



U.S. Department  
of Transportation  
**Federal Highway  
Administration**

400 Seventh St., S.W.  
Washington, D.C. 20590

January 26, 2007

In Reply Refer To: HOTO-1

Mr. John Heffernan  
C.E.O.  
Machinery Verification & Documentation Service, Inc.  
P.O. Box 12003  
Hauppauge, NY 11788

Dear Mr. Heffernan:

Thank you for your December 4 and January 5 letters to the Federal Highway Administration (FHWA) regarding your proposed "Traffic Light Safety Zone" pavement markings and signs. Your letters were forwarded to this office for reply.

Your letters propose the use of alternating red and yellow transverse pavement marking stripes to designate a "safety zone" on the approach to a traffic signal. When in this zone, you indicate that a driver seeing a green signal would be assured of being able to clear the intersection if the yellow signal subsequently appears, but a driver seeing a yellow signal should stop because of being too far from the intersection to clear it before the signal turns red. You also proposed an oval-shaped sign to notify drivers of the "safety zone." You asked for an interpretation on whether such markings and signs are compliant with the requirements of the Manual on Uniform Traffic Control Devices (MUTCD).

The MUTCD is the national standard for all traffic control devices on all roads open to public travel in the U.S. You can view the MUTCD at <http://mutcd.fhwa.dot.gov>. Section 3B.15 of the MUTCD requires all transverse markings (within or across a lane) to be white, so the red and yellow transverse markings you propose are not in compliance with the MUTCD. Further, oval is not an MUTCD approved shape for warning signs. Please note that markings and signs that are not compliant with the MUTCD can only be used on a road open to public travel if the public highway agency that owns the road requests and receives approval from the FHWA for experimentation, in accordance with Section 1A.10 of the MUTCD.

As your letters and other materials acknowledge, on each approach to a traffic signal there exists an area in which, at the onset of the yellow signal indication, it may be difficult for a driver to decide whether to stop or proceed through the intersection. In prior research this is



described as the dilemma zone. It begins at a point where an approaching driver who sees the yellow appear will make a decision to decelerate to a stop, and it ends at a point where a driver who sees the yellow appear will decide to proceed and will enter the intersection before the red signal appears. Within the dilemma zone between those two points, some drivers will decide to stop and some will decide to proceed. This has implications not only in the intersection but also for the driver immediately behind the driver making this decision.

Thorough studies have found that the dilemma zone's actual location is quite variable, depending on several factors, including:

- The operating speed of the vehicle (at, above, or below the speed limit)
- The size, weight, and type of the vehicle
- The braking characteristics of the vehicle (condition of brakes, tires, etc.)
- The perception/reaction time and passive/aggressive tendencies of the driver (elderly vs. young, night vs. day, complexity of environment, etc.)
- The pavement surface condition (wet, dry, rough, smooth, etc.)

Even if the posted speed limit is assumed to be the operating speed of all vehicles, the start and end points of the dilemma zone for any given approaching vehicle will still vary considerably depending on the individual driver, the vehicle, and the road surface condition at the time. This variability makes it infeasible to mark any specific location as the "go/no-go" demarcation point or to mark a specific segment of the approach as a "safety zone" as you have proposed. Such markings could increase the potential for crashes and could create liability for the road authorities who placed such markings.

We very much appreciate your interest in improving traffic safety. However, based on prior research into this issue, we find that your proposal would not result in improved safety. Therefore, we would not approve requests from highway agencies to experiment with them nor would we consider including such markings in a future edition of the MUTCD. If you have any questions, please feel free to contact Mr. Scott Wainwright of our staff by e-mail at [scott.wainwright@dot.gov](mailto:scott.wainwright@dot.gov) or by telephone at 202-366-0857. Please note that we have assigned your request the following official interpretation number and title: "3-200(I)—Dilemma Zone Pavement Markings."

Sincerely yours,

/s/ *Anthony T. Furst*

Anthony T. Furst  
Acting Director, Office of Transportation  
Operations

**Fuller, Gregory A**

---

**From:** Murr, Buddy  
**Sent:** Tuesday, August 28, 2012 1:53 PM  
**To:** Fuller, Gregory A  
**Subject:** FW: Information Regarding Plans of Record: 05-0873

FYI, scroll down to my email time stamped November 30, 2009 at 09:24 AM

**Buddy**

G. G. Murr, Jr., PE  
NCDOT - State Signals Engineer  
office: 919-661-5953  
main: 919-773-2800  
fax: 919-771-2745  
<http://www.ncdot.org/doh/preconstruct/traffic/ITSS/>

*Murr approved David  
Spencer to change yellow  
time to reflect ~~45~~ 45  
MPH speed limit.*

**From:** David.Spencer@townofcary.org [mailto:David.Spencer@townofcary.org]  
**Sent:** Monday, November 30, 2009 4:00 PM  
**To:** Murr, Buddy  
**Subject:** RE: Information Regarding Plans of Record: 05-0873

Yes, this is very helpful. Thank you!

David H. Spencer, PE  
Traffic Engineer  
Engineering Department  
Traffic and Transportation Group  
Town of Cary  
P.O. Box 8005  
Cary, NC 27512-8005  
(919) 462-3833  
[david.spencer@townofcary.org](mailto:david.spencer@townofcary.org)

"Murr, Buddy"  
<[gmurr@ncdot.gov](mailto:gmurr@ncdot.gov)>

To "[David.Spencer@townofcary.org](mailto:David.Spencer@townofcary.org)"  
<[David.Spencer@townofcary.org](mailto:David.Spencer@townofcary.org)>

cc

Subject RE: Information Regarding Plans of  
Record: 05-0873

11/30/2009 02:35 PM

David,  
The clearance calculation sheets dated on May 20, 1991 showed 35 mph for phases 2 & 6; 20 mph for phases 1 & 5; and 25 mph for phases 3 & 4. All grades were shown as 0%.

Using the ITE formula yielded yellows of 3.6 seconds on phases 2 & 6. These times

were rounded up to 4.0. Our general practice at that time was to not show any yellows less than 4.0 seconds. In addition, the ITE formula used 1 sec of Perception/Reaction time and a deceleration rate of 10 ft/sec/sec. The new formula calls for 1.5 sec of Perception/Reaction and a decel rate of 11.2 ft/sec/sec.

Does this info help?  
Buddy

G. G. Murr, Jr., PE  
NCDOT - State Signals Engineer  
Direct: 919-661-5953  
Main: 919-773-2800  
Fax: 919-771-2745  
[www.ncdot.org/doh/preconstruct/traffic/ITSS](http://www.ncdot.org/doh/preconstruct/traffic/ITSS)

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**From:** [David.Spencer@townofcary.org](mailto:David.Spencer@townofcary.org) [mailto:David.Spencer@townofcary.org]  
**Sent:** Monday, November 30, 2009 2:08 PM  
**To:** Murr, Buddy  
**Subject:** RE: Information Regarding Plans of Record: 05-0873

Just another random thought I had. I'm assuming that since the signal plan showed 35 mph then the clearance time was calculated using 35 mph. However, I know sometimes that what is shown may not be what was used to do a calculation. Do you have the means to verify that if a clearance time was calculated in 1991 using a 0% grade and a 35 mph design speed that the resulting yellow time would be 4.0 seconds?

David H. Spencer, PE  
Traffic Engineer  
Engineering Department  
Traffic and Transportation Group  
Town of Cary  
P.O. Box 8005  
Cary, NC 27512-8005  
(919) 462-3833  
[david.spencer@townofcary.org](mailto:david.spencer@townofcary.org)

"Murr, Buddy"

<[gmurr@ncdot.gov](mailto:gmurr@ncdot.gov)>

11/30/2009 09:24 AM

To "[David.Spencer@townofcary.org](mailto:David.Spencer@townofcary.org)"

<[David.Spencer@townofcary.org](mailto:David.Spencer@townofcary.org)>

cc "Mckay, Andrew F" <[amckay@ncdot.gov](mailto:amckay@ncdot.gov)>, "Ziemba, Robert J" <[rziemba@ncdot.gov](mailto:rziemba@ncdot.gov)>, "Maduabuchukwu, Boniface A" <[bmadu@ncdot.gov](mailto:bmadu@ncdot.gov)>

Subject RE: Information Regarding Plans of Record: 05-0873

David,

Good talking with you this morning. Per our conversation, you may go ahead and make changes to the existing yellow and red timings based on the new 11/04/09 EVP plan. Please verify the times are transferred to the new controller when you complete implementation of the new plans.

Thanks for letting us know about this.

Have a good day,  
Buddy

G. G. Murr, Jr., PE  
NCDOT - State Signals Engineer  
Direct: 919-661-5953  
Main: 919-773-2800  
Fax: 919-771-2745  
[www.ncdot.org/doh/preconstruct/traffic/ITSS](http://www.ncdot.org/doh/preconstruct/traffic/ITSS)

---

**From:** [David.Spencer@townofcary.org](mailto:David.Spencer@townofcary.org) [<mailto:David.Spencer@townofcary.org>]

**Sent:** Monday, November 30, 2009 8:51 AM

**To:** Murr, Buddy

**Subject:** Re: Information Regarding Plans of Record

Thanks for that info Buddy. The person that is contacting us is Brian Ceccarelli. It's obvious he's been looking in the Manual so they may be involved together. What the problem is now, that I've found through some digging, is that the signal plan done in 1991 used the wrong speed limit so the yellow time is incorrect. The signal plan used

a speed limit of 35 mph on Cary Towne Blvd when the speed limit was 45 mph at that time (and still is). I have the ordinances from TEAAS that shows the speed limit was set at 45 mph in 1984. We based our yellow times for the red light camera on this info but since it wasn't done correctly to begin with, it leaves us in a bind. We plan on implementing the EVP plans at this intersection very soon but we may change the clearance times in the interim since this seems to be a safety issue. If you have any history on this intersection, let me know when you call. Thanks!

David H. Spencer, PE  
Traffic Engineer  
Engineering Department  
Traffic and Transportation Group  
Town of Cary  
P.O. Box 8005  
Cary, NC 27512-8005  
(919) 462-3833  
[david.spencer@townofcary.org](mailto:david.spencer@townofcary.org)

"Murr, Buddy"  
<[gmurr@ncdot.gov](mailto:gmurr@ncdot.gov)>

To "[David.Spencer@townofcary.org](mailto:David.Spencer@townofcary.org)"  
<[David.Spencer@townofcary.org](mailto:David.Spencer@townofcary.org)>

11/25/2009 04:06 PM

cc

Subject Information Regarding Plans of Record

David,

I got your voicemail. Plan of Record updates are submitted to us via our Division offices. If a municipal jurisdiction is maintaining and operating their own signals/signal system, they should send a POR marked up plan to the responsible Division and they, in turn, will submit the plans to us for updating.

Depending on what work is to be done to an intersection, please understand that certain situations require different treatments and a POR may not be the approved method. A POR update is basically an as-built plan of the intersection. In many cases, the construction of the signal may vary slightly from the approved plan that was sent out. I'm attaching TEPPL T-67 which gives examples of what constitutes a plan change versus what could qualify as a POR update (which may be done after-the-fact).

In the case of the intersection you mentioned in your voicemail, those changes would require an updated plan in lieu of a POR update. Now that Rob has given you an updated plan for your EVP installation, that will become the new POR after construction is complete. If your EVP system is still several months out, you may want to consider an interim plan change.

I'll be in at 6:30 am on Monday, but will be out from 7:30 to 10:00 or so for a Dr. appt. I'll call you when I get back in.

Happy Thanksgiving,  
Buddy

P.S. The party in question wouldn't have the last name of Keith, by chance? Mr. Keith had questions about how we time our clearance and he requested a copy of our Design Manual. He didn't discuss specifics with me. I did relay the link to the online version of our Manual to him.

G. G. Murr, Jr., PE  
NCDOT - State Signals Engineer  
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[www.ncdot.org/doh/preconstruct/traffic/ITSS](http://www.ncdot.org/doh/preconstruct/traffic/ITSS)

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NC Department of Transportation  
Division of Highways  
Highway Building  
1 S. Wilmington Street  
Raleigh, NC 27601

SUBJECT \_\_\_\_\_ PROJECT 1-12-11  
\_\_\_\_\_ COUNTY \_\_\_\_\_  
PREPARED BY \_\_\_\_\_ DATE \_\_\_\_\_ STATION \_\_\_\_\_  
CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_ STR NO \_\_\_\_\_ SHEET \_\_\_\_\_ OF \_\_\_\_\_

Lari Love, Jerry Jensen, Wesley No David Spivey, Murr, Madon, Zickman, Fuller  
Month-to-month contract with REDFLEX

Cam allowed 15 locations per Town Council

4 month period to increase yellow at Cam Towne Rd and Convention once they realized yellow was based on incorrect speed. This was one of first locations to have R/R cameras.

Town is constantly checking clearance intervals in Controller to make sure they are not changed by REDFLEX. Done under signal PM's and Wesley uploads database

Police Dept responds to all appeals.



**Subject: Signal Plan Review Comments - Harrison Avenue at SAS Entrance**

**Date:** Fri, 3 Feb 2006 09:23:00 -0500

**From:** Dick.Moore@TownofCary.org

**To:** "Pamela L. Alexander" <palexander@dot.state.nc.us>

**CC:** al.rager@sas.com, Bryan.Hayes@townofcary.org, Dale.Privette@TownofCary.org, Don Darity <ddarity@rameykemp.com>, "Greg A. Fuller" <gfuller@dot.state.nc.us>, Mike.Billings@TownofCary.org, "Richard E. Mullinax" <rmullinax@dot.state.nc.us>, Steve Johnson <stevejohnson@dot.state.nc.us>, Tom.Reilly@townofcary.org, Wesley.Vo@townofcary.org

Good morning Pamela,

The traffic signal plan proposes to reduce yellow times from 4.5 seconds (existing) to 3.0 to 3.3 seconds for left turns and side street phases along Harrison Avenue. With a speed limit of 45 mph for Harrison Avenue, it would appear that this major decrease in yellow time could create a safety problem.

MUTCD

Section 4D.10 Yellow Change and Red Clearance Intervals

Guidance:

A yellow change interval should have a duration of approximately 3 to 6 seconds.

The longer intervals should be reserved for use on approaches with higher speeds.

Traffic signal controller manufacturers also design controllers for a minimum of 3 seconds for all normal conditions as a safety factor.

The operating speeds on Harrison Avenue are higher speeds. While the left turning speed may be 20-25 mph at the stopbar, the approach speed approaching the traffic signal is much greater.

The Town of Cary would recommend a slow reduction in yellow time (no more than 0.5 seconds per six months), and conduct accident studies at the intersection to ensure that the accident rate does not increase.

The North Carolina section of the Institute of Transportation Engineers (ITE) "2005 Task Force for Yellow and Red Intervals" report indicates "excessive red time ... to be greater than 3.0 seconds." Long red clearance intervals encourages red light running.

As a result, the Town of Cary recommends all reds be no longer than 3 seconds.

We hope this information is helpful in your review of traffic signals maintained by the Town of Cary.

C. Richard (Dick) Moore  
Town Traffic Engineer  
Engineering Department  
Town of Cary  
318 North Academy Street  
Cary, North Carolina 27512-8005  
919-462-3937  
919-460-4935 fax  
dick.moore@townofcary.org (Note: new e-mail address)

"Pamela L.  
Alexander"  
<palexander@dot.  
state.nc.us>

02/01/2006 03:11  
PM

Don Darity <ddarity@rameykemp.com>

To

cc

Dale.Privette@TownofCary.org, Steve  
Johnson  
<stevejohnson@dot.state.nc.us>,  
al.rager@sas.com,  
Dick.Moore@TownofCary.org,  
Wesley.Vo@townofcary.org,  
Tom.Reilly@townofcary.org,  
Mike.Billings@TownofCary.org,  
Bryan.Hayes@townofcary.org, "Greg A.  
Fuller" <gfuller@dot.state.nc.us>,  
"Richard E. Mullinax"  
<rmullinax@dot.state.nc.us>

Subject

Re: Signal Plan Review Comments

With regard to clearance calculations, unless there are mitigating circumstances at a specific intersection that would warrant changing from our standard practice, the standard practice should be followed. A personal preference is not sufficient justification to discard the recommendations of the NCSITE Task Force. Without mitigating circumstances at this location, Ramey Kemp & Associates should follow the standard practice for calculating clearance times. If you wish to discuss further, please let me know.

Don Darity wrote:

> Dale,  
>  
> Thank you for the response. By copy of this e-mail, I will forward your  
> comments to NCDOT-S&G for their input on the clearance issues. As you  
> are probably aware that this intersection is on the State system and  
> NCDOT dictates the way clearance times are calculated. I am also  
> requesting Steve Johnson respond to whether or not we can reuse the  
> existing cabinet pad. If cable routing and splice detail designs are  
> required, RKA will need approval from our client before proceeding with  
> the design work. All other comments will be addressed and corrected.  
>  
> Don Darity, P.E.  
>  
> Ramey Kemp & Associates, Inc.  
> 4928-A Windy Hill Drive  
> Raleigh, NC 27609  
> (919) 872-5115 - Phone  
> (919) 872-0480 x 103 - Direct Line  
> (919) 878-5416 - Fax  
>  
> -----Original Message-----  
> From: Dale.Privette@TownofCary.org [<mailto:Dale.Privette@TownofCary.org>]

>  
> Sent: Friday, January 13, 2006 10:01 AM  
> To: Don Darity  
> Cc: Dick.Moore@TownofCary.org; Wesley.Vo@townofcary.org;  
> Tom.Reilly@townofcary.org; Mike.Billings@TownofCary.org;  
> Bryan.Hayes@townofcary.org  
> Subject: Signal Plan Review Comments  
>  
> Good Morning Don,  
>  
> The Town of Cary has completed its review of the preliminary signal plan  
> you submitted for the intersection of Harrison Avenue and SAS Campus  
> Drive  
> (05-1327) on December 22, 2005. We have the following review comments  
> for  
> you to consider:  
>  
> 1. With regard to clearance calculations and timings shown in the  
> timing  
> chart, Dick Moore, Cary's Traffic Systems Manager, prefers that ALL  
> yellow  
> times in the Town of Cary be greater than or equal to 3.5 seconds. Mr.  
> Moore also prefers an absolute maximum all red time of 3.0 seconds at  
> ALL  
> signals in Cary. Please review your total clearance time calculations  
> and  
> make adjustments accordingly, keeping in mind Mr. Moore's preferences.  
> 2. Also, in the Timing Chart, you had indicated with an asterisk that  
> the  
> yellow clearance times may be field adjusted. We believe this is a  
> mistake.  
> 3. For proposed loop 1A, please bring the lead-in out of the forward  
> end  
> of this loop, then eastward across the northbound lanes and then  
> trenched  
> over to the signal cabinet.  
> 4. The Town of Cary currently has a fiber optic drop cable that is  
> spliced  
> into an interconnect center in the existing signal cabinet. Are you  
> proposing to reuse the existing cabinet foundation and install the new  
> cabinet on it? If so, we assume you will reuse the existing fiber modem  
> and cables, but there will need to be details in the specifications  
> directing the contractor to re-splice the Town's fiber drop into a new  
> interconnect center provided by the contractor.  
> If, however, you are proposing the installation of a new cabinet  
> foundation, then the Town will require you to develop cable routing  
> plans  
> and splice diagrams to be included in your plan set, in addition to the  
> specifications language and appropriate pay items.  
>  
> Please consider these comments and make changes to your plans as needed.  
> Let me know if you have any questions.  
>  
> Dale W. Privette  
> Senior Engineer  
> Town of Cary  
> Post Office Box 8005  
> Cary, NC 27512-8005  
> Tel. (919) 462-3833  
> FAX (919) 460-4935

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Signal Plan Review Comments - Harrison Avenue at SAS Entrance

Pamela L. Alexander, PE  
S & G Special Projects Engineer  
919-715-8333

**Subject: Re: Walnut Street Lane Addition Project - Plan Review Comments**

**Date:** Fri, 30 Jun 2006 07:54:18 -0400

**From:** "Greg A. Fuller" <gfuller@dot.state.nc.us>

**Organization:** North Carolina Department of Transportation

**To:** Dick.Moore@TownofCary.org

**CC:** Steve Johnson <stevejohnson@dot.state.nc.us>

Dick,

Please don't assume our comments concerning the clearance intervals mean we are opposed to red light cameras. As a matter of fact, a working group of the Department's Executive Committee for Highway Safety has been seriously discussing the red light cameras as a strategy to improve intersection safety statewide. As you know, the NCSITE Task Force discussed the red light cameras and agreed the presence or absence of red light cameras would not determine how the clearance intervals would be calculated. We feel a 0.5 second reduction every 6 months of the yellow change interval is excessive. I suggest we discuss this issue with Don Darity and Steve Johnson to see if we can determine a more appropriate timeframe to reduce the yellow change interval. If the Town of Cary believes drivers should be given additional leeway, the red light camera system can increase the time into the red clearance before a violation is recorded. Once again, we will use the standard practice recommended by the NCSITE Task Force unless there are extraordinary circumstances or additional engineering data at the specific location. Our personal opinions do not meet this criteria. We can meet to discuss further if needed. Thanks

Dick.Moore@TownofCary.org wrote:

> Good morning Greg,  
>  
> The Town of Cary is disappointed that NCDOT by these comments will increase  
> the number of Red light violations by Cary residents at the intersection of  
> Walnut and Meeting Street. Because most red light camera installations have  
> been removed across the country because of shorter yellows being installed,  
> we can only assume that NCDOT is opposed to Red light cameras.  
>  
> The Town of Cary continues to maintain:  
>  
> Red light cameras are an useful tool to make intersections safer and reduce  
> red light violations.  
>  
> No reduction of yellows at Red light camera locations.  
>  
> The North Carolina section of the Institute of Transportation Engineers  
> (ITE) "2005 Task Force for Yellow and Red Intervals" report indicates  
> "excessive red time ... to be greater than 3.0 seconds. Long red clearance  
> intervals encourages red light running and may increase accidents.  
>  
> Reduction of yellow time from 5.0 seconds to 3.0 seconds in ten(10) weeks  
> is too short and excessive and will create an increased safety hazard. We  
> recommend no more than 0.5 second reduction every six months.  
>  
> These issues were raised early in February in our meeting and in e-mails  
> and remain unresolved.  
>  
> C. Richard(Dick) Moore  
> Town Traffic Engineer  
> Engineering Department  
> Town of Cary  
> 318 North Academy Street  
> Cary, North Carolina 27512-8005

> 919-462-3937  
> 919-460-4935 fax  
> dick.moore@townofcary.org (Note: new e-mail address)  
> ----- Forwarded by Dick Moore/Cary on 06/29/2006 08:01 AM -----

> "Pamela L.  
> Alexander"  
> <palexander@dot.  
> state.nc.us>

> 06/28/2006 01:56  
> PM

To  
Don Darity <ddarity@rameykemp.com>,  
Dale.Privette@TownofCary.org

cc  
Hemang Surti <hsurti@rameykemp.com>,  
Grant Livengood  
<glivengood@mckimcreed.com>, Gordon  
Rose <GRose@mckimcreed.com>,  
Mike.Billings@TownofCary.org,  
Dick.Moore@TownofCary.org,  
Wesley.Vo@townofcary.org,  
Bryan.Hayes@townofcary.org,  
Jane.Stricklin@TownofCary.org,  
"Richard E. Mullinax"  
<rmullinax@dot.state.nc.us>, Steve  
Johnson  
<stevejohnson@dot.state.nc.us>,  
"Kelly L. Becker, PE"  
<kbecker@dot.state.nc.us>, "Greg A.  
Fuller" <gfuller@dot.state.nc.us>

Subject

Re: Walnut Street Lane Addition  
Project - Plan Review Comments

> Dale and Don, S&G responses in green. If you need to discuss further,  
> please let me know. Pam

> Don Darity wrote:

> Dale, below are our responses to your comments noted in blue:

> Don Darity, P.E.

> Ramey Kemp & Associates, Inc.  
> 4928-A Windy Hill Drive  
> Raleigh, NC 27609  
> (919) 872-5115 - Phone  
> (919) 872-0480 x 103 - Direct Line  
> (919) 878-5416 - Fax

> -----Original Message-----

> From: Dale.Privette@TownofCary.org [  
> <mailto:Dale.Privette@TownofCary.org>]  
> Sent: Friday, June 23, 2006 9:31 AM  
> To: Don Darity; palexander@dot.state.nc.us  
> Cc: Mike.Billings@TownofCary.org; Dick.Moore@TownofCary.org;  
> Wesley.Vo@townofcary.org; Bryan.Hayes@townofcary.org;  
> Jane.Stricklin@TownofCary.org  
> Subject: Walnut Street Lane Addition Project - Plan Review Comments

> Don,

> The Town has completed its review of your submittal dated May 31,  
> 2006 for this Town of Cary project. This project includes the  
> signalized intersections of Walnut Street at Dillard Drive (05-1732),  
> Walnut Street at Meeting Street (05-1558), and Walnut Street at US1  
> NB Ramp (05-0270). I am providing review comments regarding the  
> traffic signal and cable routing/splice plans only. Jane Stricklin,  
> project manager for this project, will provide review comments for  
> the traffic control and pavement marking plans under separate  
> correspondence. Our review comments follow:

> Walnut at US1 Ramp (05-0270)

> 1. You have provided a plan that only shows the final geometry of  
> Walnut Street. We are concerned that the existing detection (loops  
> and lead-ins) in the northbound lanes of Walnut Street will be  
> damaged by the construction of the additional NB lane. How do you  
> plan to maintain detection throughout construction? This situation  
> occurs at all existing signalized intersections where loop detection  
> is present. The only 2 alternatives that I know of to resolve this  
> are 1- prepare Temporary signal designs showing recutting of loops  
> during construction or installing video detection during construction  
> with loops in final; or 2- negotiate with selected contractor to  
> maintain loops w/o Temp Signal designs. The Town of Cary would be  
> responsible with all negotiations of contract.

> 2. Clearance Times - Your plan recommends a full 2 second decrease  
> to the Yellow time for phase 4 (5 sec existing). You plan recommends  
> a 1.3 second decrease for phase 1 (4.5 sec existing). The Town has  
> voiced its concerns with short yellow times in the past. If these  
> proposed times are approved by NCDOT, please consider staging the  
> reduction of yellow times from existing to proposed over an adequate  
> period of time to allow driver adjustment. This sounds reasonable,  
> however RKA would not be responsible for this implementation and I am  
> uncertain as how to show this on the signal designs. You can add a  
> note to the plan, such as, "Existing Yellow Change Interval for phase  
> 2 may be decreased by 0.2 seconds per week until the required value  
> is reached." See Design Manual 5.2.2:4.

> 3. On the electrical diagram (sheet Sig.2), under note #9, please  
> add "Channel 7, Address 3." to the end of the existing note. RKA will  
> comply.

> Walnut at Meeting (05-1558)

> 1. You have provided a plan that only shows the final geometry of  
> Walnut Street. We are concerned that the existing detection (loops  
> and lead-ins) in the northbound lanes of Walnut Street will be damaged  
> by the construction of the additional NB lane. How do you plan to  
> maintain detection throughout construction? Same as above.

> 2. Please show all NEW pedestrian heads and all NEW signal heads to  
> be  
> provided for the entire intersection. RKA will comply.

> 3. The existing signal plan of record shows the red light camera  
> loops in the dual southbound left turn lanes, approximately where  
> your loop 5C and 5D labels are shown. Please show the existing red  
> light camera loops on your plan. Also, please show the existing red  
> light camera and flash units on this plan (located in the NW  
> quadrant). Place a note on the plans that the red light camera and

> flash units to be relocated by others. It is my understanding that  
> NCDOT does not allow showing any Red Light Camera items on NCDOT  
> plans. Pam Alexander may need to elaborate on this issue. A note  
> can be added concerning relocation of cameras, etc. Red Light Camera  
> loops and equipment may be treated like other underground utilities  
> or geometric features and shown on the plans as long as they are  
> labeled "by others" or something similar. It needs to be clear that  
> they are not part of the signal operation.

>  
> 4. As you are aware, the signal cabinet for the intersection of  
> Meeting Street at Caitboo Ave. is located in the NE quadrant  
> currently. It is not shown on this plan. Are you assuming that this  
> cabinet will be relocated prior to this project being let for  
> construction? This cabinet needs to be accounted for. Yes, it is  
> assumed this cabinet will be relocated to Caitboo Ave prior to  
> widening improvements on Walnut St.

>  
> 5. Clearance Times - Currently, phase 5 is monitored by a red light  
> running camera. Your plan recommends reducing the yellow clearance  
> time from 4.0 seconds to 3.2 seconds. We are opposed to reducing  
> this yellow  
> time as many jurisdictions have lost automated enforcement systems  
> after motorists argued that the municipality lowered the yellow times  
> without warrant. We do not want this controversy in Cary. Please  
> compare existing yellow times to your proposed yellow times for  
> phases 1,3,4, and 5 and consider our comments in #2 above. Pam will  
> need to address this issue. The supplement to the MUTCD states in  
> Section 4D.10 that "The use of redlight camera photo enforcement  
> systems shall not be a consideration in determining the duration of  
> yellow and red clearance intervals." Therefore, the selection of  
> these times needs to be looked at separately from the red light  
> camera issue. This practice was reaffirmed by the NCSITE Clearance  
> Task Force. These times can also be lowered incrementally and/or the  
> Town may want to consider a grace period after the new times are  
> installed.

>  
> 6. The requested "Permanent Signal Easement" is labeled in the NW  
> quadrant but not the NE quadrant. Please label both requested  
> easements. RKA will comply.

>  
> 7. The street name is "Meeting Street" on both side streets.  
> Please revise your label and title block accordingly. RKA will  
> comply.

>  
> 8. On the electrical diagram (sheet Sig.5), under note #9, please  
> add "Channel 7, Address 2." to the end of the existing note. RKA  
> will comply.

>  
> Walnut at Dillard (05-1732)

>  
> 1. You have provided a plan that only shows the final geometry of  
> Walnut Street. The existing detection is provided by Econolite Solo  
> Pro video detection systems. During construction, these cameras will  
> have to be adjusted as lanes are narrowed/closed. How do you plan to  
> show this in this plan set? Same as above.

>  
> 2. Please show all new signal and pedestrian heads to be provided  
> for this entire intersection. RKA will comply.

>  
> 3. Former Division Traffic Engineer John Grant had agreed to change  
> the outside westbound Dillard Drive lane to a shared through and  
> right whenever a detector could be placed in that existing exclusive



> right turn lane. Please change that lane on this plan to a shared  
> through/right turn lane. You will need to remove the right turn  
> overlap and change the signal head facing that lane, along with your  
> table of operation, phasing diagram, and electrical drawings. RKA  
> will comply.

>  
> 4. The existing northbound Walnut Street through lanes are monitored  
> by a red light camera system. The red light camera loops are  
> existing near the stop bar in the existing two northbound through  
> lanes. Please show these loops on this plan, and show the red light  
> camera and flash units that are existing on the SE corner of the  
> intersection. Place a note on the plans that the red light camera  
> and flash units to be relocated by others. Again, this is not a  
> NCDOT standard, however a note can be added as above. Same as above.

>  
> 5. The traffic signal poles, cabinet, and loop lead-ins in the NE  
> and SE quadrants are shown outside of the existing right of way. If  
> you will need easements to enable the installation of the loop  
> lead-ins, then show the needed easements on this plan. RKA will  
> comply, however, McKim & Creed will need to acquire these easements  
> and coordinate w/ TOC.

>  
> 6. In the Timing Chart, we believe that the Max 1 times for phases 6  
> and 7 are reversed. Please check. RKA will comply.

>  
> 7. On the electrical diagram (sheet Sig.8), under note #9, please  
> add "Channel 6, Address 5." to the end of the existing note. RKA  
> will comply.

>  
> I also have extensive comments on the cable routing and splice  
> diagrams  
> that are a part of this plan set. Rather than list all of the  
> comments

>  
> here, I would prefer that you come by and pick up a set of red lined  
> plans at your earliest convenience. Please leave plans with the  
> receptionist and we will have someone pick them up.  
> As mentioned above, you may be receiving additional review comments  
> on the traffic control and marking plans.

>  
> Let me know if you have any questions.

>  
> Dale W. Privette  
> Senior Engineer

>  
> Town of Cary  
> Post Office Box 8005  
> Cary, NC 27512-8005  
> Tel. (919) 462-3833  
> FAX (919) 460-4935

> --  
> Pamela L. Alexander, PE  
> S & G Special Projects Engineer  
> 919-715-8333

--  
Greg Fuller, PE  
State ITS & Signals Engineer  
phone - 919-733-8021



STATE OF NORTH CAROLINA  
DEPARTMENT OF TRANSPORTATION

MICHAEL F. EASLEY  
GOVERNOR

LYNDO TIPPETT  
SECRETARY

December 15, 2004

Memorandum

To: Holders of the Traffic Management & Signal Systems Design Manual  
Private Engineering Firms and Municipality Traffic Engineers

From: G. A. Fuller, PE *G. A. Fuller*  
State ITS and Signals Engineer

Subject: Vehicle Clearance Interval Timing Calculations (Std. No. 5.2.2, sheet 4 of 4)

Please find attached a revised page on the subject matter for the Traffic Management & Signal Systems Design Manual.

The revision specifies a minimum yellow change interval of 3.5 seconds versus the original requirement of 3.0 seconds and specifies red clearance intervals greater than 3.5 seconds require special circumstances versus the original requirement of 4.0 seconds. In addition, a range of 20 mph to 30 mph is now shown in the notes for design speeds that may be used for most left turn movements rather than the original suggestion of 20 mph. Note that it remains critical for engineers to appropriately evaluate the design speed for left turn movements. Consideration should be given to intersection geometrics, adjacent intersection timing, and other factors to ensure that clearance intervals are properly timed.

This is an interim practice to address issues that have been raised with the recently adopted practice by the Department of utilizing a strict interpretation of the Institute of Transportation Engineers recommended clearance interval formula. In reviewing practices across North Carolina and the Nation, there appears to be no consistency on appropriate clearance interval timings. As such, we will be submitting to the NCSITE Traffic Engineering Council a proposal to form a task force to investigate and develop a consensus for a standard practice in North Carolina.

The complete Traffic Management & Signal Systems Design Manual is available at the following web page: <http://www.doh.dot.state.nc.us/preconstruct/traffic/tmssu/default.htm>

If I may be of any further assistance in this matter, please contact me at (919)733-8021.

w/ attachment

GAF/REM

Cc: J. Kevin Lacy, PE  
Division Traffic Engineers  
Regional Traffic Engineers

# Determination of Yellow Change and Red Clearance Intervals

## Yellow Change Interval

$$\text{Yellow interval} = t + \frac{v}{2a + 64.4g}$$

t = perception reaction time, typically 1.5 seconds  
 v = design speed\*, in ft/s  
 a = deceleration rate, typically 11.2 ft/s<sup>2</sup>  
 g = grade (for positive grades, use 0%)

Round up to nearest 0.1 second

Minimum yellow change interval is 3.5 seconds and generally should not be greater than 6 seconds.

## Red Clearance Interval

$$\text{Red interval} = \frac{w + l}{v}$$

w = width of intersection, in feet  
 l = vehicle length, generally assumed to be 20 feet  
 v = design speed\*, in ft/s

Round up to nearest 0.1 second

Red clearance intervals of less than 1.0 second and greater than 3.5 seconds require special circumstances.

## Notes

\* Design speed is the speed limit unless a speed study determines that the 85th percentile speed is faster or intersection geometrics compel vehicles to traverse the intersection slower.

For most left turn lanes, assume a speed of 20 mph (32 kph) to 30 mph (48 kph). For locations with unusual conditions a higher or lower speed may be appropriate.

For separate left turn phases, calculate yellow and red intervals.

For left turns without a separate phase, calculate yellow and red times for both the through movement and the left turn movement. Use the highest yellow and enough red to equal the highest total time.

Where existing times are higher than calculated times, use the calculated values unless there is a documented history of the need for higher times. If approach is high speed and existing times are significantly higher than the calculated times, use the calculated values but consider adding a note to the plan to direct field forces to reduce the time incrementally. Include in the note how much and how often to reduce time until the final value is reached. (EX. Existing Yellow Change Interval for phase 2 may be decreased by 0.2 seconds per week until the required value is reached.)

### Sources:

- Traffic Engineering Handbook, Fifth Edition, Institute of Transportation Engineers, 1999.
- A Policy on Geometric Design of Highways and Streets, Fourth Edition, American Association of State Highway and Transportation Officials, 2001.

## Change and Clearance Intervals

SIGNALS & GEOMETRICS SECTION  
 TRAFFIC ENGINEERING AND SAFETY SYSTEMS BRANCH  
 NORTH CAROLINA DEPARTMENT OF TRANSPORTATION



Home > Camera Enforcement > Engineering/Signals > Opinion: When a Yellow Light is Too Long

PRINTER-FRIENDLY EMAIL TO A FRIEND

4/30/2012

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Opinion: When a Yellow Light is Too Long

Increasing yellow times beyond 6 seconds is going too far.

Opponents of red light cameras argue that the primary reason vehicles run red lights is that yellow signal times are too short. By this, they mean drivers who come upon a light that has just changed from green to yellow do not have enough time either to comfortably come to a stop or proceed through to the other side of the intersection before the signal begins displaying a steady red. Some have taken the concept of "longer yellows" as a remedy for the problem to the extreme.

Responsible organizations like the National Motorists Association advocate a modest boost in yellow time as part of a suite of engineering improvements rendering photo ticketing entirely unnecessary (view alternatives). Others are actively promoting yellow intervals that range from a low of 4.8 seconds at 25 MPH to a high of 10.0 seconds at 65 - far beyond the 6-second maximum allowed under federal regulations. The longer figures are said to be absolutely correct and required.



Search Go

"The equation embeds Newton's Laws of Motion," Brian Ceccarelli wrote on his Red Light Robber website. "Therefore by the laws of the universe, no yellow light duration can be set less than these values. If less, then the yellow duration is illegal by the Canute Rule."

View Main Topics:

Camera Enforcement go

Short yellows are a serious problem. In 2001, the Office of the US House Majority Leader issued a report, "The Red Light Running Crisis: Is it intentional?" explaining in detail the changes the Institute of Transportation Engineers (ITE) made to the commonly used yellow timing formula between 1976 and 1999 (view signal timing chapter). Engineers manipulated the standard equation so that it produced yellow times generally shorter by around a second so that, according to the ITE, "enforcement can be used instead" of longer yellows. Prior to the arrival of photo enforcement at intersections, engineers were told to use the equation as a starting point, lengthening the timing until the desired result was achieved.



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"When the percent of vehicles that are lost through the intersection which enter on red exceeds that which is locally acceptable (many agencies use a value of one to three percent), the yellow interval should be lengthened until the percentage conforms to local standards," the ITE wrote in its 1985 recommended practice (read report in PDF).

Back To Front Page

This practice reflects the proper understanding of traffic engineering. The daily interplay at a given intersection of tens of thousands of drivers varying widely in age and ability driving anything from lightweight sports cars with impressive braking ability to heavily laden 18-wheelers cannot be captured by a mathematical equation. Visibility at the intersections also varies between night and day and pavement conditions can change with the weather. The ITE equation attempts to get the engineer in the ballpark of the best value by producing a recommended minimum, and it is his duty to ensure the theoretical timing is appropriate in practice. The equation is the starting point, not the end point.

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The ITE had it right with the formula published in 1976, adjusted to suit actual intersection conditions. Both the states of Georgia and Ohio have enacted laws mandating an across-the-board one second increase in yellow times at red light camera intersections. This was a crude way of correcting the current ITE formula so that photo enforced intersections would have signal timing close to what they would have had decades ago.

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The results in practice speak for themselves. After the one second law took effect, violations in Georgia dropped to such a low level that Lasercraft, the state's primary photo enforcement company at the time, essentially went out of business and was acquired by a competitor. TheNewspaper reviewed the before and after results after obtaining documents from every red light camera program in the state. Straight through signal violations are a non-issue, leaving a handful of locations that survive on ticketing for rolling right-turns on red. Likewise, in Fairfax County, Virginia, the data show a signal lengthened from 4.0 to 5.5 seconds cut violations by over 90 percent (view data), resulting in less than one percent of daily traffic violating the red. Nothing would be gained by further increasing the yellow. These real-world results are the only thing that matters.

A yellow should only be as long as it needs to be to achieve compliance, in actual practice, with the ultimate goal of reducing the number of accidents to an absolute minimum. There is no benefit in further lengthening yellows simply to satisfy a theoretical assumption.

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**Subject: Re: Walnut Street Lane Addition Project - Plan Review Comments**

**Date:** Fri, 30 Jun 2006 13:57:23 -0400

**From:** Kevin Lacy <jklacy@dot.state.nc.us>

**Organization:** North Carolina Department of Transportation

**To:** "Greg A. Fuller" <gfuller@dot.state.nc.us>

Greg,

I like the option where the Town provides a grace period after the clearance intervals are changed. This approach is easily documented by the Town and it does not require any alterations to the equipment. The Town could turn off the cameras at these intersections for as long or as short of a time period they choose. This will also be a highly defensible position from the public's perspective.

I believe a three month period is plenty of time, most drivers through this corridor are everyday drivers and will adapt to the changes. Those who infrequently travel the corridor will not have a reliable basis to determine if there was a real change.

I am also supportive of setting the clearance intervals to the appropriate levels based upon the most recent standards. I am not sure what justification would be convincing enough to exempt these intersections.

Kevin

"Greg A. Fuller" wrote:

> Dick,  
> Please don't assume our comments concerning the clearance intervals mean we are  
> opposed to red light cameras. As a matter of fact, a working group of the  
> Department's Executive Committee for Highway Safety has been seriously  
> discussing the red light cameras as a strategy to improve intersection safety  
> statewide. As you know, the NCSITE Task Force discussed the red light cameras  
> and agreed the presence or absence of red light cameras would not determine how  
> the clearance intervals would be calculated. We feel a 0.5 second reduction  
> every 6 months of the yellow change interval is excessive. I suggest we discuss  
> this issue with Don Darity and Steve Johnson to see if we can determine a more  
> appropriate timeframe to reduce the yellow change interval. If the Town of Cary  
> believes drivers should be given additional leeway, the red light camera system  
> can increase the time into the red clearance before a violation is recorded.  
> Once again, we will use the standard practice recommended by the NCSITE Task  
> Force unless there are extraordinary circumstances or additional engineering  
> data at the specific location. Our personal opinions do not meet this  
> criteria. We can meet to discuss further if needed. Thanks

>  
> Dick.Moore@TownofCary.org wrote:

>  
> > Good morning Greg,  
> >  
> > The Town of Cary is disappointed that NCDOT by these comments will increase  
> > the number of Red light violations by Cary residents at the intersection of  
> > Walnut and Meeting Street. Because most red light camera installations have  
> > been removed across the country because of shorter yellows being installed,  
> > we can only assume that NCDOT is opposed to Red light cameras.

> >  
> > The Town of Cary continues to maintain:

> >  
> > Red light cameras are an useful tool to make intersections safer and reduce  
> > red light violations.

> >  
> > No reduction of yellows at Red light camera locations.

> >  
> > The North Carolina section of the Institute of Transportation Engineers

[Fwd: Clearance times]

**Subject:** [Fwd: Clearance times]

**Date:** Mon, 31 Oct 2005 16:13:12 -0500

**From:** David Naylor <DNaylor@dot.state.nc.us>

**Organization:** North Carolina Department of Transportation

**To:** "Greg A. Fuller" <gfuller@dot.state.nc.us>

FYI

--

David Naylor, P.E.  
Deputy Division Traffic Engineer  
NCDOT  
716 W. Main Street  
Albemarle, NC 28001  
Office: (704) 982-0101  
Fax: (704) 982-3146

---

**Subject:** Clearance times

**Date:** Mon, 31 Oct 2005 15:06:38 -0500

**From:** "Abel, Charles" <cabel@ci.charlotte.nc.us>

**To:** <dnaylor@dot.state.nc.us>

**CC:** "Babson, Liz" <ebabson@ci.charlotte.nc.us>

David,

This email is to inform you of how we are calculating and implementing clearance times within the City of Charlotte in light of the Clearance Interval Task Force's recommendations from this summer.

#### CALCULATION

We are using the recommendations of the Clearance Interval Task Force for calculating yellow, red and total clearance times. There is one exception, the CBD, where we will use the formula to calculate average clearance values and use them exclusively at CBD locations.

The speed that we use for left turning vehicles is found this way:  
posted speed limit <= to 35 mph, use lesser of 25 mph or posted speed limit  
posted speed limit >= to 40 mph, use 30 mph

This is somewhat higher than NCDOT's recommendation of 20 mph and somewhat lower than the 10 mph below the posted speed limit that CDOT was using. The speed studies that CDOT conducted for left turns found, on average, a much higher 85th percentile left turning speed than 20 mph. We felt that while 20 mph may fit widely varying conditions across the state, this low speed is not appropriate for the drivers of Charlotte. The speed studies also showed that the way CDOT calculated the left turn speed for high speed approaches was not appropriate as well and led to the modification that lowered those speeds.

#### IMPLEMENTATION

We are implementing the new clearance times on a case by case basis as we retime the signals. It will take approximately 2-1/2 years before all NCDOT signals will be modified.

If you want to discuss this, please give me a call at 704-336-3945.

Charles

Feller



# TEXAS SOUTHERN UNIVERSITY

Project Summary Report 0-4273-S

Project 0-4273: Yellow and Red Intervals to Improve Signal Timing Plans for Left-Turn Movement

Authors: Lei Yu, Fengxiang Qiao, Yusong Zhang (Texas Southern University)  
Zong Z. Tian and Nadeem Chaudhary (Texas Transportation Institute)

## Summary Report on Yellow and Red Intervals to Improve Signal Timing Plans for Left-Turn Movement

PROJECT SUMMARY REPORT

Signal intervals have long been used at intersections for clearing one traffic movement before allowing another conflicting movement to proceed. Among the signal intervals, a yellow change interval, the yellow signal period, is adopted for a driver approaching the intersection to make the decision to either stop or proceed into the intersection after the green signal turns to yellow. A red clearance interval, the all red signal period, is used to clear the intersection before the green signal for

the conflicting traffic movement starts.

For the left-turn movement, shown in Figure 1, the determination of the yellow change and red clearance intervals is more complicated than for the through movement. However, the yellow change and red clearance intervals for left-turn movements are not yet fully understood in either theory or practice. In practice, the yellow change and red clearance intervals for the through movement are simply used for the left-turn

movement. The lack of an appropriate method for determining the left-turn yellow change and red clearance intervals may result in inappropriate signal timings, which are either unsafe for left-turn vehicles or inefficient for the intersection.

### What We Did...

In this research project, we (1) prioritized the parameters potentially affecting the yellow change and red clearance intervals for the left-turn movement; (2) established the framework; (3) developed the approach to calibrate the parameters in the framework; and (4) conducted field tests at 21 intersections in Texas.

### Prioritized parameters potentially affecting the yellow change and red clearance intervals

A survey of transportation engineers, researchers, and executives was conducted to identify

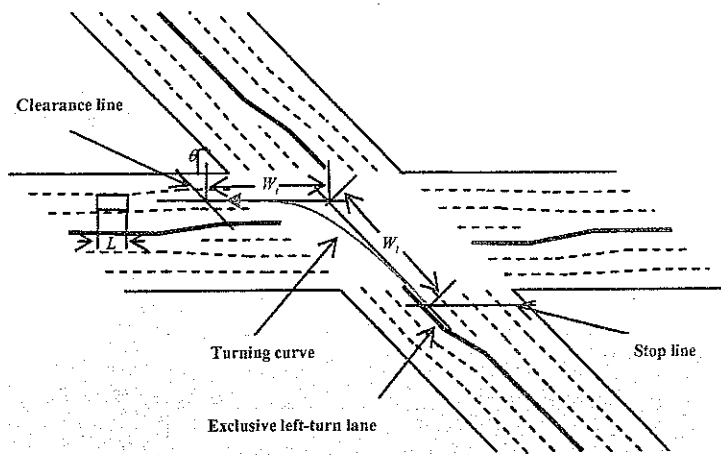


FIGURE 1 A Schematic Drawing of the Left-Turn Movement at a Signal-Controlled Intersection.



and prioritize the parameters that potentially affect the yellow change and red clearance intervals for the left-turn movement. A review of the top 10 prioritized factors reveals that the number one concern was related to accidents. Others include geometric design, visibility and impeding factors, speed, traffic laws, perception-reaction time, and signal phasing.

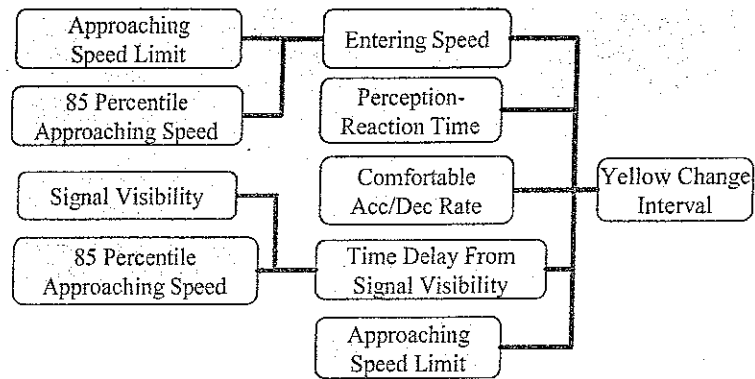


FIGURE 2 Description of Framework for Yellow Change Interval.

**Established the framework determining the yellow change and red clearance intervals**

Based on the survey, a framework was proposed, which was designed to incorporate a comprehensive set of factors related to the determination of the change intervals for the left-turn movement.

Figure 2 and Figure 3 describe the framework for determining the yellow change and red clearance intervals, respectively. From these two figures it is shown that many parameters are taken into consideration in the developed framework.

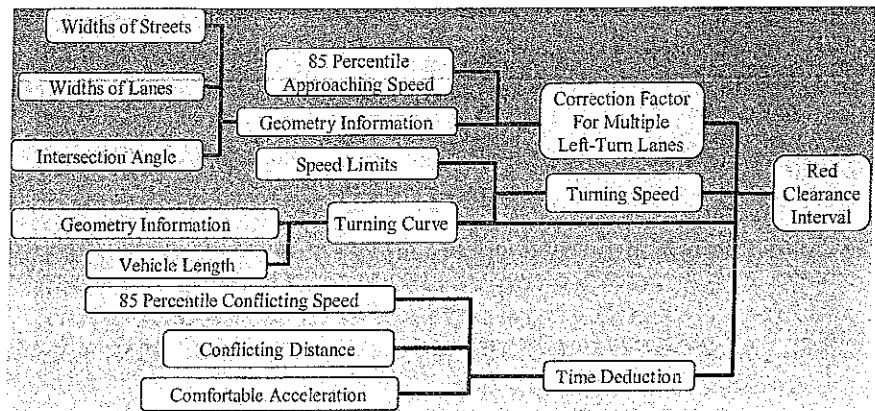


FIGURE 3 Description of Framework for Red Clearance Interval.

**Developed the approaches calibrating the parameters of the proposed framework**

Calibration of the framework was developed as well. The purpose was to ensure that the results from the framework be consistent with the field observations. The first step was to conduct a preliminary calibration to the parameters and calculate the change intervals for the surveyed intersections. The second step was to further calibrate the framework to extend the results to any target intersections.

**Conducted field tests at 21 intersections in Texas**

In order to compare the calculated versus observed yellow change and red clearance intervals, field tests were conducted at 21 Texas intersections. Comparison results were used to examine the effectiveness of the proposed framework. Historical accident data from these intersections were used to identify the problem intersections for further examination.

**What We Found...**

**Existing yellow change intervals for left-turn movements are longer than those calculated**

By comparing the calculated yellow change intervals from the framework with the existing intervals at the 21 surveyed intersections, it is found that the existing yellow change intervals are longer than those calculated. The dashed and solid blue lines in Figure 4 show this kind of comparison.





**Existing red clearance intervals for left-turn movements are shorter than those calculated**

Also plotted in Figure 4 are the existing red clearance intervals (dashed red line) and the calculated red clearances (solid red line) for the 21 Texas intersections. For most of the intersections, the existing red clearance intervals are shorter than those calculated.

**Existing total change intervals are close to those calculated**

Although the existing yellow change and red clearance intervals are different from the calculated intervals, the existing total change intervals for the 21 Texas intersections are close to the calculated total change intervals. These are shown as the dashed and solid green lines in Figure 4.

This fact implies that the adjustment of yellow change and red clearance intervals by the proposed framework will not reduce the total green time, and thus will not decrease the efficiency of the intersection.

**The Researchers Recommend**

The researchers recommend further testing and implementation of the proposed framework. Table 1 summarizes the calibration results for a wide range of intersection configurations.

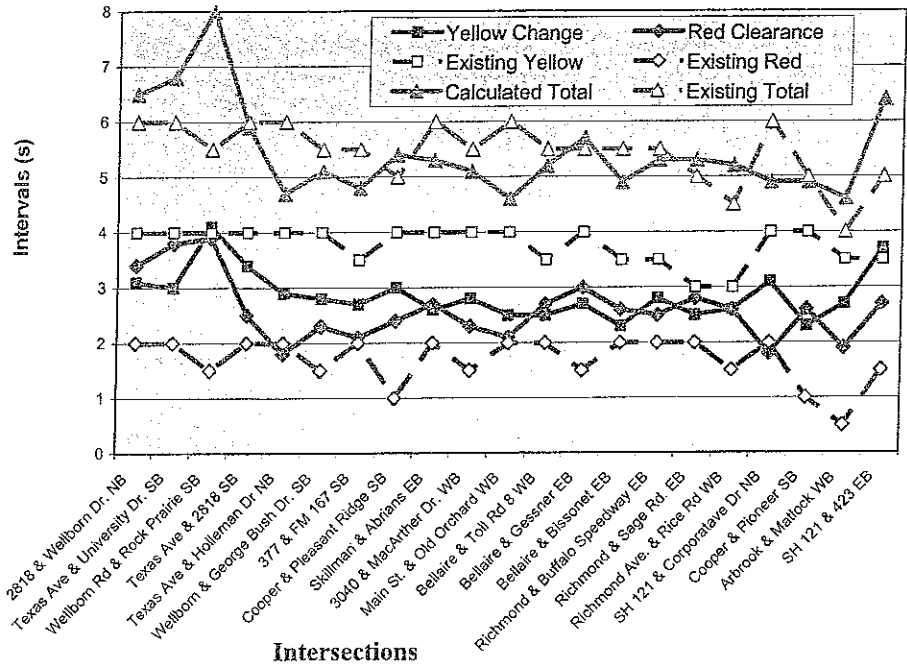
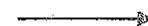


FIGURE 4 Comparison of Calculated and Existing Yellow Change and Red Clearance Intervals.

Approach Speed	No of Lanes		Depth							
			70ft		90ft		110ft		130ft	
			Yellow	Red	Yellow	Red	Yellow	Red	Yellow	Red
30	1	PT	3.0	2.2	3.0	2.9	3.0	3.6	3.0	4.3
		PM	3.0	2.2	3.0	2.8	3.0	3.5	3.0	4.2
	2	PT	3.0	2.5	3.0	3.2	3.0	3.9	3.0	4.6
		PM	3.0	2.4	3.0	3.1	3.0	3.8	3.0	4.5
40	1	PT	3.0	2.4	3.0	2.9	3.0	3.6	3.0	4.3
		PM	3.0	2.6	3.0	2.8	3.0	3.5	3.0	4.2
	2	PT	3.0	2.6	3.0	3.2	3.0	3.9	3.0	4.6
		PM	3.0	2.8	3.0	3.1	3.0	3.8	3.0	4.5
50	1	PT	3.0	2.9	3.0	3.1	3.0	3.6	3.0	4.3
		PM	3.0	3.1	3.0	3.3	3.0	3.5	3.0	4.2
	2	PT	3.0	3.1	3.0	3.2	3.0	3.9	3.0	4.6
		PM	3.0	3.3	3.0	3.5	3.0	3.8	3.0	4.5
55 or above	1	PT	3.0	3.1	3.0	3.3	3.0	3.6	3.0	4.3
		PM	3.4	3.5	3.3	3.7	3.3	3.9	3.2	4.2
	2	PT	3.3	3.5	3.2	3.6	3.1	3.8	3.1	4.5
		PM	3.4	3.7	3.3	3.8	3.2	4.0	3.2	4.2

Note: for trucks, yellow change remains same, red clearance increases 0.1s for 5%-10% trucks in the traffic; 0.3 for 10%-15% trucks; 0.4s for 15%-20% trucks; and 0.5s for 20% or above trucks. PT: Protected; PM: Protected/Permitted

TABLE 1 Recommended Intervals for Right Angle Intersections.



## For More Details . . .

This research is documented in reports 0-4273-1 and 0-4273-2, *Yellow and Red Intervals to Improve Signal Timing Plans for Left-Turn Movement*

Research Supervisor: Lei Yu, [yu\\_lx@tsu.edu](mailto:yu_lx@tsu.edu), (713) 313-7282

Researchers: Fengxiang Qiao, [qiao\\_fg@tsu.edu](mailto:qiao_fg@tsu.edu) and Yusong Zhang, [zhang\\_yx@tsu.edu](mailto:zhang_yx@tsu.edu), TSU  
Zong Z. Tian, Nadeem Chaudhary, TTI

Project Director: Roy Parikh, TxDOT Fort Worth District, [rparikh@dot.state.tx.us](mailto:rparikh@dot.state.tx.us), (817) 370-6617

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## TxDOT Implementation Status — June 2004

The objective of this research project was to develop a comprehensive framework for determining the yellow change and red clearance intervals for left-turn movements at intersections with various geometric configurations and protected/permissive signal phases. One product was required for this project — a Guidebook containing guidelines for determining yellow changes and red clearance intervals for left-turn movement. The Guidebook will help facilitate the implementation of the proposed framework on Texas highways at signalized intersections with left-turn phases.

For more information, contact Mr. Wade Odell, P.E., RTI Research Engineer, at (512) 465-7403 or e-mail [wodell@dot.state.tx.us](mailto:wodell@dot.state.tx.us).

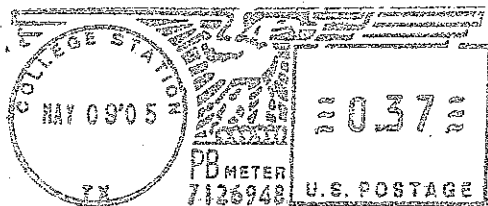
**Your Involvement Is Welcome!**

TT10501.0405.525 TSU PSR 0-4273-S

## Disclaimer

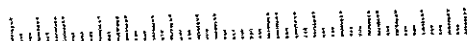
The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Texas Department of Transportation or the Federal Highway Administration (FHWA). This report does not constitute a standard, specification, or regulation, nor is it intended for construction, bidding, or permit purposes. Trade or manufactures' names used in this report do not represent endorsement and appear solely because they are considered essential to the subject of this report. This report was prepared by Lei Yu, Fengxiang Qiao, Yusong Zhang, Zong Z. Tian and Nadeem Chaudhary.

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**FIRST CLASS**

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**Intersection:** Main St. / Parkway Avenue

**Direction:** Eastbound Parkway Ave. Left Turn Movement

**Study by:** M Bunk

**Type:** Single lane

**Method:** Data was collected per cycle for 20 cycles. One car was targeted at the beginning of the queue, middle of the queue and at the end of the queue each cycle.

**Date:** 2/10/2005

**Time:** 8:30 - 9:00 AM

**Time:** 2:30 - 3:00 PM

**Speed Shown in MPH**

Front-Queue	Mid-Queue	End-Queue
15	12	19
9	11	14
12	16	15
13	14	12
14	14	13
15	14	17
9	12	11
10	10	10
12	14	16
10	14	16
13	14	15
13	16	20
10	12	12
10	13	15
10	14	15
12	12	12
15	16	16
12	14	15
13	14	15
13	13	15

**Speed Shown in MPH**

Front-Queue	Mid-Queue	End-Queue
14	14	14
11	14	20
12	15	16
10	12	13
12	14	14
14	16	16
10	14	18
12	12	12
18	15	16
11	15	16
12	15	16
11	13	14
12	12	14
13	16	18
14	14	15
11	12	14
12	14	15
11	13	11
14	15	15
14	14	16

Ave	14
Min	9
Max	20
85th	16