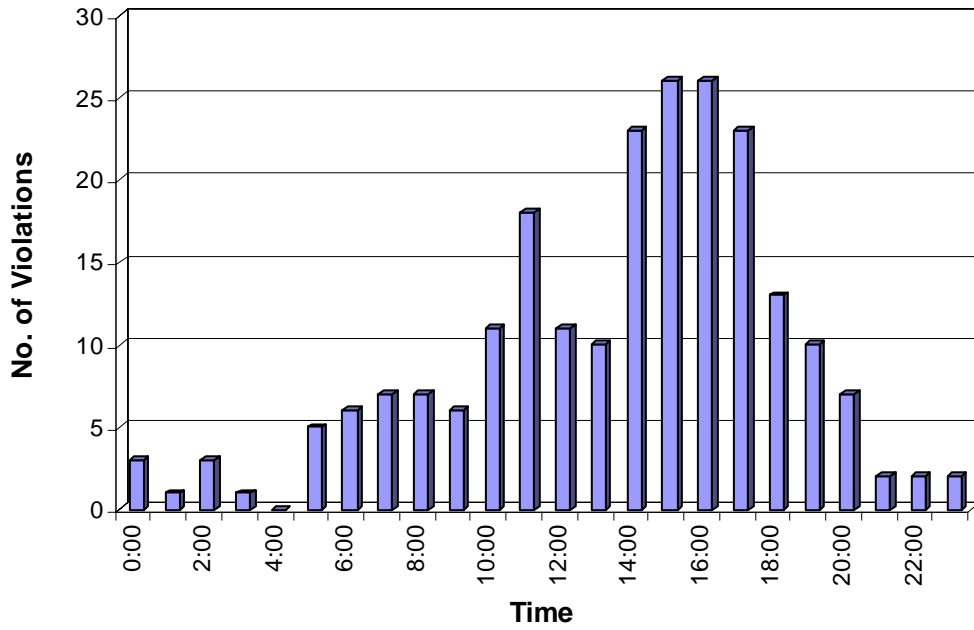


Figure E-7. Site 2 - violations by time of day

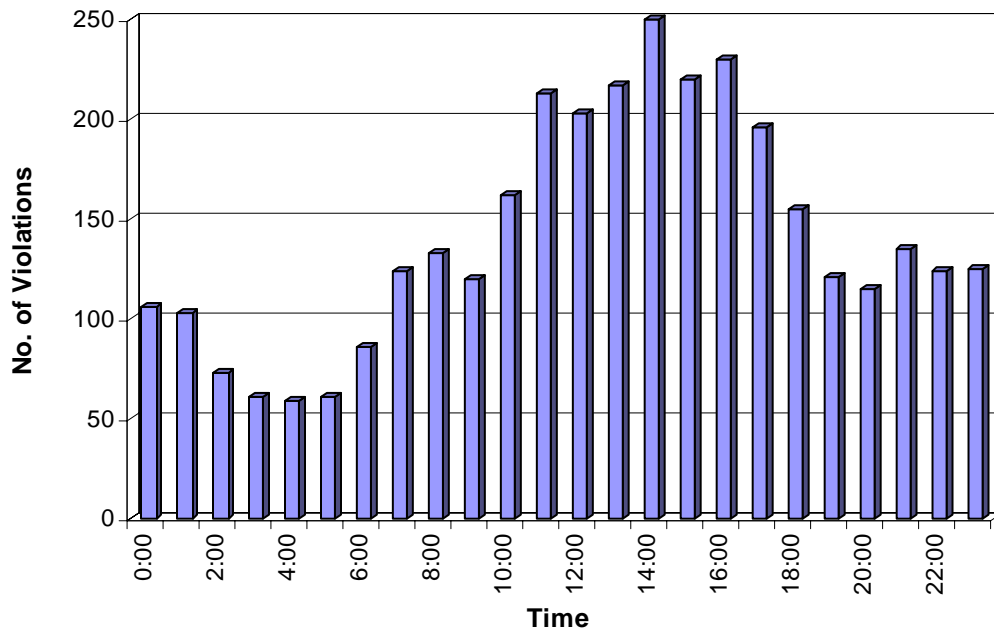


Figure E-8. Site 3 - violations by time of day

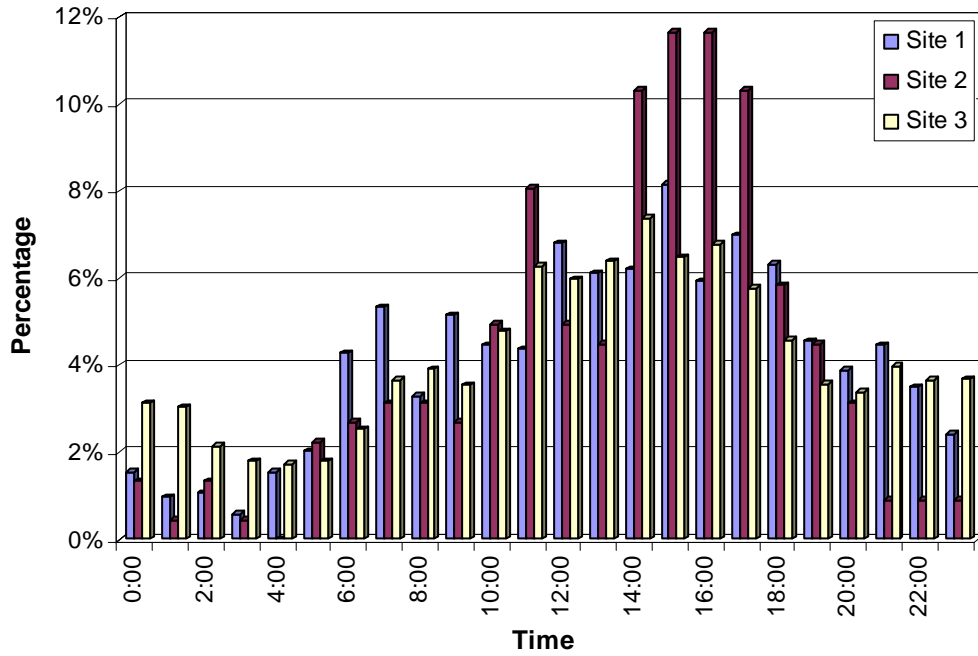


Figure E-9. All sites - violations by time of day for all sites

**PART III - Violations by Day of Week**

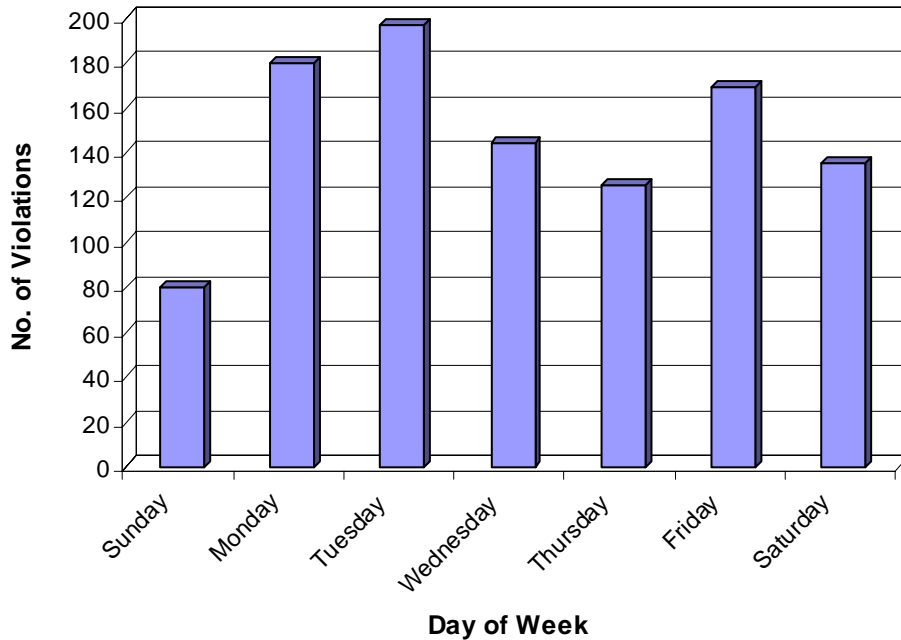


Figure E-10. Site 1 - violations by day of week

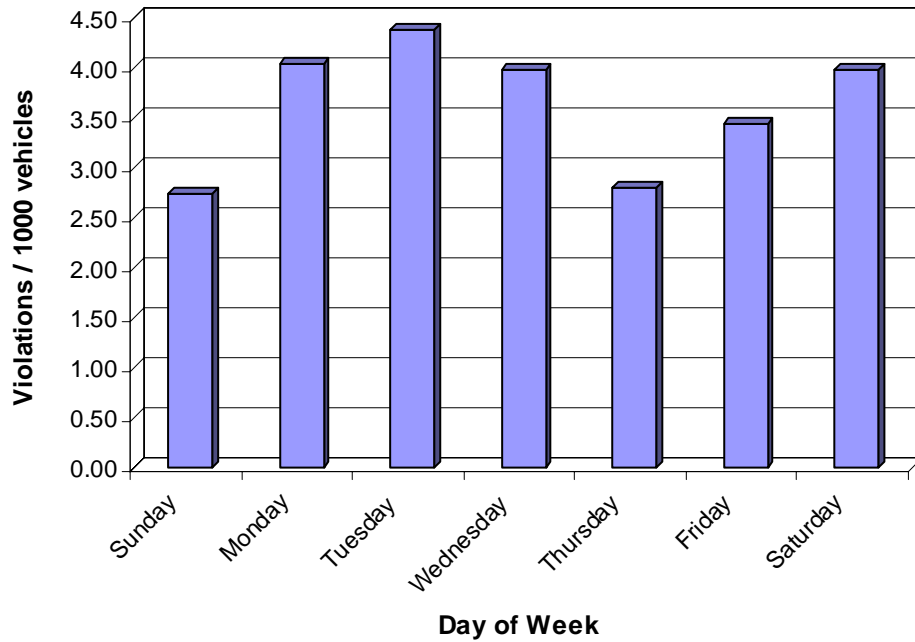


Figure E-11. Site 1 - violations per 1000 vehicles by day of week

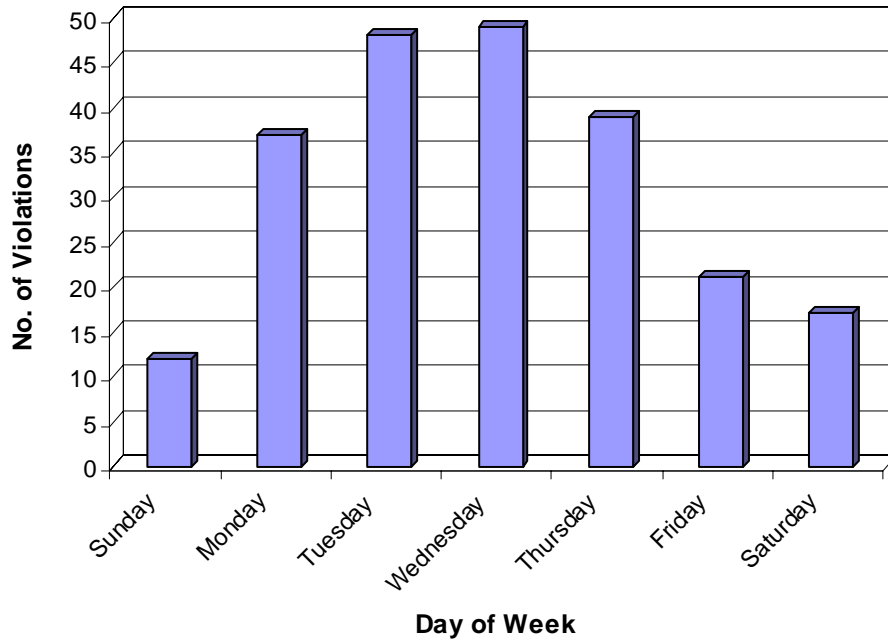


Figure E-12. Site 2 - violations by day of week

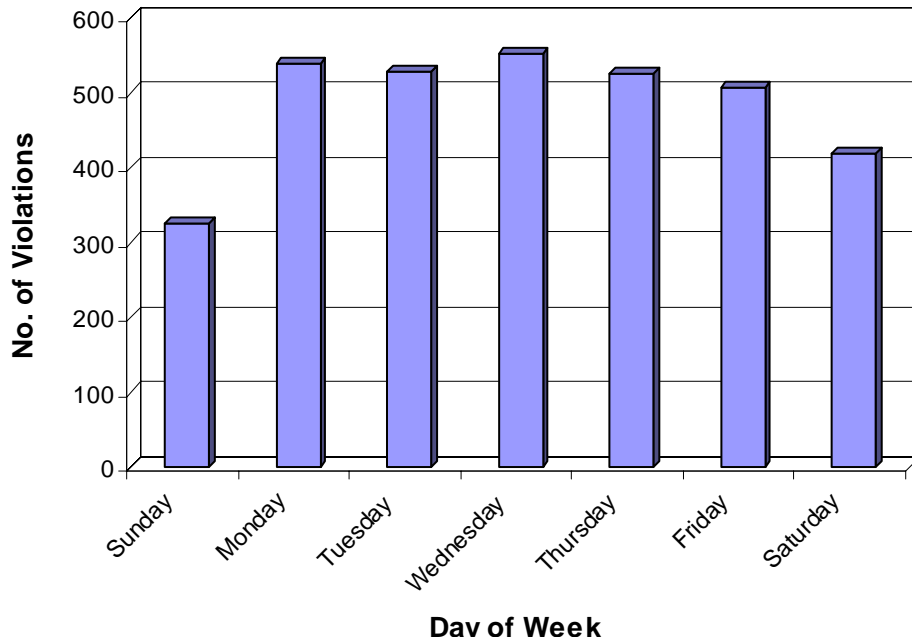


Figure E-13. Site 3 - violations by day of week

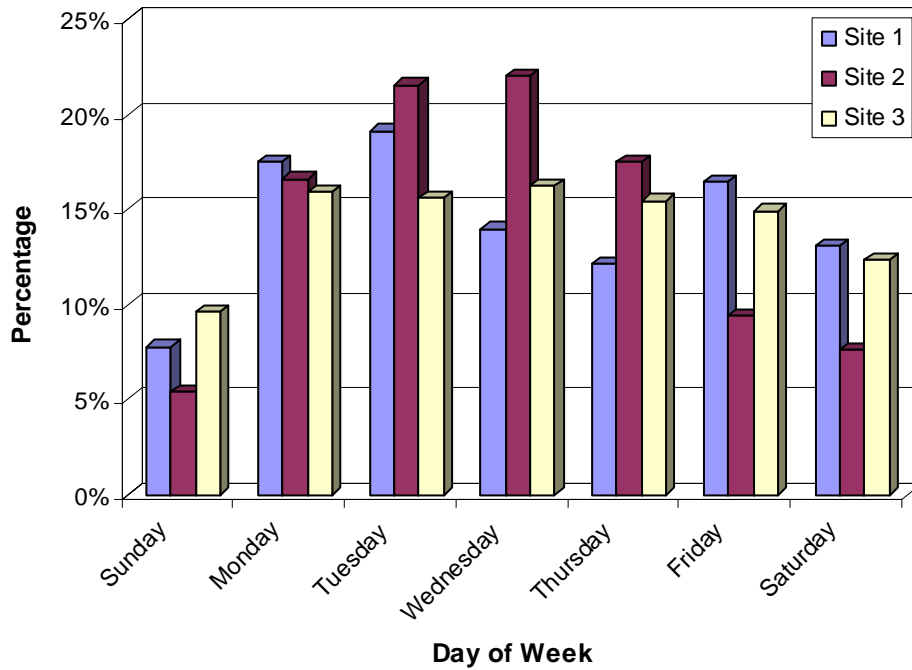
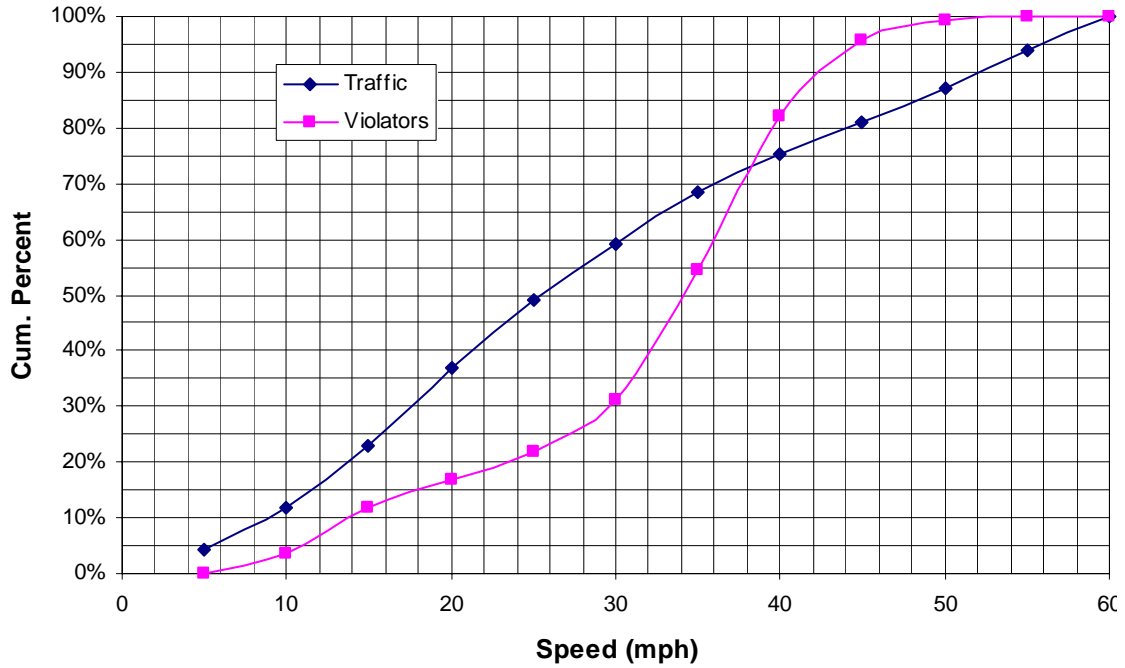
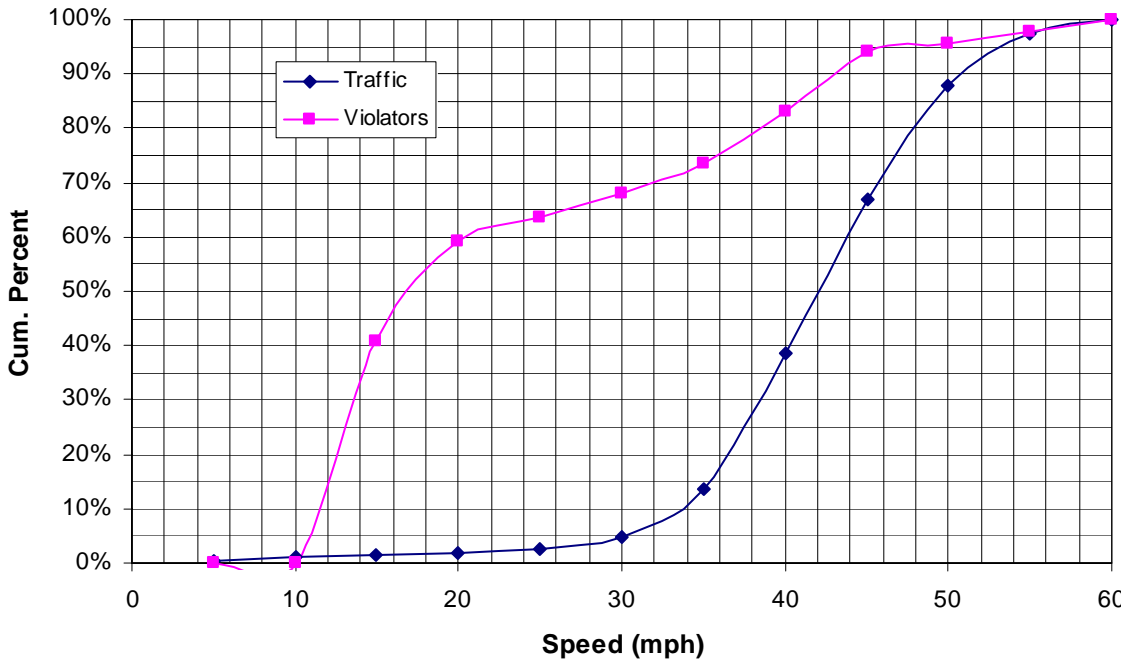


Figure E-14. All sites - violations by day of week

**PART IV - Cumulative Distribution of Speed**



**Figure E-15. Site 1 - cumulative distribution of speed data**



**Figure E-16. Site 2 - cumulative distribution of speed data**

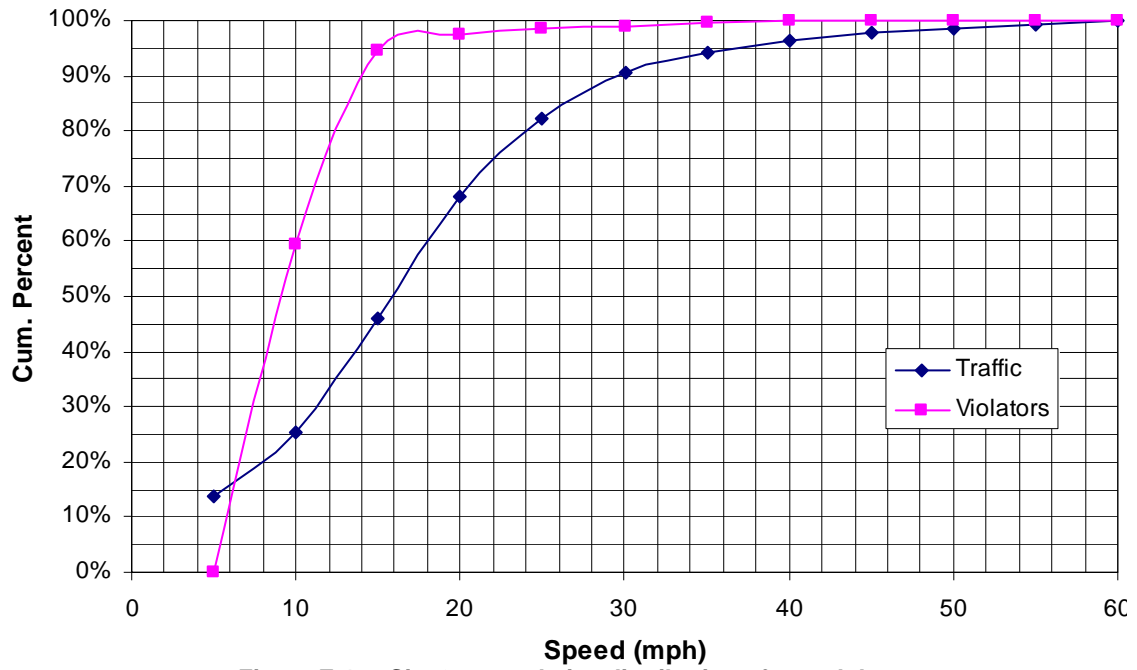
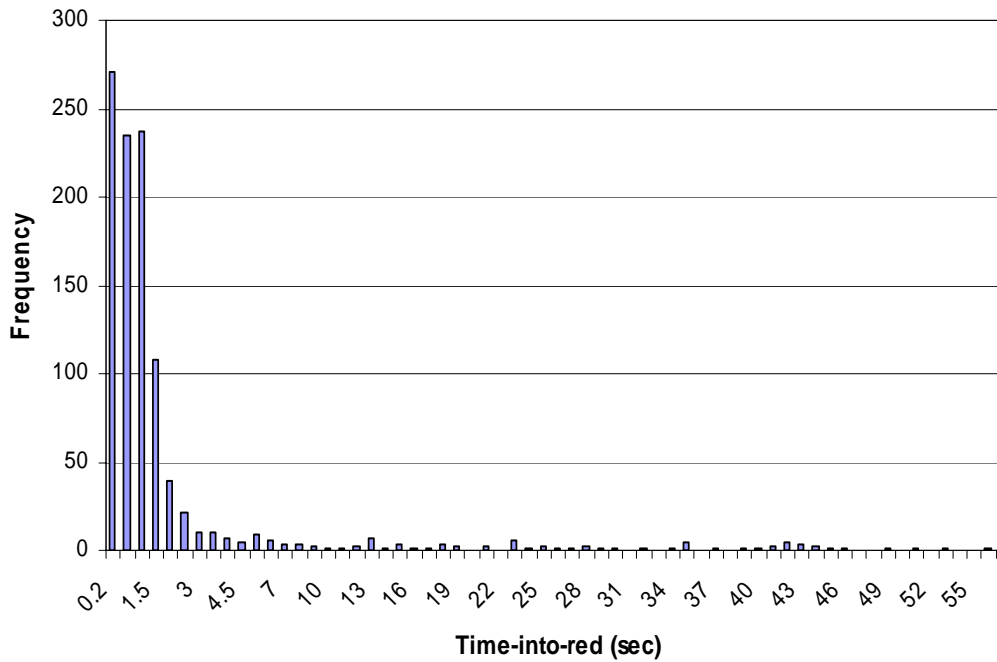
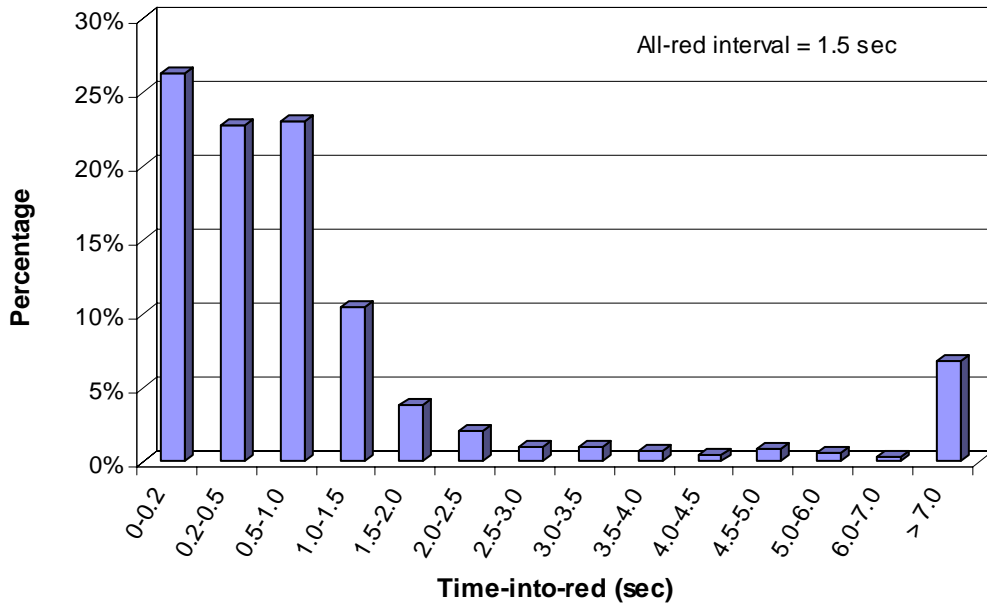


Figure E-17. Site 3 - cumulative distribution of speed data



**PART V - Distribution of Violations by Red Interval Duration**



**Figure E-18. Site 1 - distribution of violations by time-into-red**

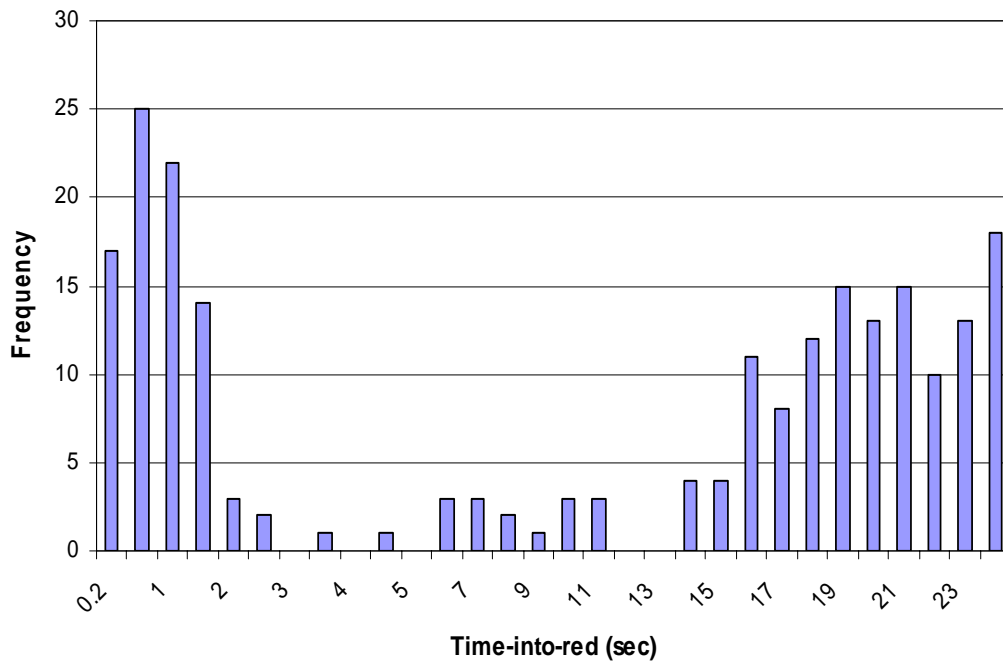
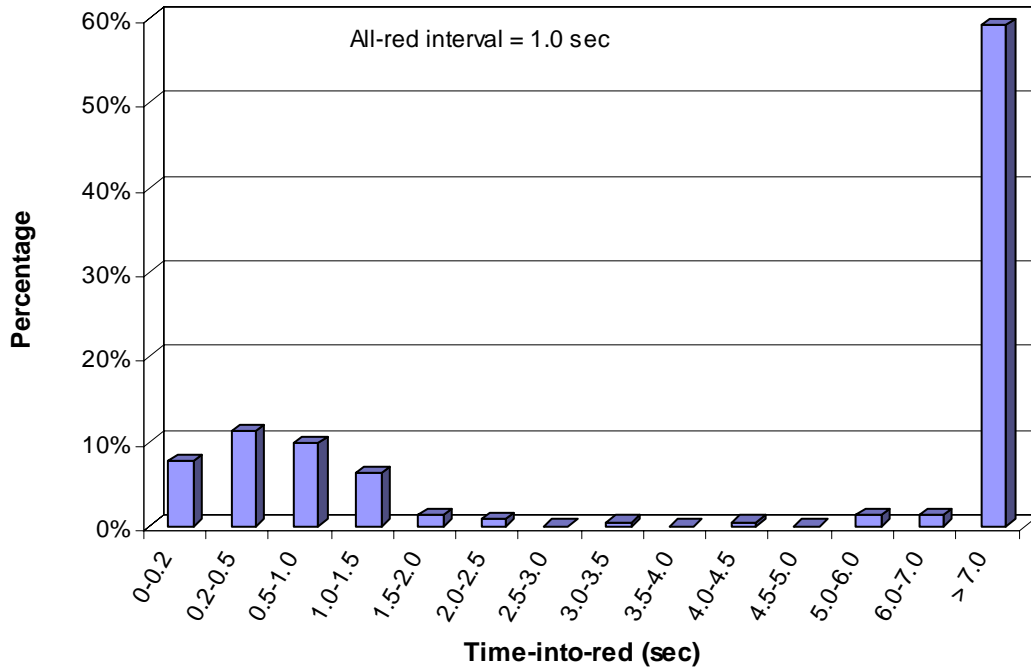


Figure E-19. Site 2 - distribution of violations by time-into-red

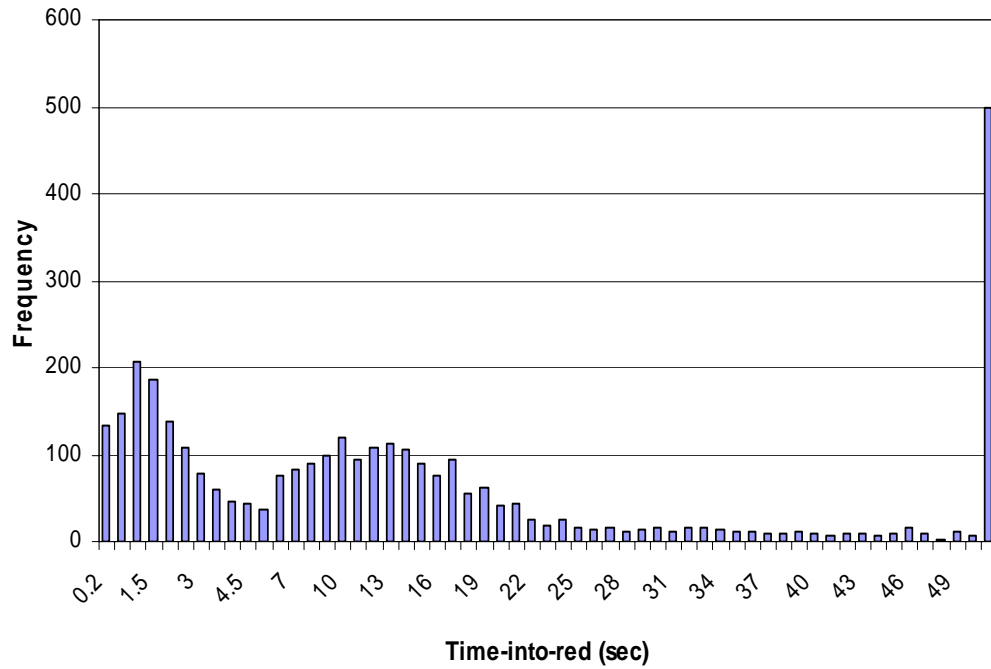
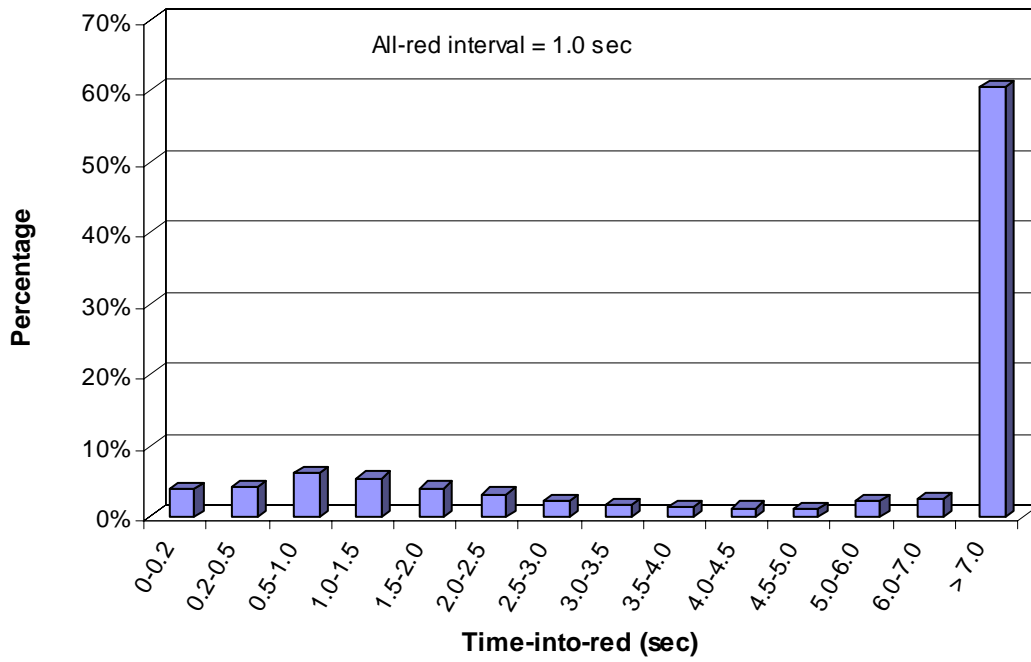
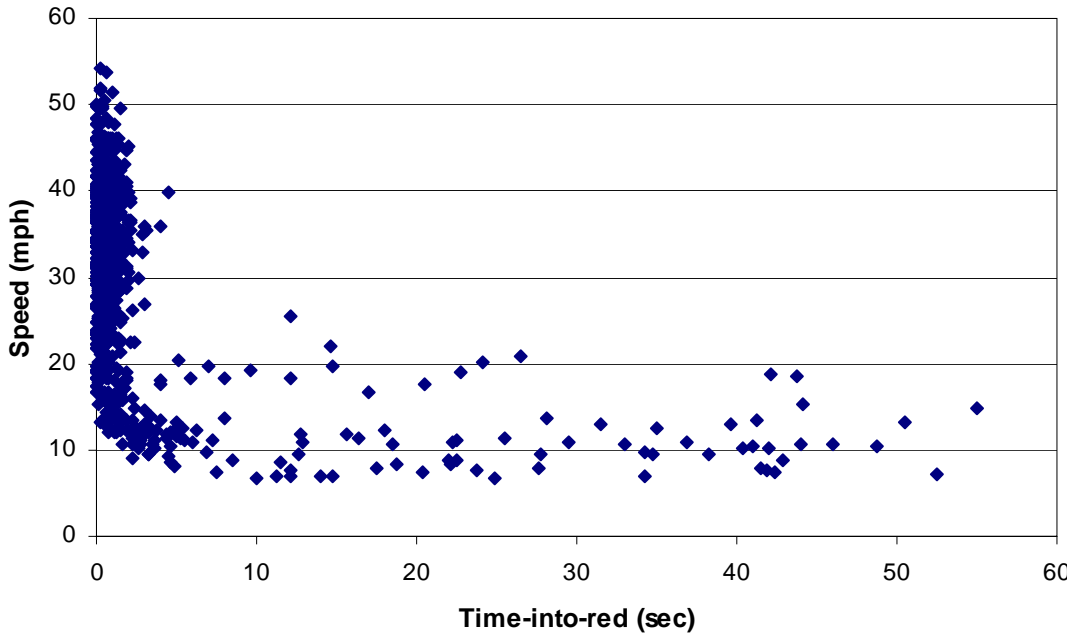
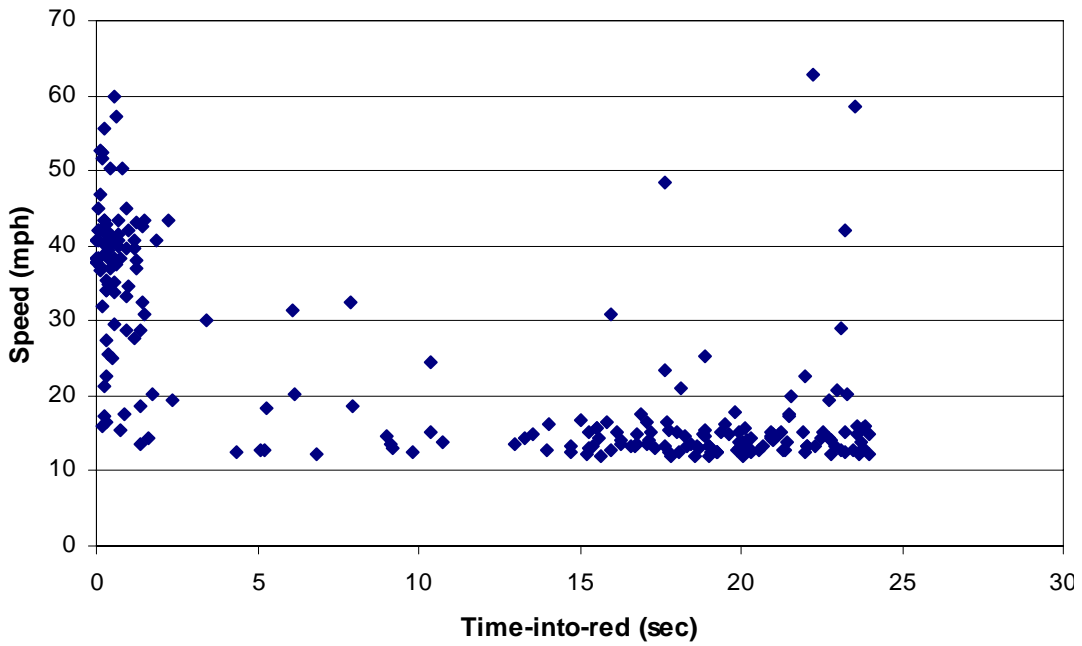


Figure E-20. Site 3 - distribution of violations by time-into-red

**PART VI - Violation Speed versus Time-into-red**



**Figure E-21. Site 1 – violation speed versus time into red**



**Figure E-22. Site 2 – violation speed versus time into red**

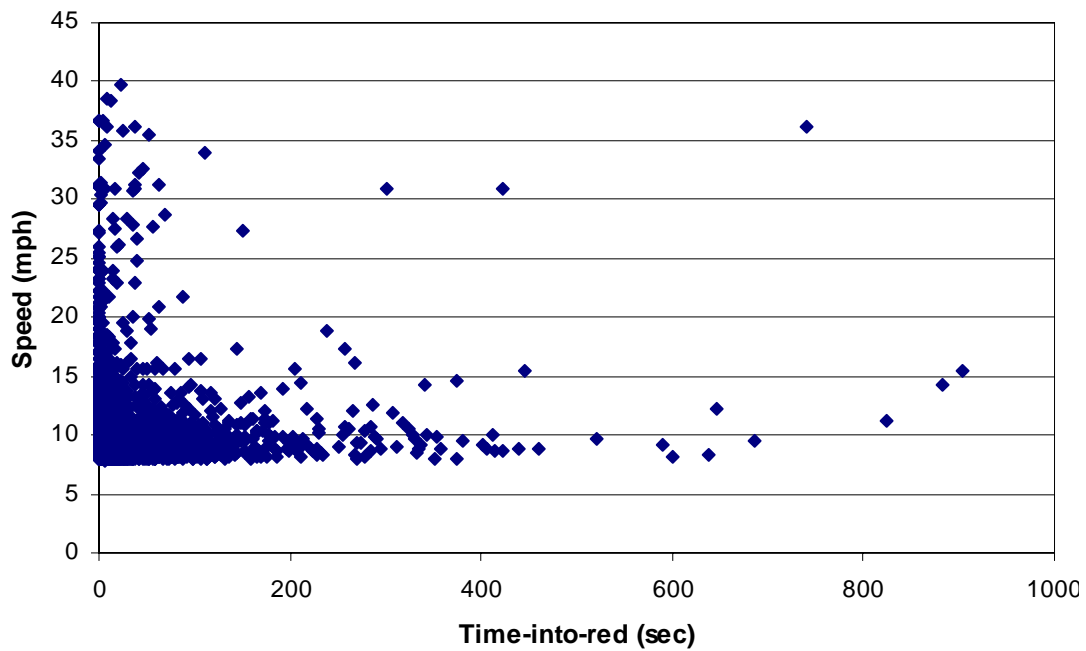


Figure E-23. Site 3 – violation speed versus time into red

**PART VII - Violation Speed versus Time of Day**

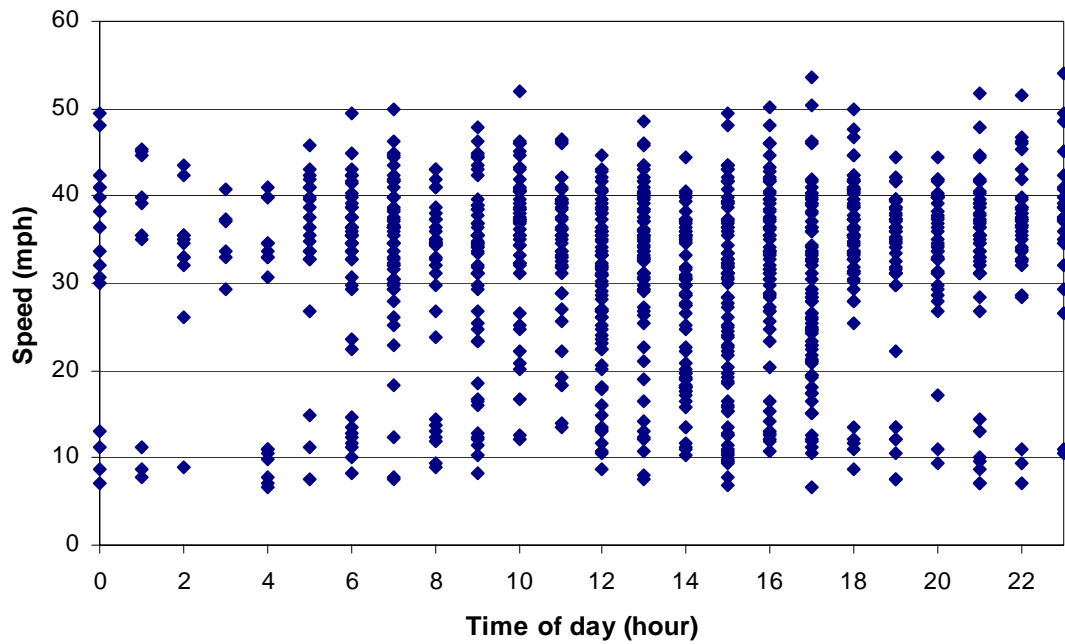


Figure E-24. Site 1 - violation speed versus time of day

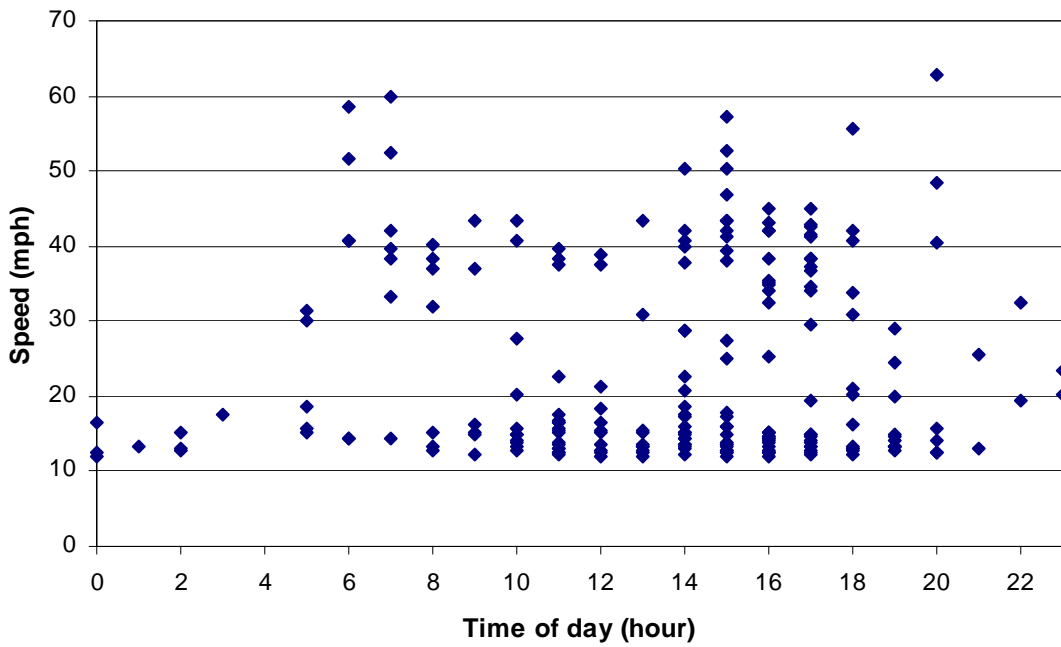


Figure E-25. Site 2 - violation speed versus time of day

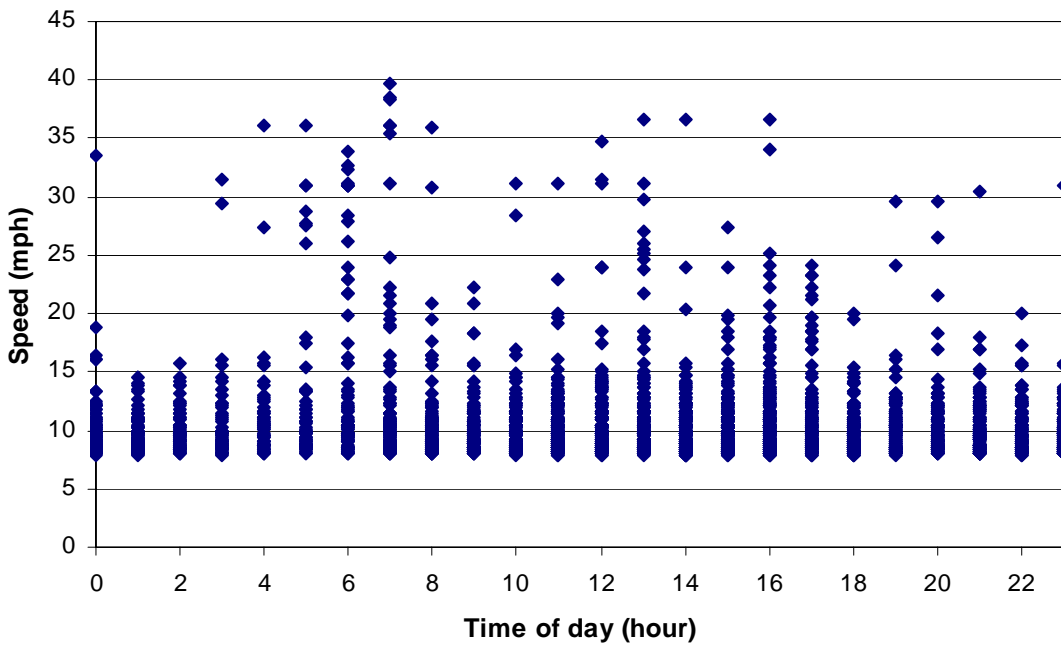


Figure E-26. Site 3 - violation speed versus time of day