Yellow Signal Timing –
Lessons Learned from a Red Light Camera Program

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Abstract: The City Council for the City of Springfield, Missouri, approved a contract to install up to sixteen cameras for automated red light enforcement in the spring of 2006. During the implementation phase of the program, test sampling of potential intersections for placement of the cameras revealed significant differences in yellow timings and red light running at city signals compared to Missouri DOT signals inside the city.

This difference prompted city and state traffic engineers to review their respective methods of calculating the yellow and all-red timings. Despite using the same equation recommended by ITE, the agencies used different assumptions for perception-reaction time and how to interpret and use the results. City and state traffic engineers came to agreement and documented the assumptions to be used in a Memo of Understanding (MOU) to bring consistency to the yellow and all-red timings throughout the city. The result was that yellow time at all city signals was increased and yellow time at nearly all state signals was decreased.

All signals were retimed in conformance with the MOU in the spring of 2008 and in conformance to ITE recommended practice, three months prior to the first red light camera start-up and 18 months prior to the installation of a camera on an intersection where the yellow time had been reduced. The result of the signal retiming has brought credibility to the red light camera program for the public and media with a reduction in rear-end crashes in addition to a reduction in total crashes at traffic signals.

INTRODUCTION

The City of Springfield, Missouri, has developed a model red light camera enforcement program. The program has reduced red light running and right-angle crashes while being virtually revenue neutral. From the start of the program, Springfield has been committed to a program that helps save lives and property. Because the program has been focused on safety, not revenue, community support has been high which is reflected in the news media.

This paper is a summary of practices applied and lessons learned. The keys to success have been 1) implementation of traffic engineering countermeasures before considering a red light camera program; 2) the traffic engineering staff has been engaged in the red light camera program from the start; 3) the selection of the vendor; 4) the selection of intersections and approaches that will raise motorist awareness to “Respect Red” and contribute to improved driver behavior and safety at all signalized intersections; 5) using the ITE proposed recommended practice to calculate the yellow change interval with retiming of all traffic signals prior to the start of the camera program; 6) reducing red light running and angle crashes; 7) being revenue neutral; and 8) achieving public (and media) acceptance of the program.

BACKGROUND

According to a recent USA Today article, there are 439 communities using red light cameras, yet there continues to be organized efforts to ban the use of the cameras. Unfortunately, camera programs have been operated wherein 1) the vendors have specified the yellow signal timing, 2) yellow times have been found to be shorter at intersections with cameras than at adjacent intersections, 3) right turn on red is being strictly enforced at the stop line, 4) there is a lack of uniformity and consistency in the application of the ITE nationally recommended practice for determining the yellow change interval, and 5) many programs are making large sums of money. The programs that are making large amounts of money are the primary targets of the anti-camera advocates because the revenue is indicative of motorists continuing to run red traffic signals.

WHAT IS THE LEGAL DEFINITION OF YELLOW AND RED SIGNALS?

The Manual on Uniform Traffic Control Devices (MUTCD) and the Uniform Vehicle Code (UVC) defines yellow and red signals as follows:

Yellow Indication – Vehicular traffic facing a steady circular yellow or yellow arrow signal is thereby warned that the related green movement is being terminated or that a red indication will be exhibited immediately thereafter. A circular yellow or yellow arrow indication, as appropriate, shall be displayed immediately after every circular green or green arrow interval. **Vehicles may legally enter the intersection while the yellow indication is displayed.**

Red Indication – Vehicular traffic facing a steady circular red or red arrow indication alone shall stop at a clearly marked stop line, but if none, before entering the crosswalk on the near side of the intersection, or if none, then before entering the intersection, and shall remain standing until an indication to proceed is shown. **Vehicles that legally entered the intersection while a green or yellow indication was displayed may continue to cross the intersection.**

The red indication definition does not exclude right turn on red, as may be allowed. Enforcement of RTOR has become highly controversial with red light enforcement cameras, particularly if motorists stop but at a point past the stop line, which blocks the path for pedestrians, with either a marked or unmarked crosswalk. **(1), (2)**

WHAT IS RED LIGHT RUNNING? STATE LAWS GOVERN

The "Permissive Yellow Rule" is that stated in the MUTCD and Uniform Vehicle Code (UVC). That is, vehicles can enter on yellow and legally be in the intersection on red as long as they entered the intersection on yellow. 37 states and the District of Columbia have laws in substantial conformity with the meaning of yellow and red indications in the MUTCD and UVC.

State laws in the other states use what is called the "Restrictive Yellow Rule" taking one of two forms: that is, vehicles can neither enter the intersection nor be in the intersection on red; or

vehicles must stop upon receiving the yellow indication unless it is not possible to do so safely. States using the Restrictive Yellow Rule are not in conformity to the MUTCD and UVC. **(1), (2)**

The Permissive Yellow Rule is the legal basis for ITE's procedure for calculating the yellow phase change interval. **(3)** "ITE's procedure is the same for all states regardless of the provision of the local laws. The engineer must use judgment in the application of the procedure to ensure that the yellow signal length is compliant with any local or state laws that govern the jurisdiction." **(4)**

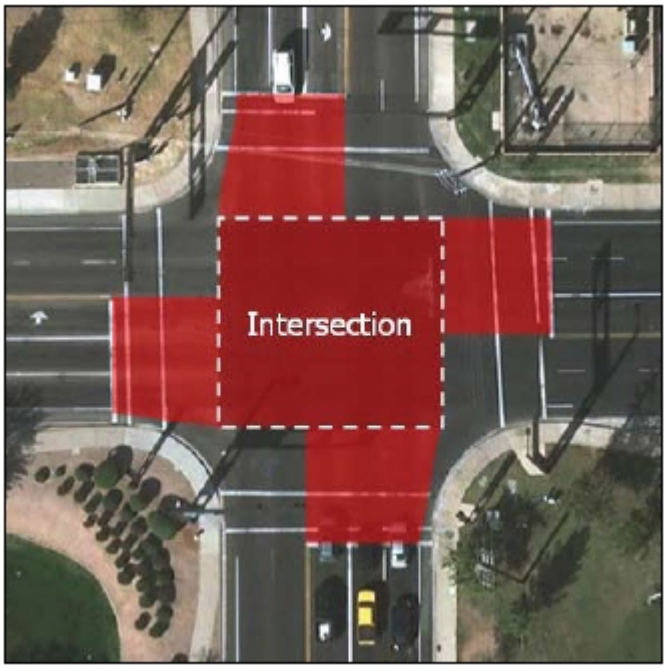


Figure 1. Boundary for a red light violation using stop lines. **(5)**

According to the MUTCD, the boundary for a red light violation begins at the marked stop line and for purposes of a red light camera program, it is necessary to provide a stop line to define the intersection. A driver is running a red light if his or her vehicle enters the red shaded area as shown in Exhibit 1, after the light turns red. **(5)**

SPRINGFIELD'S RED LIGHT CAMERA SYSTEM

In the early 2000's, concern began to rise in the community regarding red light running. Enforcement of red light running by officers in the field had become nearly impossible. The courts were requiring that officers testify that they saw the same traffic signal as the motorist who was cited for running a red signal. It was virtually impossible for officers to follow a red light runner through an intersection after the signal had changed to red and use of two officer teams was not a good use of limited manpower. In response to this concern, in January 2001, City Council raised the minimum fine for running a red signal from $29 to $100.

In the spring of 2006, the City Council authorized installation of 16 red light enforcement cameras with certain conditions: no photos of the drivers, civil penalty of $100 (no points or info to the insurance company), violations would be confirmed by a police officer, citations would be sent to the registered owner of the vehicle, the vendor to be paid a flat rate per camera, and revenue from the paid citations would be used to pay the cost of the program. The City Traffic Engineer would select the camera locations with concurrence of the City Manager.

RED LIGHT RUNNING COUNTERMEASURES

In the three years prior to beginning the red light camera program, the City implemented a number of red light running countermeasures which would help motorists to reduce red light running. These countermeasures included complete conversion to LED traffic signal lamps, a pilot program of red light indicator lights at several intersections to assist the police to know when a motorist is running a red signal, launched a major public education program. The Public Information campaign included PSA's, brochures, media events, bumper stickers and on-street signing to remind motorists to "Respect Red".

SELECTION OF CANDIDATE INTERSECTIONS

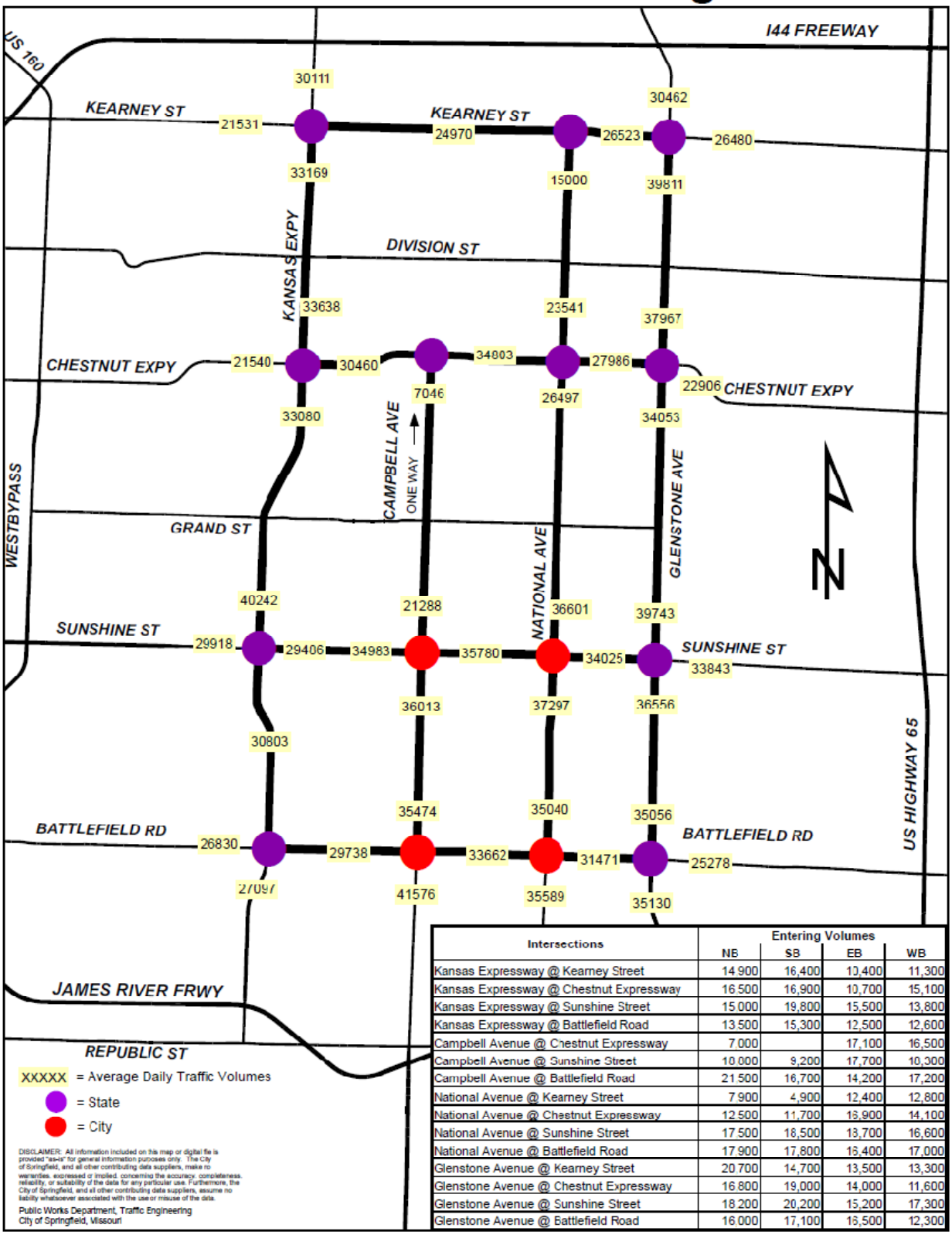
Following authorization of the red light camera program, traffic engineering staff determined that it would be advantageous to place cameras at high volume, high crash frequency intersections throughout the city. Using the highest volume four (4) north-south major arterials and their intersections with the highest volume four (4) east-west major arterials would include 13 of the highest 14 volume intersections in the city. In addition, there were collectively over 500 crashes at these intersections (in 2005) with over 8% of the angle type.

Of the 15 candidate intersections, 11 intersections were under the jurisdiction of the Missouri Department of Transportation (MoDOT) and only four (4) intersections were under the City of Springfield jurisdiction. See Figure 2. Selection of the intersections in this manner also helped to insure a geographic distribution of the cameras throughout the city.

These high volume intersections had several features in common:

- Traffic volume was > 50,000 vpd at every intersection (Over 800,000 vpd total)
- Over 500 crashes total at these intersections in 2005 with over 8% angle types
- High volume made these intersections the most difficult for police to enforce
- 40 mph speed limits on all streets (except 35 mph on one approach at one intersection)
- Separate right turn lanes with channelizing islands on all approaches
- "Protected Only" left turn signal operation with dual left turn lanes on all approaches
- Signal operation is interconnected with adjacent signals

Possible Intersections for Red Light Cameras



Intersections	Entering Volumes			
	NB	SB	EB	WB
Kansas Expressway @ Kearney Street	14,900	16,400	10,400	11,300
Kansas Expressway @ Chestnut Expressway	16,500	16,900	10,700	15,100
Kansas Expressway @ Sunshine Street	15,000	19,800	15,500	13,800
Kansas Expressway @ Battlefield Road	13,500	15,300	12,500	12,600
Campbell Avenue @ Chestnut Expressway	7,000		17,100	16,500
Campbell Avenue @ Sunshine Street	10,000	9,200	17,700	10,300
Campbell Avenue @ Battlefield Road	21,500	16,700	14,200	17,200
National Avenue @ Kearney Street	7,900	4,900	12,400	12,800
National Avenue @ Chestnut Expressway	12,500	11,700	13,900	14,100
National Avenue @ Sunshine Street	17,500	18,500	13,700	16,600
National Avenue @ Battlefield Road	17,900	17,800	16,400	17,000
Glenstone Avenue @ Kearney Street	20,700	14,700	13,500	13,300
Glenstone Avenue @ Chestnut Expressway	16,800	19,000	14,000	11,600
Glenstone Avenue @ Sunshine Street	18,200	20,200	15,200	17,300
Glenstone Avenue @ Battlefield Road	16,000	17,100	16,500	12,300

Figure 2. Candidate Intersections for Red Light Cameras. (Red – City; Purple – MoDOT)

Figure 3. Typical geometrics for a high volume intersection of two major arterials

With the start the red light camera program, Springfield traffic engineers recognized that they would need to be involved in the program. This included selection of the vendor, to approval of design plans and wiring interface to city signal controllers, approval of the location and installation of the field equipment, be responsible for monitoring crash records, and most importantly, insure proper yellow signal timing. Although City staff had used the ITE recommended equation for over 20 years, staff was not sure how MoDOT was timing the yellow intervals at their signals. It was also important to the success of the red light camera program that the City and MoDOT time the yellow signals using the same procedure since motorists could drive through City and MoDOT signals on the same street.

TESTING FOR RED LIGHT RUNNING

The need to look closer at the yellow times became even clearer as the selected vendor completed the first round of pre-testing for red light running at the candidate intersections. To the vendor's credit, the vendor immediately advised staff to review the data because there was a remarkable difference between red light running at MoDOT intersections compared to City intersections. Table 1 below summarizes the initial pre-testing results:

Table 1: Red Light Running Pre-Testing – Before & After Retiming

Pre-Testing for Red Light Running - Before Retiming – 12/15/06

	Approaches/Intersections	# of Violations	Violations/Approach
City Signals	16/4	210	13.1
MoDOT Signals	23/11	64	2.78

Pre-Testing for Red Light Running - After Retiming – 9/5/07

	# of Approaches	# of Violations	Violations/Approach
City Signals	8/2	42	5.25
MoDOT Signals	8/2	19	2.38

Note: Before Installation of Cameras for Both Studies

Based on the pre-test results, there was significantly more red light running at City intersections than at MoDOT intersections. One City intersection was found to have a total of 69 red light running violations in a 10 hour period and all be one of the 16 approaches in the testing before the retiming had at least 10 violations. 18 of the 23 approaches to MoDOT signals had 5 or fewer violations in the testing before retiming.

A review of MoDOT yellow timing revealed that MoDOT was using a much longer yellow time than the City. Table A-1 in the Appendix summarizes the yellow phase change and all-red clearance interval timings at the candidate traffic signals prior to the retiming of the yellows.

With 115 MoDOT signals and 137 City signals in the city, were motorists running the City signals with greater frequency because MoDOT signals had a longer yellow and the shorter yellow for City signals was unexpected? Or, were motorists not running the MoDOT signals with as much frequency because motorists familiar with City signals were expecting shorter yellows?

It would have been a simple solution for the City to simply lengthen all yellow intervals to match MoDOT. However, since both agencies use the ITE equation to calculation the yellow phase change interval, shouldn't both agencies be arriving at the same results, assuming that the agencies were using the same assumptions for the variables?

Advice was sought from Richard Retting, formerly of the Insurance Institute for Highway Safety (IIHS), an ITE member and recognized expert on red light running and applications with red light camera enforcement. Richard advised the City and MoDOT to use the ITE recommended equation and find agreement on the assumptions so the yellow times would be determined in a consistent manner for all signals within the City of Springfield.

ITE PROPOSED RECOMMENDED PRACTICE FOR DETERMINING VEHICLE SIGNAL CHANGE INTERVALS

ITE recommended practice was developed in consideration of state laws for a **permissive yellow rule**, consistent with the Uniform Vehicle Code and MUTCD definitions of a red light violation, to support safe stopping and an all red clearance interval to provide for safe passage of vehicles that may have just entered the intersection when the signal turns red. **(3)** The equation for calculation the Change Period is shown below:

Figure 4 - Equation for Calculating the Change Period **(6)**

$$CP = t + \frac{V}{2a \pm 64.4g} + \frac{W + L}{V}$$

Yellow Change Interval *All-Red*

CP = Total Phase Change Interval (seconds)
t = Driver's Perception-Reaction Time
V = Approach Speed (ft/sec)
a = Vehicle Deceleration Rate (ft/sec^2)
g = Percent Grade of Roadway Approach
L = Length of Vehicle (feet)
W = Width of Intersection (feet)

The Proposed Recommended Practice published in the July 1989 ITE Journal states, "As vehicles may legally enter the intersection during the display of the yellow indication, the yellow warning interval is not a clearance interval . . . If it is the policy of the local agency to provide clearance time, the traditional practice has been either to add the time to the yellow warning interval, or to use what has previously been call the "all red interval," herein referred to as the red clearance interval. When clearance time is to be provided, it should be in the form of a red clearance interval . . .". **(3)**

CITY OF SPRINGFIELD/MODOT TIMING MOU

Traffic engineering staff from both agencies reviewed the recommended practice and current agency policies. Yellow times were as much as 1.6 seconds longer at MoDOT signals on streets with the same speed limit as City signals. The difference was in the assumption for Perception Reaction Time (City used 1.0 seconds / MoDOT used 1.5 seconds) and MoDOT had a policy of using 0.5 or 1.0 seconds for the all-red clearance interval resulting in a longer yellow time.

As a result of these discussions, a Memorandum of Understanding (MOU) was drafted for consideration by both agencies. The MOU was approved on January 26, 2007 and a copy is attached in the Appendix.

The basic points of the MOU agreement are summarized below:

- 1.5 second Perception/Reaction Time *(Note: City had been using 1.0 seconds)*
- Use of speed limit for Approach Speed
- Vehicle Deceleration Rate (10 ft/sec/sec)
- Adjust for Percent Grade for Downgrade Only
- Length of Vehicle = 20 feet
- How to measure the Width of Intersection
- Use the first two terms for the yellow time
- Use of the third term for the all-red time

RETIMING OF ALL TRAFFIC SIGNALS

Four months prior to the first camera going live, City and MoDOT engineers retimed the yellow times and the "all-red" time that follows in accordance with the MOU at all signals in the City of Springfield. A copy of the Springfield News-Leader newspaper article is attached in the Appendix which followed the news release to the public about the retiming project. Because many signals would have the yellow times reduced, this was an extremely important part of the process.

Table A-1 in the Appendix summarizes the yellow phase change and all-red clearance interval timings at the candidate traffic signals after the retiming. It should be emphasized that all signals in the City of Springfield were retimed in accordance with the MOU, not just the signals which have or may ultimately have a red light enforcement camera. Consistent yellow times at all signals in accordance with recommended national practice is one of the keys to success of a red light camera program.

RED LIGHT CAMERA PROGRAMS ARE BEING WATCHED

The City of Springfield along with other cities has been cited in national news stories and on various websites for shortening yellow times to create violators and . . . make money. Referring back to Table 1, the MoDOT signals which had the yellow time shortened actually reduced the number of red light violators compared to the number of violators with the longer yellow times.

ITE has been accused by opponents of red light cameras of making a deliberate change in the yellow time calculation to force more drivers to run red lights, thus promoting the use of red light cameras. On one of these websites, cited in the list of references, has a quote from Tom Brahms as follows:

"We do not believe in entrapment," says Thomas W. Brahms, executive director of the Institute of Transportation Engineers. “Any engineer or municipality that timed traffic lights to maximize ticket revenue would create huge legal liabilities”, he says. "It would be an absolutely ludicrous thing to do." **(7)**

BEFORE/AFTER CRASHES

A comparison has been made of the crashes before and after installation of red light cameras in Springfield from the first camera going live on June 30, 2007 thru February 20, 2010. Although the amount of time that each camera has been operational varies, the same time periods of the year have been used for comparison for this summary.

As shown in Table 2, angle crashes at intersections with red light cameras have reduced by 20.51% and by 13.98% at all signals since the start of the program. Rear end crashes have increased by 11.24% at the camera locations which is actually less of an increase than the 15.76% experienced at all signals. However, total crashes are up by 5.97% at camera locations compared to all signals which are up by 3.07%. The increase at the camera locations could be due to the fact that these intersections are the heaviest volume intersections in the city. Concurrent with this increase has been a 2.5% decrease in total crashes reported in the city in 2009 with the crash history for the city shown in Figure 5.

Table 2 - Crashes Before/After Installation of Cameras

At Signals w/Cameras			
Angle Crashes	-	20.51%	↓
Rear End Crashes	-	11.24%	↑
Total Crashes	-	5.97%	↑
At All Signals			
Angle Crashes	-	13.98%	↓
Rear End Crashes	-	15.76%	↑
Total Crashes	-	3.07%	↑
City-Wide Totals 2006 TO 2009			
Total Annual Crashes	-	2.50%	↓

SPRINGFIELD PROGRAM CITATIONS & REVENUE

Table 3 summarizes the citations issued and theoretical revenue over the duration of the red light camera program in Springfield. Citations per camera have averaged 1.34 per day per camera with an average of 1.38 citations per day needed to theoretically break even with the vendor's cost. Although some could accuse the City of attempting to generate revenue, the program has lost a minimum of $32,724 despite the fact that the program has a theoretical income of just under $1 million since June 30, 2007. It is reported in some cities that one camera has made over $1 million in less than a year.

Table 3 - Citations & Revenue - 6/30/07 to 2/20/10

7,231	Camera Days
9,684	Approved Citations
1.34	Average Citations Per Day Per Camera
1.38	Average Citations Per Day Per Camera (To Break Even with Vendor)
$ 968,400	Theoretical Income @ $100 / Citation (If all penalties are collected)
$1,001,124	Vendor Cost @ $4,194/Month/Camera
< $ 32,724 >	Net Expense over Revenue

From the start of the program thru February 20, 2010, red light running at camera locations has been reduced by 36%. In the 30 days ending, February 20, 2010, the average violation rate had been reduced to 1.05 violations per day per camera or 13.6 violations per day at the 13 active cameras with daily approach volumes of 208,250 vehicles per day. It is estimated that there is 99.9 % compliance by motorists at intersection approaches with cameras when signals turn yellow and only 0.1% of motorists violating the red signals.

It would be easy to say that camera enforcement would not be necessary with such high compliance at signals in the city, however, the 36% reduction in red light running, at intersections with cameras, and nearly 14% reduction in angle crashes, city-wide, have made the camera enforcement an essential ingredient in the city's traffic safety program.

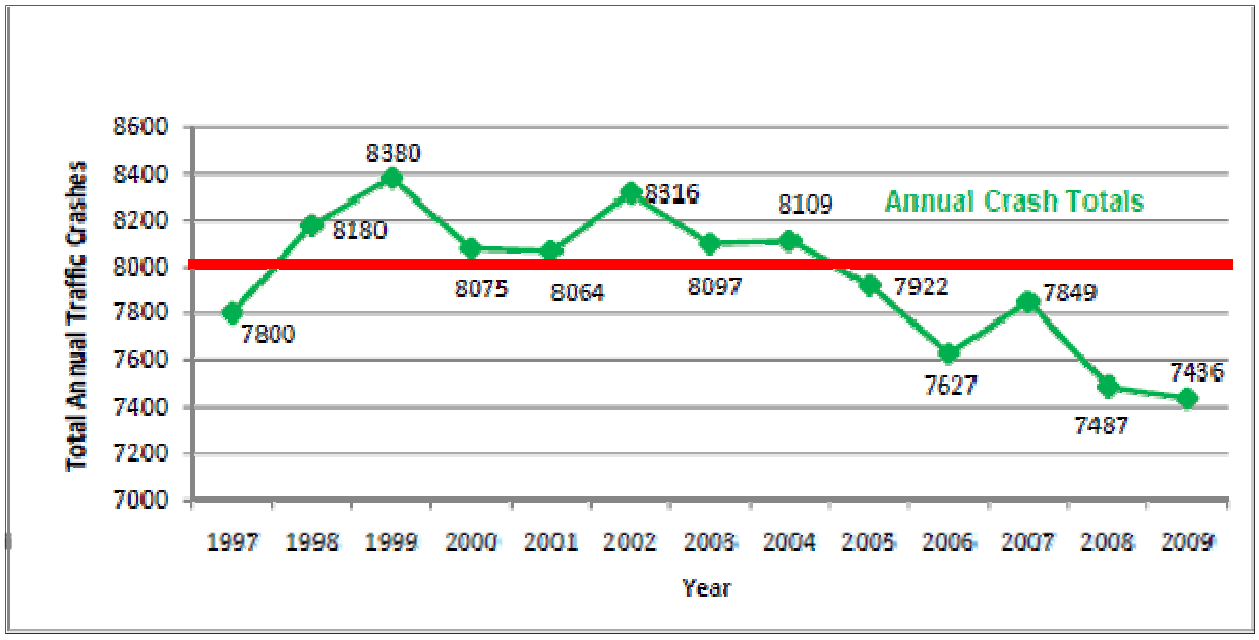


Figure 5. 1997-2009 Annual Crash Trends, Springfield, Missouri.

Annual traffic crashes reached a 14 year low in 2009 with 7,436. The reduction in crashes in Springfield since the high of 8,390 reached in 1999 is the result of efforts in Enforcement, Education and Engineering which includes major intersection bottleneck elimination program, designing for all users, computerized signal system and transportation management center, access management, reduced neighborhood speed limits, traffic calming, safe routes to school, conversion to LED signal lamps, traffic safety education, and . . . use of red light cameras.

LEGAL CHALLENGE / PUBLIC ACCEPTANCE

As successful as the Springfield program has been, it is not without its challenges.

On March 2, 2010, the Missouri Supreme Court ruled that Springfield has not followed state law with the appeal process establishes for red light camera citations. The City had established an administrative process for hearing citations which are appealed using an administrative hearing officer outside of municipal court. This process is used for several other types of civil violations in the city and it was thought to be an acceptable manner of due process.

It is important to note that the cameras were not ruled unconstitutional, only the process. However, with the ruling of the Missouri Supreme Court, it has been necessary to place the red light camera system on hold. This was done immediately on the date of the ruling.

The Springfield News-Leader newspaper lead editorial on March 3, 2010, stated, ". . . When they (*the cameras*) were first installed . . . we expressed concern that they could be used primarily as revenue generators. The city has shown that isn't the case . . . No one should forget that preventing death and injury is the . . . goal. If cameras can help, the city should find a way to keep them up and running." A copy of this editorial is attached in the Appendix.

CONCLUSIONS

1. Red light running countermeasures to reduce red light running should be applied before considering red light cameras with retiming of the yellow change intervals consistent city-wide.

2. There can be differences between agencies, even in the same city. It is important to be able to say to the public and media that the City and MoDOT use nationally recommended practice. Consistent timing of yellow change intervals and all-red clearance intervals throughout the community has improved safety and given credibility to the program.

3. Angle crashes will vary year to year at individual signals. The selection of high volume, high frequency crash locations using major arterial roadways distributed around the community has helped to educate over 800,000 motorists each day to the presence of a red light camera enforcement system and to raise awareness to "Respect Red" at signals throughout the city.

4. Close monitoring of crashes, citations, cost and revenue for a red light camera program is important. Agencies should proactively work towards reducing red light running if the program begins to make money. A program that is successful in reducing red light running would have a diminishing revenue stream and the public support received in the city of Springfield is primarily due to have a program that has been revenue neutral.

5. A red light camera program is just one of the tools in the toolbox to reducing crashes and all safety initiatives contribute to the overall safety program.

ACKNOWLEDGMENTS

The author wishes to acknowledge and thank Ms. Mandy Buettgen, Senior Traffic Technician, City of Springfield, for providing crash data and analyses in support of the City's Automated Red Light Enforcement Program.

REFERENCES

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(2) National Committee on Uniform Traffic Laws and Ordinances, **"Uniform Vehicle Code – Millennium Edition"**, (UVC), (2000).

(3) ITE Technical Council Committee 4A-16. **"Proposed Recommended Practice, Determining Vehicle Signal Change Intervals."** *ITE Journal* (July 1989): p. 27-32.

(4) Eccles, Kimberly A. and McGee, Hugh W., **"A History of the Yellow and All-Red Intervals for Traffic Signals,"** prepared for the Institute of Transportation Engineers, 2001.

(5) FHWA, **"Red Light Running,"** Safer Roads for a Safer Future, 2009, http://safety.fhwa.dot.gov/intersection/redlight/outreach/marketing/rlr_pps022509/long/rlr_long.pdf

(6) FHWA, **"Traffic Control Devices Handbook,"** U.S. Department of Transportation, Federal Highway Administration (2001).

(7) Jonathan Berr, **"Shorter Yellow Lights: Is it Your Town's Latest Cash Cow," Daily** Finance, 2010, http://www.dailyfinance.com/story/insurance/shorter-yellow-lights-is-it-your-towns-latest-cash-cow/19378356/

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APPENDIX

- City of Springfield / MoDOT Signal Phase Change & Clearance Interval Timing – Memorandum of Understanding (MOU), Approved by MoDOT January 26, 2007

- Reprint of Article from February 6, 2007, Springfield (MO) News-Leader – *"Timing slows red-light cam plan"*, News Release RE: Change in Yellow Timing

- Reprint of Editorial from March 3, 2010, Springfield (MO) News-Leader – "City of Springfield should adjust red light camera program instead of scrapping it."

- Table A-1 – Phase Change & Clearance Interval Timing – Old and New Timings

MEMORANDUM OF UNDERSTANDING
RE: Yellow Change and Red Clearance Interval Timing

City of Springfield / MoDOT District 8 (Springfield Office)
Approved on January 26, 2007

Based on discussions January 8, the City and MoDOT District 8 agree to determine and provide traffic signal yellow change interval and red clearance timing using common application procedure guidelines as defined below for all signals within the city of Springfield:

FORMULA FOR CALCULATIONS

The following equation, provided in the 2001 Traffic Control Devices Handbook, will be used to determine the Total Phase Change Interval Time (CP). The equation includes consideration of driver perception-reaction time, deceleration element, and time needed to clear the intersection.

$$CP = t + \frac{V}{2a \pm 64.4g} + \frac{W + L}{V}$$

Terms in the equation are defined as follows:

CP = Total Phase Change Interval (seconds)
t = Driver's Perception-Reaction Time
V = Approach Speed (ft/sec)
a = Vehicle Deceleration Rate (ft/sec^2)
g = Percent Grade of Roadway Approach
L = Length of Vehicle (feet)
W = Width of Intersection (feet)

YELLOW CHANGE INTERVAL TIME

Yellow Change Interval Time (Y) will be calculated using the first two terms of the Phase Change Interval Time Period equation as follows:

$$Y = t + \frac{V}{2a \pm 64.4g}$$, rounded up to nearest 0.1 second.

Perception Reaction Time "t" – It is agreed to use 1.5 seconds for "t" in the equation.

Approach Speed "V" – It is agreed to use the posted speed limit for the approach speed. If the speed limit changes across the intersection, the Yellow Change Interval Time shall be calculated for each approach using the posted speed limits. The Yellow Change Interval Time calculated using the higher approach speed may be used for both directions on the same street.

Deceleration Rate "a" – It is agreed to use a deceleration rate of 10 ft/sec².

Percent Grade of the Roadway Approach "g" – It is agreed to use g = 0 except where the approach has a down-grade for which the slope is determined to be greater than -2%.

If the calculation result is less than 3.0 seconds, the Yellow Change Interval Time will be set at 3.0 seconds.

RED CLEARANCE INTERVAL TIME

Red clearance time (R) will be calculated using the third term of the Phase Change Interval Time equation as follows:

$$\mathbf{R} = \frac{\mathbf{W + L}}{\mathbf{V}}$$, rounded up to nearest 0.1 second.

Width of Intersection "W" – It is agreed that the width of the intersection is to be measured from the stop bar on the near side to the curb line, or lane edge line extended, on the far side of the intersection.

Length of Vehicle "L" – It is agreed to use 20 feet as the length of vehicle for this calculation.

Approach Speed "V" – It is agreed to use the posted speed limit for the approach speed. If the speed limit changes across the intersection, the Red Clearance Interval Time shall be calculated for each approach using the posted speed limits. The Red Clearance Interval Time calculated using the lower approach speed may be used for both directions on the same street.

APPLICATION OF PHASE CHANGE INTERVAL TIME CALCULATIONS TO LEFT-TURN PHASES

Protected/Permissive (P/P) Left Turn Phasing w/Protected Left Turn Phase in Leading Position – When a leading protected left turn (ARROW) phase is followed by a permissive left turn (CIRCULAR GREEN) phase, use same Yellow Change Interval Time as calculated for adjacent through movement to terminate the protected phase. This guideline is given recognizing that a motorist may enter the intersection on Yellow Arrow signal, knowing that the signal will turn to a Circular Green indication which may be used to complete the left turn after yielding to conflicting vehicles and/or pedestrians.

Protected Only (PO) Left Turn Phasing – When Protected Only left turn phasing is used, either in the leading or lagging position, use same Yellow Change Interval Time and Red Clearance Interval Time as calculated for adjacent through movement.

Published February 6, 2007
CAMERA DELAYED »

Timing slows red-light cam plan

City, state must align yellow signal timing before camera use can begin.

Jane Huh
News-Leader

Plans to install cameras at select Springfield intersections have hit a delay as officials of the city and the Missouri Department of Transportation work to align the timing of the yellow signal lights.

City and state roads operate under the same equation to calculate the total time for the yellow and all-red clearance. It was found, however, that "the agencies use slightly different assumptions (perception-reaction time, deceleration rates, and measure of the speed of approaching traffic) ...," the City Council was told in a memo from city management.

When the City Council approved the $1.1 million contract with Laser-Craft in early January, it was expected that the city would see its first camera at the intersection of National Avenue and Battlefield Road by February.

The delay puts the first camera's implementation by the end of February and then three additional cameras at city signals by the end of May.

Enforcement, however, begins after a 30-day grace period. So anyone who violates the red light signal at the intersection within the first 30 days will receive a warning but will not have to pay the $100 fine.

For the next month, city and state traffic engineers will work to re-time the yellow signal times aligning the length with the state-operated traffic signals.

The changes likely will result in an approximate half-second increase on city signals and a half-second decrease for the state-operated signals, totaling 241 intersections, said Earl Newman, the city's traffic engineer.

"We'll be retiming everything so it's all consistent," Newman said. "That is so important for the system to work and for the credibility of the camera system to work."

Officials plan to have 16 cameras installed through- out the city by the first quarter of 2008.

SPRINGFIELD NEWS-LEADER - OUR VOICE

City of Springfield should adjust red light camera program instead of scrapping it
City should examine ways to make system adhere to court ruling.

MARCH 3, 2010

Ouch. The Missouri Supreme Court has put a big hurt on the city of Springfield.
No more red light cameras. At least for now.

All pending $100 tickets are dismissed. And there's a chance those who have already paid fines -- a total of more than $800,000 since the cameras started operating in June 2007 -- will get their money back.

Of course, it's too early to tell the overall impact of the court's ruling, which found fault not with the cameras themselves but with the process the city uses to force car owners to pay fines.

Trying to move that enforcement process along more quickly, the city opted to use "administrative hearings" with lesser standards of proof and fewer appeal options. That, the court said, conflicts with state law.

So, you could say that on this traffic-control issue, the court found fault with the city for speeding.

Well, it's time now for everyone to please slow down. If you're a critic who never liked the cameras, try to resist that urge to shout "I told you so." The city was not reckless to install these devices. And, if you've been a proponent of the cameras, it's not time to throw in the towel yet, either.

If there's a way to make this system adhere to the Supreme Court ruling with adjustments that are affordable, the city should pursue them. We offered cautious support to the cameras when they were first installed. Though we expressed concern that they could be used primarily as revenue generators, the city has shown that isn't the case.

What the city could not do, though, was fend off a challenge to a ticket issued to an indomitable former state trooper, Adolph Belt Jr. Looking for an upside to this case, it's a heartening reminder that the system can work for the little guy. With the help of an unflappable and effective attorney, Belt got the attention and support of the state's top jurists. That certainly doesn't happen every day.

Hopefully, the city can respond through a careful weighing of costs versus benefits and find a way -- as other cities have done -- to more fairly balance a driver's right to a fair hearing against the pervasive power of this innovative photographic monitoring.

No one should forget that preventing death and injury is the overarching goal here. If cameras can help, the city should find a way to keep them up and running.

Table A-1 - Candidate Intersections for Cameras

(Note: City intersections in white, MoDOT intersections in green)

Old Phase Change & Clearance Interval Timing - 12/13/2006

	North-South Thru			East-West Thru			Northbound Left Turn			Southbound Left Turn			Eastbound Left Turn			Westbound Left Turn		
Intersection	**Y**	**R**	**Total**	**Y**	**R**	**Total**	**Y**	**R**	**Total**	**Y**	**R**	**Total**	**Y**	**R**	**Total**	**Y**	**R**	**Total**
National and Sunshine	3.6	2.4	6.0	3.9	2.1	6.0	3.6	2.4	6.0	3.6	2.4	6.0	3.9	2.1	6.0	3.9	2.1	6.0
National and Battlefield	3.9	2.3	6.2	3.9	2.0	5.9	3.9	2.3	6.2	3.9	2.3	6.2	3.9	2.0	5.9	3.9	2.0	5.9
Campbell and Sunshine	3.9	2.1	6.0	3.9	2.1	6.0	3.9	2.1	6.0	3.9	2.1	6.0	3.9	2.1	6.0	3.9	2.1	6.0
Campbell and Battlefield	3.9	2.2	6.1	3.9	2.2	6.1	3.9	2.2	6.1	3.9	2.2	6.1	3.9	2.2	6.1	3.9	2.2	6.1
Kansas and Battlefield	4.4	1.0	5.4	4.8	1.0	5.8	4.4	1.0	5.4	4.4	1.0	5.4	4.8	1.0	5.8	4.8	1.0	5.8
Kansas and Sunshine	5.0	1.0	6.0	5.0	1.0	6.0	5.0	1.0	6.0	5.0	1.0	6.0	5.0	1.0	6.0	5.0	1.0	6.0
Kansas and Chestnut	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5
Kansas and Kearney	5.5	0.5	6.0	6.0	0.5	6.5	5.5	0.5	6.0	5.5	0.5	6.0	6.0	0.5	6.5	6.0	0.5	6.5
Chestnut and Campbell	5.0	1.0	6.0	5.0	0.5	5.5		N/A			N/A		5.0	0.5	5.5		N/A	
Chestnut and National	4.9	0.5	5.4	4.5	0.5	5.0	4.0	0.5	4.5	4.0	0.5	4.5	4.0	0.5	4.5	4.5	0.5	5.0
Kearney and National	5.0	0.5	5.5	5.0	0.5	5.5	4.0	0.5	4.5	4.0	0.5	4.5	4.0	0.0	4.0	4.0	0.0	4.0
Glenstone and Battlefield	5.0	0.5	5.5	5.0	0.5	5.5	4.0	0.5	4.5	4.0	0.5	4.5	4.0	0.5	4.5	4.0	0.5	4.5
Glenstone and Sunshine	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5
Glenstone and Chestnut	5.0	1.0	6.0	5.0	1.0	6.0	5.0	1.0	6.0	5.0	1.0	6.0	5.0	1.0	6.0	5.0	1.0	6.0
Glenstone and Kearney	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5	5.0	0.5	5.5

New Phase Change & Clearance Interval Timing - 3/19/2007

	North-South Thru			East-West Thru			Northbound Left Turn			Southbound Left Turn			Eastbound Left Turn			Westbound Left Turn		
Intersection	**Y**	**R**	**Total**	**Y**	**R**	**Total**	**Y**	**R**	**Total**	**Y**	**R**	**Total**	**Y**	**R**	**Total**	**Y**	**R**	**Total**
National and Sunshine	4.4	2.5	6.9	4.4	2.2	6.6	4.4	2.5	6.9	4.4	2.5	6.9	4.4	2.2	6.6	4.4	2.2	6.6
National and Battlefield	4.4	2.2	6.6	4.4	2.0	6.4	4.4	2.2	6.6	4.4	2.2	6.6	4.4	2.0	6.4	4.4	2.0	6.4
Campbell and Sunshine	4.4	2.0	6.4	4.4	2.0	6.4	4.4	2.0	6.4	4.4	2.0	6.4	4.4	2.0	6.4	4.4	2.0	6.4
Campbell and Battlefield	4.4	2.0	6.4	4.4	2.0	6.4	4.4	2.0	6.4	4.4	2.0	6.4	4.4	2.0	6.4	4.4	2.0	6.4
Kansas and Battlefield	4.8	1.8	6.6	4.4	2.3	6.7	4.8	1.8	6.6	4.8	1.8	6.6	4.4	2.3	6.7	4.4	2.3	6.7
Kansas and Sunshine	4.8	2.0	6.8	4.8	2.3	7.1	4.8	2.0	6.8	4.8	2.0	6.8	4.8	2.3	7.1	4.8	2.3	7.1
Kansas and Chestnut	4.4	2.1	6.5	4.4	2.0	6.4	4.4	2.1	6.5	4.4	2.1	6.5	4.4	2.0	6.4	4.4	2.0	6.4
Kansas and Kearney	4.4	2.3	6.7	4.8	2.2	7.0	4.4	2.3	6.7	4.4	2.3	6.7	4.8	2.2	7.0	4.8	2.2	7.0
Chestnut and Campbell	3.7	2.6	6.3	4.7	1.5	6.2		N/A			N/A		4.7	1.5	6.2		N/A	
Chestnut and National	4.2	2.0	6.2	4.4	1.6	6.0	4.2	2.0	6.2	4.2	2.0	6.2	4.4	1.6	6.0	4.4	1.6	6.0
Kearney and National	4.1	1.9	6.0	4.4	1.8	6.2	4.1	1.9	6.0	4.1	1.9	6.0	4.4	1.8	6.2	4.4	1.8	6.2
Glenstone and Battlefield	4.4	2.1	6.5	4.4	2.3	6.7	4.4	2.1	6.5	4.4	2.1	6.5	4.4	2.3	6.7	4.4	2.5	6.9
Glenstone and Sunshine	4.4	2.1	6.5	4.4	2.0	6.4	4.4	2.1	6.5	4.4	2.1	6.5	4.4	2.0	6.4	4.4	2.0	6.4
Glenstone and Chestnut	4.4	2.1	6.5	4.4	2.0	6.4	4.4	2.1	6.5	4.4	2.1	6.5	4.4	2.0	6.4	4.4	2.0	6.4
Glenstone and Kearney	4.9	0.5	5.4	4.9	2.0	6.9	4.9	2.1	7.0	4.9	2.1	7.0	4.9	2.0	6.9	4.9	2.0	6.9

Note: Yellow time for Campbell at Sunshine was adjusted to 4.7 seconds for all approaches on May 14, 2007 due to downgrades greater than 2%.