TRANSPORTATION
ENGINEERS+PLANNERS

Illinois Department of Transportation

2016 THE Short Course

Flashing Yellow Arrows

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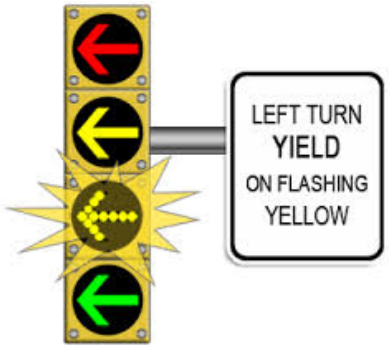
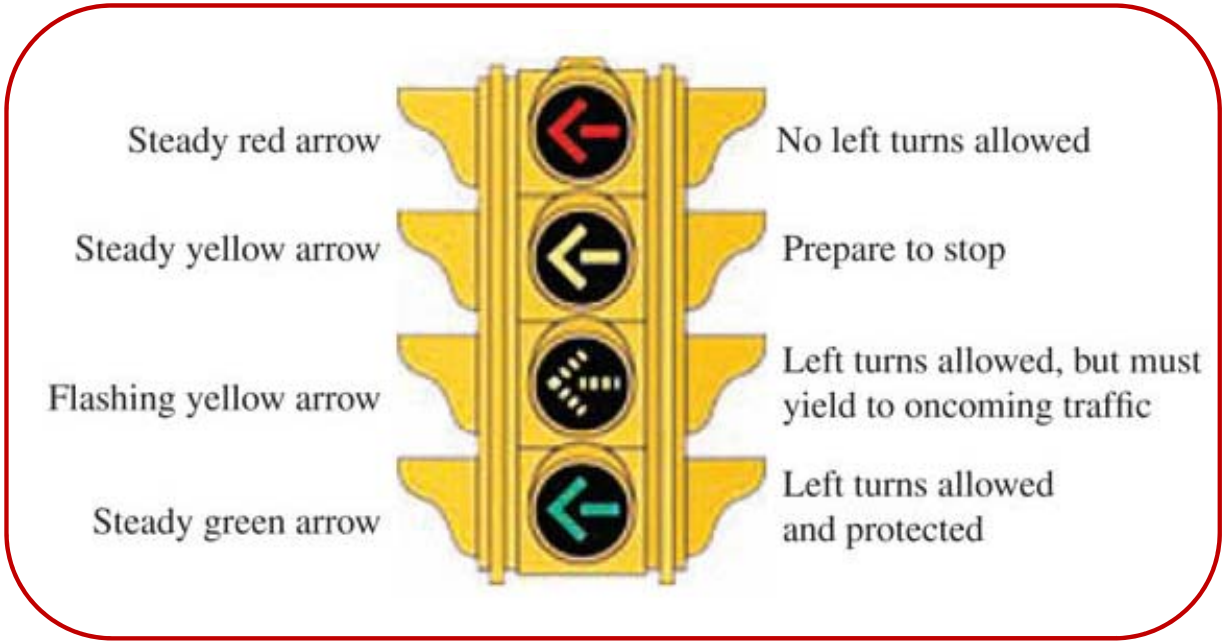


SHORT COURSE OBJECTIVES

- History
- Operation
- Planning
- Design
- Implementation
- Evaluation
- Lessons Learned

HISTORY OF FYA

- Why?
  - Improve Safety
  - Improve Operations



HISTORY OF FYA

- When
  - First Evaluated In 2003
    - National Cooperative Highway Research Program (NCHRP Report 493 - 2003)
  - Approved For Use By FHWA On Interim Basis in 2006
  - Included As Optional Left Turn Type in 2009 MUTCD

ADVANTAGES PER NCHRP 493 & 123

- Provides an exclusive display for left turn control
- Reduces Left Turn Crashes
- Eliminates the left turn trap for lagging lefts.
- Better progression using lead - lag lefts.
- Increases capacity
- Can be used for different phasing schemes.
- Promotes nationwide consistency for protected/permissive display

HISTORY OF FYA

- Where
  - District 4, Peoria Installed first locations in Illinois

Agency	Implementation Date	Number of Implementation Sites
Montgomery County, MD	September 2000	3
City of Tuscon, AZ	May 2001	3
Jackson County, OR	May 2001	1
Oregon DOT	June 2001	2
City of Beaverton, OR	April 2002	3
Broward County, FL	June 2002	3

STARTING IN PEORIA

- Noticed Flashing Circular Red in Michigan
- Turned down by Central Office
- City of Peoria tries two locations of FRA for national study.
- My request turned by Central Office
- Depositions on two fatal crashes
- Safety project approved after 2009 MUTCD.

DISTRICT FOUR FYA PROJECT

- Two Major Safety Projects
  - April 2010 Letting
    - IL 40 (Knoxville Ave) & US 150 (War Memorial Drive)
    - $400,000
  - June 2010 Letting
    - Rest of the State routes in Peoria, East Peoria, Pekin, Bartonville, Creve Coeur, North Pekin and Morton
    - $500,000
- Multiple small projects
- Galesburg, Aledo and Macomb
- Total of 150+ intersections

OUTREACH

- Support from the cities
- Presentations
- Brochures
- You Tube
- Attempted Press Conference
- Television News Stories
- News Paper Articles

TYPICAL COMMENTS

- “Wait a minute, wait a minute, wait a minute. The federal and local governments are spending nearly $1 million total to let people know that turning left can be dangerous? **I have to say, if you turn left into traffic, you deserve to be slammed** (obviously not fair to the people who have to hit you).

  When I took the driver's test (mind you, that was a while ago), I was told to wait for oncoming traffic to pass before making the turn. Has this changed in the last several years?

  People will still try to make left turns in front of oncoming traffic, regardless of the yellow light. Unless the light is solid red, **all of this is a waste of money**.

  {'Workers will run new cables, replace the heads, rewire and reprogram the lights.'}

  Let me guess...Unions? Seems to be the only reason you would create such a stupid project for such a stupid reason

NO SENSE

- “This is it people. Society has become so stupid that they cannot stop themselves from turning into oncoming traffic. And so these flashing yellow lights are supposed to save the day? Darwin must be spinning in his grave right about now....”

CELL PHONES IS TO BLAME

- **“This is another waste of money brought on by cell phones.**

  The best way to reduce accidents is for manufacturers to make cell phones inoperable when the vehicle engine is running.

  It doesn't matter what the law says, stupid people will insist on using their cell when they are going down the road. And those stupid people will continue to be a major cause of accidents.

  Take the toys out of the hands of the stupid people, or continue to suffer the consequences.”

FINALLY SOME GOOD SENSE

- This isn't nearly as difficult as most commenters seem to think it is.

  Here's the way it works:
  -Green arrow means you have the priority to turn left without any oncoming traffic.
  -Yellow (steady) arrow means that your left turn priority is about to end.
  -Red arrow means that you are not allowed to turn left.
  -Yellow (flashing) arrow means that you can turn left after yielding to oncoming traffic, because they have a green.

  This isn't rocket science, and it's becoming a national standard.
  Peoria just happens to be one of the earliest markets for these new signals.

FINALLY SOME GOOD MATH

- “@cwilson60: If we used your logic for the past 100 years, we wouldn't have traffic signals at all. I'm sure some of our grandparents complained about paying taxpayer dollars to replace traffic cops with those new-fangled 'electric policemen', as signals were originally called. And I'm sure some of our parents complained about adding a yellow light to the old red/green signals, confusing drivers with a whole new light to worry about. And even colored turn arrow lights were introduced within most readers' lifetimes.

  If you want to get financial with it, **let's assume that IDOT is putting these up at the 100 intersections mentioned in the article at a cost of $1M. That's $10,000 per intersection. That means if each new signal upgrade prevents one single accident where a vehicle gets totaled, there's an overall cost benefit for the improvement. Note that that's not one accident a year; that's one accident FOR THE LIFETIME OF THE SIGNAL.** That doesn't even include the costs of hospital bills in injury accidents, time paid for police, fire and medical crews responding to the accident, nor the lost travel time caused by accident delays.”

GOOD POINT

- OKAY...call me stupid...but is it just me or does this article NOT tell us what the h*ll a flashing yellow light means?????? Seriously - I once lived in a city where the left turn signal would start flashing red. I had no clue what to do - do I not turn? Do I wait? Do I go REALFAST? **So what does a flashing yellow light mean exactly??? Good reporting PJStar.**

MUTCD REQUIREMENTS (section 4D.04)

Section 4D.04 Meaning of Vehicular Signal Indications

E. Flashing yellow signal indications shall have the following meanings:

1. Vehicular traffic, on an approach to an intersection, facing a flashing CIRCULAR YELLOW signal indication is permitted to cautiously enter the intersection to proceed straight through or turn right or left or make a U-turn except as such movement is modified by lane-use signs, turn prohibition signs, lane markings, roadway design, separate turn signal indications, or other traffic control devices. Such vehicular traffic, including vehicles turning right or left or making a U-turn, shall yield the right-of-way to:
   A. Pedestrians lawfully within an associated crosswalk, and
   B. Other vehicles lawfully within the intersection

In addition, vehicular traffic turning left or making a U-turn to the left shall yield the right-of-way to other vehicles approaching from the opposite direction so closely as to constitute an immediate hazard during the time when such turning vehicle is moving across or within the intersection.

MUTCD REQUIREMENTS (section 4D.04)

2. Vehicular traffic, on an approach to an intersection, facing a flashing YELLOW ARROW signal indication, displayed alone or in combination with another signal indication, is permitted to cautiously enter the intersection only to make the movement indicated by such arrow, or other such movement as is permitted by other signal indications displayed at the same time. Such vehicular traffic, including vehicles turning right or left or making a U-turn, shall yield the right-of-way to:
   A. Pedestrians lawfully within an associated crosswalk, and
   B. Other vehicles lawfully within the intersection

In addition, vehicular traffic turning left or making a U-turn to the left shall yield the right-of-way to other vehicles approaching from the opposite direction so closely as to constitute an immediate hazard during the time when such turning vehicle is moving across or within the intersection

MUTCD REQUIREMENTS (section 4D.04)

3. Pedestrians facing any flashing yellow signal indication at an intersection, unless otherwise directed by a pedestrian signal indication or other traffic control device, are permitted to proceed across the roadway within any marked or unmarked associated crosswalk. Pedestrians shall yield the right-of-way to vehicles lawfully within the intersection at the time that the flashing yellow signal indication is first displayed.
4. When a flashing CIRCULAR YELLOW signal indication(s) is displayed as a beacon (see Chapter 4L) to supplement another traffic control device, road users are notified that there is a need to pay extra attention to the message contained thereon or that the regulatory or warning requirements of the other traffic control device, which might not be applicable at all times, are currently applicable.

MUTCD REQUIREMENTS (section 4D.20)

Section 4D.20 Signal Indications for Protected/Permissive Mode Left-Turn Movements

If a separate left-turn signal face is being operated in a protected/permissive left-turn mode and a flashing left-turn yellow arrow signal indication is provided, it shall meet the following requirements (see Figure 4D-12):

A. It shall be capable of displaying the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, flashing left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the four indications shall be displayed at any given time.

B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.

C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.

D. During the permissive left-turn movement, a flashing left-turn YELLOW ARROW signal indication shall be displayed.

MUTCD REQUIREMENTS (section 4D.20)

E. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn YELLOW ARROW signal indication if the permissive left-turn movement is being terminated and the separate left-turn signal face will subsequently display a steady left-turn RED ARROW indication.

F. It shall be permitted to display a flashing left-turn YELLOW ARROW signal indication for a permissive left-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications and the opposing left-turn signal faces display left-turn GREEN ARROW signal indications for a protected left-turn movement.

G. When a permissive left-turn movement is changing to a protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing left-turn YELLOW ARROW signal indication. A steady left-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing left-turn YELLOW ARROW signal indication and the display of the steady left-turn GREEN ARROW signal indication.

MUTCD REQUIREMENTS (section 4D.20)

H. The display shall be a four-section signal face except that a three-section signal face containing a dual-arrow signal section shall be permitted where signal head height limitations (or lateral positioning limitations for a horizontally-mounted signal face) will not permit the use of a four-section signal face. The dual-arrow signal section, where used, shall display a GREEN ARROW for the protected left-turn movement and a flashing YELLOW ARROW for the permissive left-turn movement.

I. During steady mode (stop-and-go) operation, the signal section that displays the steady left-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing left-turn YELLOW ARROW signal indication for permissive left turns.

J. During flashing mode operation (see Section 4D.30), the display of a flashing left-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady left-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation

MUTCD GUIDANCE

- "Guidance:
- 09 For new or reconstructed signal installations, on an approach with an exclusive turn lane(s) for a left-turn (or U-turn to the left) movement and with opposing vehicular traffic, **signal faces that display a CIRCULAR GREEN signal indication should not be post-mounted on the far-side median or mounted overhead above the exclusive turn lane(s) or the extension of the lane(s)."**

MUTCD GUIDANCE

- "**If a separate left-turn signal face is mounted overhead at the intersection, it is positioned over the extension of the left-turn lane**. In a separate left-turn signal face, a flashing left-turn YELLOW ARROW signal indication or a flashing left-turn RED ARROW signal indication is used to control permissive left-turning movements."

FYA OPERATION

- How it Works

SOLID RED – means stop, drivers turning left must stop

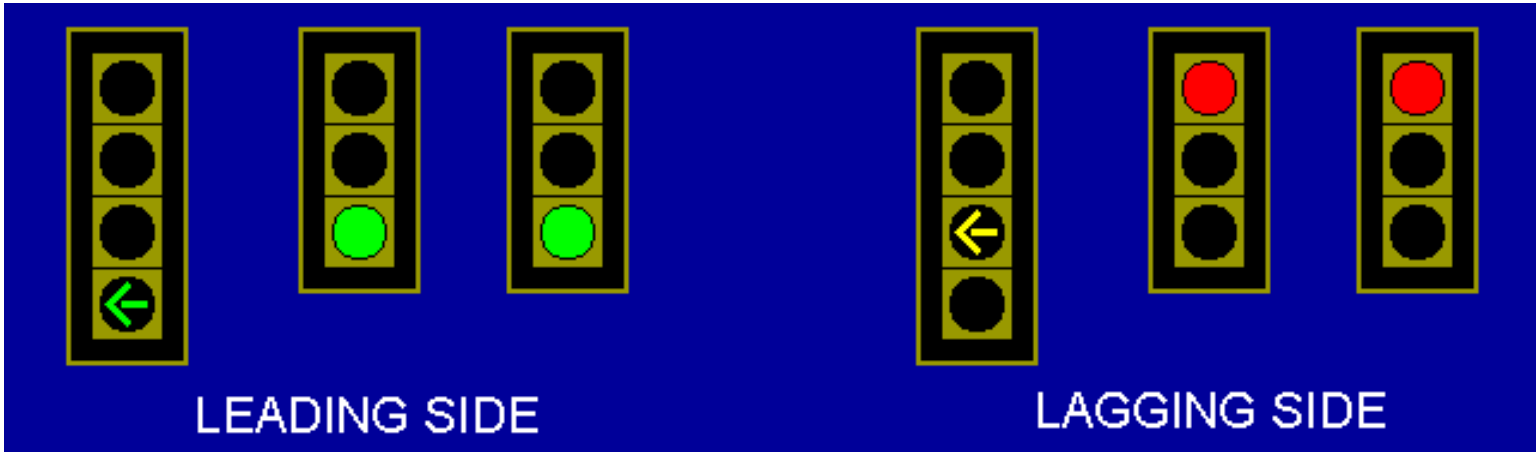
SOLID YELLOW – indicates this traffic signal will be turning red

FLASHING YELLOW– means turns are permitted, but you must first yield to oncoming traffic & pedestrians, then proceed with caution

SOLID GREEN – turn left; oncoming traffic must stop

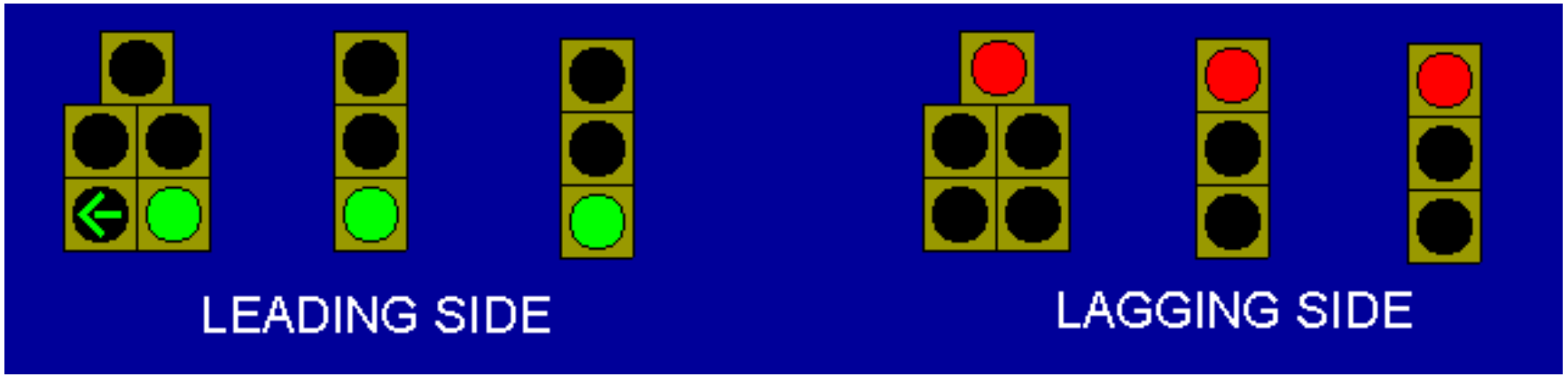
FYA OPERATION

- How it Works
  - Flashing Yellow Arrows with Lead/Lag Sequence



FYA OPERATION

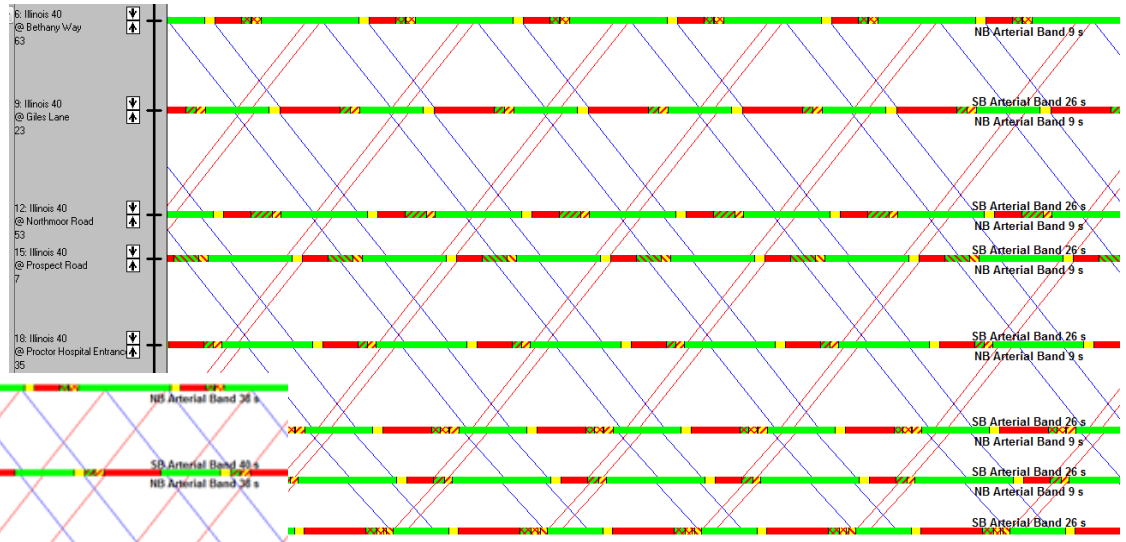
- Safety Benefits
  - Original Protected/Permissive with Yellow Trap

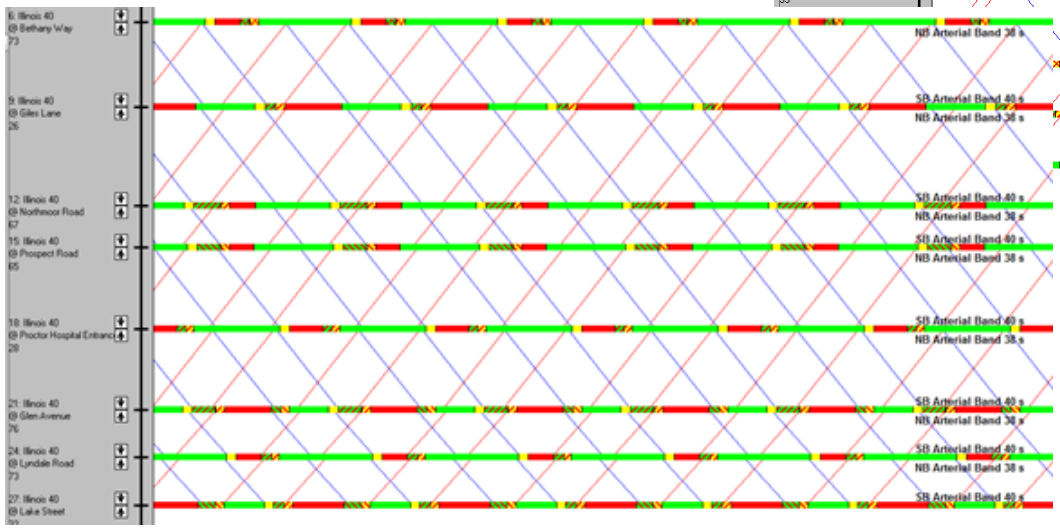


FYA OPERATION

- Operational Benefits

Without FYA





With FYA

FYA OPERATION

- Operational Benefits

FYA OPERATION

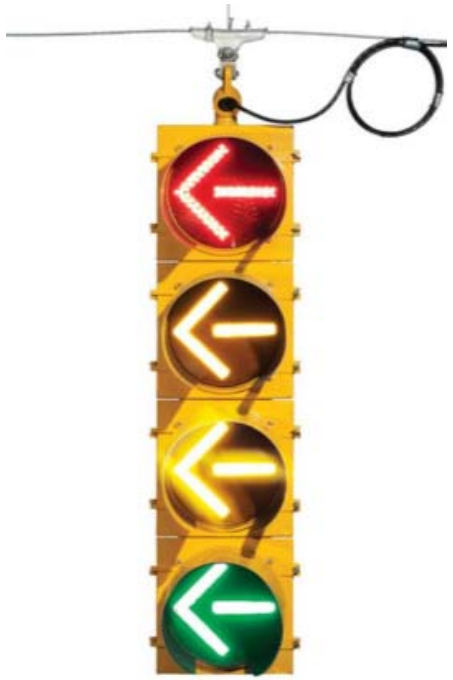
- Equipment
  - Signal Heads
  - Controller
  - MMU
  - Signage

FYA PLANNING

- Implementation Strategy
  - Citywide vs. Corridor
  - Public Education
- Identifying Appropriate Locations

FYA PLANNING

- Identifying Appropriate Locations



FYA PLANNING

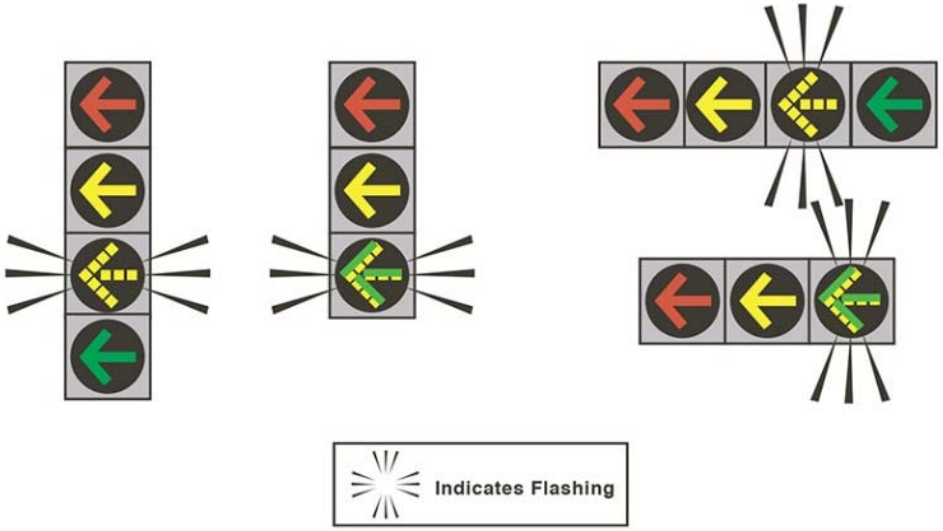
- Determining Extent of Improvements

FYA DESIGN

- Required Components
  - Controller
    - Econolite ASC/3 or Higher
    - Siemens M50 or Higher
  - MMU
    - EDI – MMU-16LE FYA
    - Reno – V1.07.19 or Higher

FYA DESIGN

- Required Components
  - Signal Heads



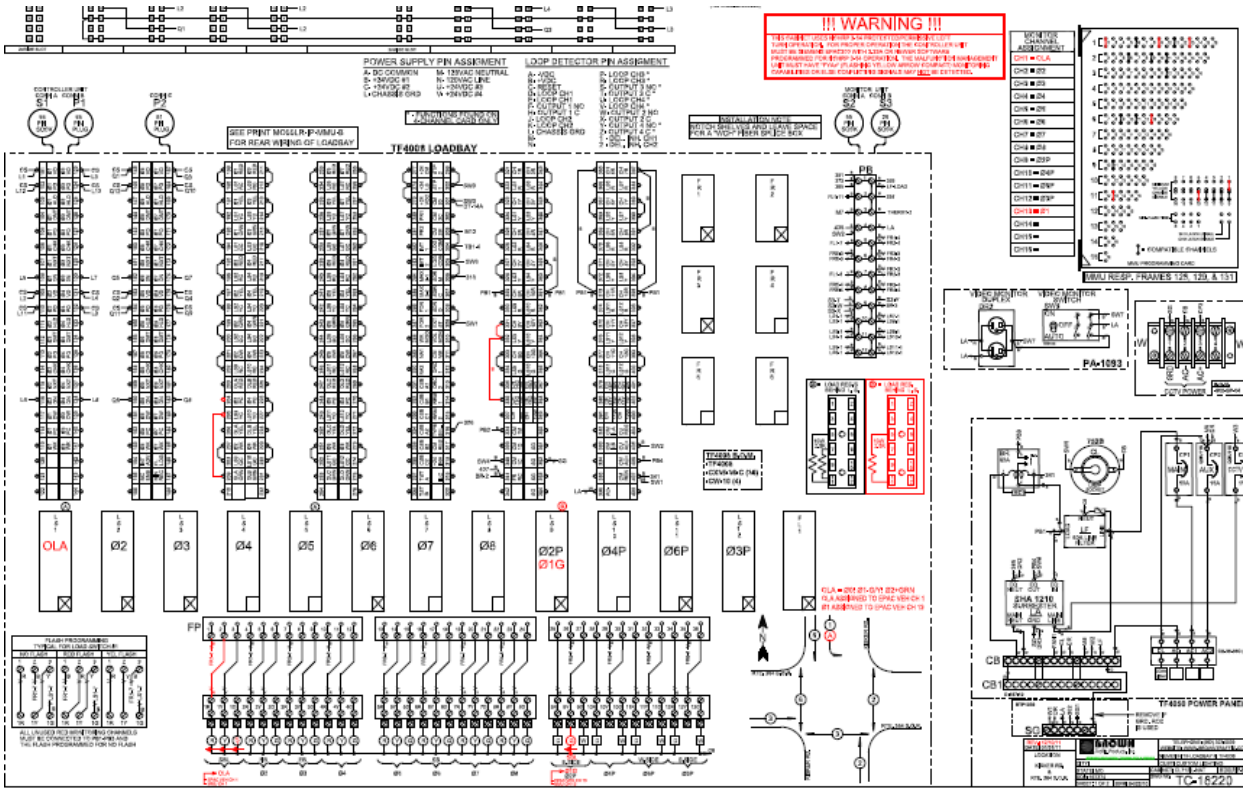
  - Signage

FYA DESIGN

12-POSITION CABINET:		16-POSITION CABINET:	
LS 1	OLA (RL, YL, FYA)	LS 1	VEH ϕ 1 (GL)
LS 3	OLB (RL, YL, FYA)	LS 3	VEH ϕ 3 (GL)
LS 5	OLC (RL, YL, FYA)	LS 5	VEH ϕ 5 (GL)
LS 7	OLD (RL, YL, FYA)	LS 7	VEH ϕ 7 (GL)
LS 9	VEH ϕ 1 (GL) / PED ϕ2	LS 9	OLA (RL, YL, FYA)
LS 10	VEH ϕ 3 (GL) / PED ϕ4	LS 10	OLB (RL, YL, FYA)
LS 11	VEH ϕ 5 (GL) / PED ϕ6	LS 11	OLC (RL, YL, FYA)
LS 12	VEH ϕ 7 (GL) / PED ϕ8	LS 12	OLD (RL, YL, FYA)
N/A		LS 13	PED ϕ2
N/A		LS 14	PED ϕ4
N/A		LS 15	PED ϕ6
N/A		LS 16	PED ϕ8

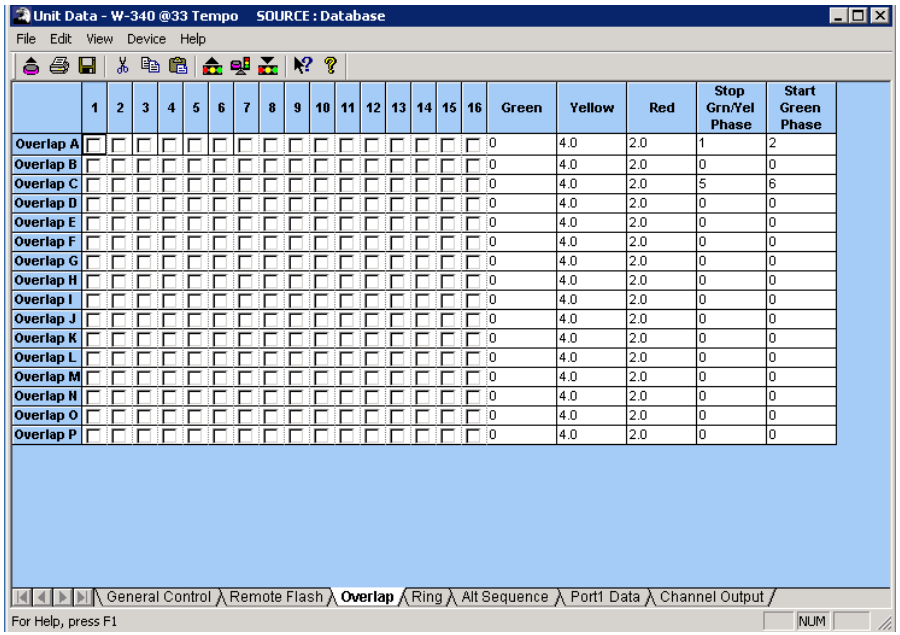
FYA IMPLEMENTATION

- Installation

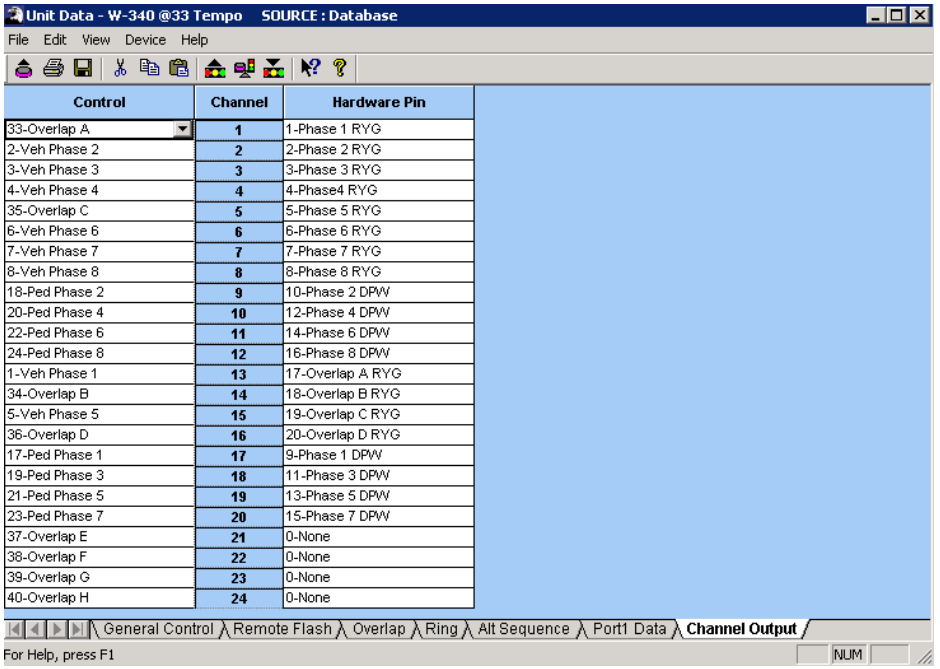


FYA IMPLEMENTATION

- Programming - Siemens



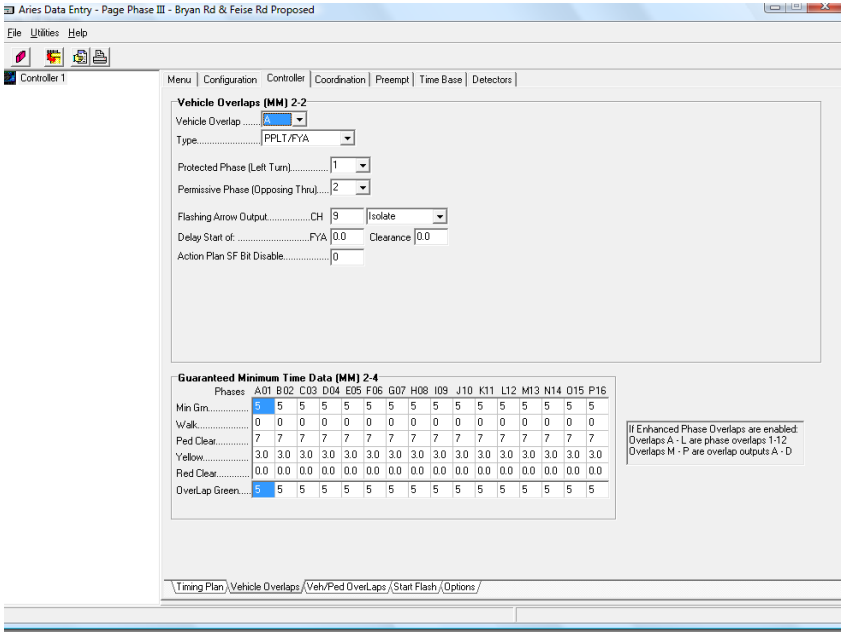
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Green	Yellow	Red	Stop Grn/Yel Phase	Start Green Phase
Overlap A	☐																0	4.0	2.0	1	2
Overlap B		☐															0	4.0	2.0	0	0
Overlap C			☐														0	4.0	2.0	5	6
Overlap D				☐													0	4.0	2.0	0	0
Overlap E					☐												0	4.0	2.0	0	0
Overlap F						☐											0	4.0	2.0	0	0
Overlap G							☐										0	4.0	2.0	0	0
Overlap H								☐									0	4.0	2.0	0	0
Overlap I									☐								0	4.0	2.0	0	0
Overlap J										☐							0	4.0	2.0	0	0
Overlap K											☐						0	4.0	2.0	0	0
Overlap L												☐					0	4.0	2.0	0	0
Overlap M													☐				0	4.0	2.0	0	0
Overlap N														☐			0	4.0	2.0	0	0
Overlap O															☐		0	4.0	2.0	0	0
Overlap P																☐	0	4.0	2.0	0	0

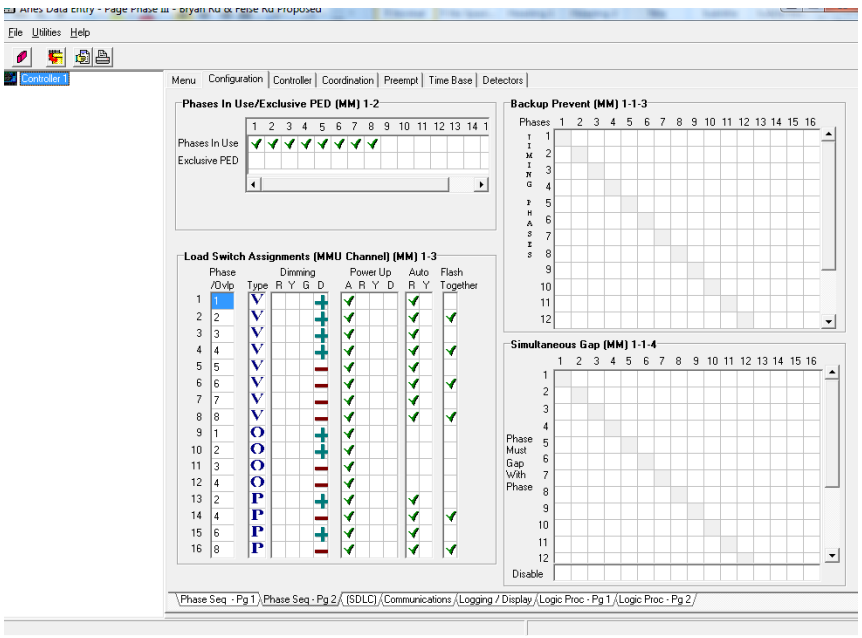


Control	Channel	Hardware Pin
33-Overlap A	1	1-Phase 1 RYG
2-Veh Phase 2	2	2-Phase 2 RYG
3-Veh Phase 3	3	3-Phase 3 RYG
4-Veh Phase 4	4	4-Phase4 RYG
35-Overlap C	5	5-Phase 5 RYG
6-Veh Phase 6	6	6-Phase 6 RYG
7-Veh Phase 7	7	7-Phase 7 RYG
8-Veh Phase 8	8	8-Phase 8 RYG
18-Ped Phase 2	9	10-Phase 2 DPW
20-Ped Phase 4	10	12-Phase 4 DPW
22-Ped Phase 6	11	14-Phase 6 DPW
24-Ped Phase 8	12	16-Phase 8 DPW
1-Veh Phase 1	13	17-Overlap A RYG
34-Overlap B	14	18-Overlap B RYG
5-Veh Phase 5	15	19-Overlap C RYG
36-Overlap D	16	20-Overlap D RYG
17-Ped Phase 1	17	9-Phase 1 DPW
19-Ped Phase 3	18	11-Phase 3 DPW
21-Ped Phase 5	19	13-Phase 5 DPW
23-Ped Phase 7	20	15-Phase 7 DPW
37-Overlap E	21	0-None
38-Overlap F	22	0-None
39-Overlap G	23	0-None
40-Overlap H	24	0-None

FYA IMPLEMENTATION

- Programming - Econolite





FYA IMPLEMENTATION

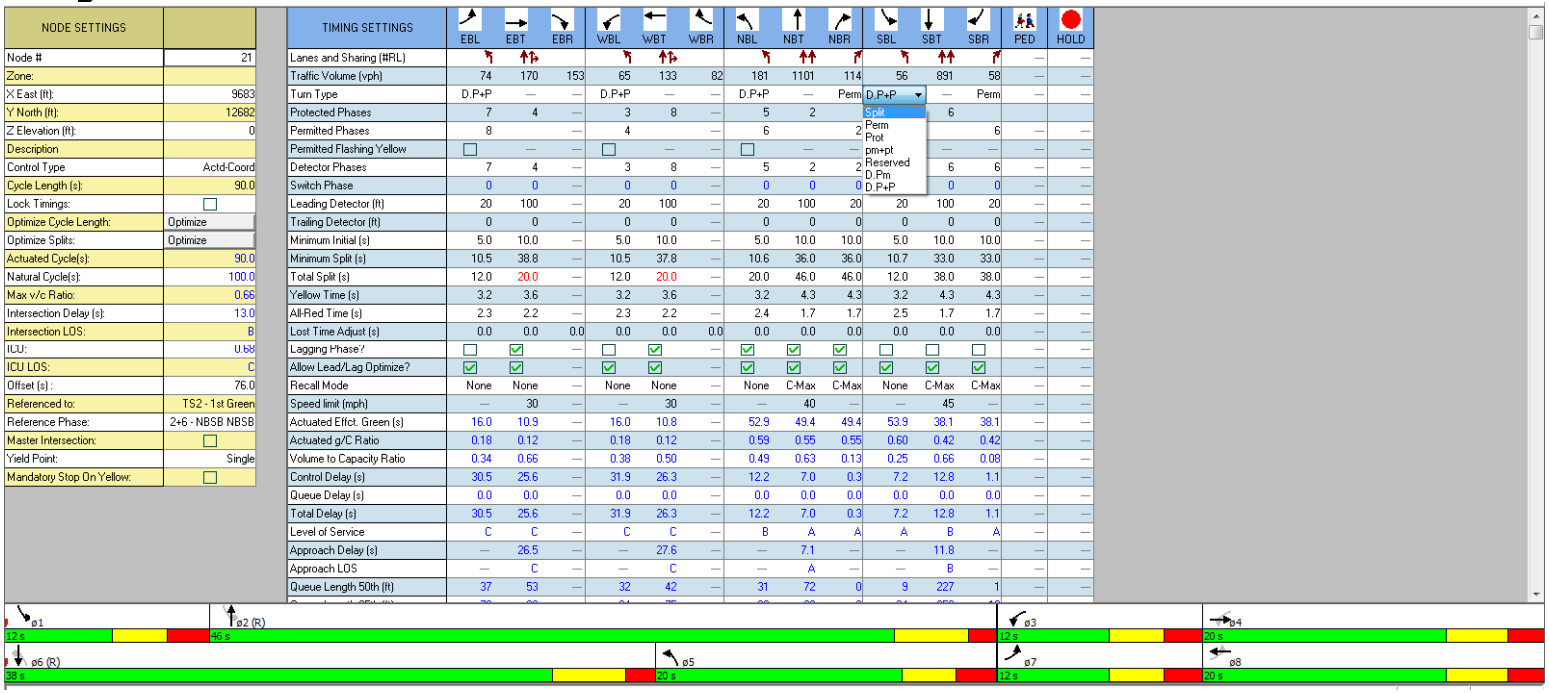
- Signal Timing
  - 24 Hour FYA Left Turn Warrant Analysis
    - Phase Omit
    - Overlap Omit

FYA IMPLEMENTATION

- Obstacles

FYA EVALUATION

- Analysis



NODE SETTINGS	
Node #	21
Zone:	
X East (ft):	9683
Y North (ft):	12682
Z Elevation (ft):	0
Description	
Control Type	Actd-Coord
Cycle Length (s):	90.0
Lock Timings:	☐
Optimize Cycle Length:	Optimize
Optimize Splits:	Optimize
Actuated Cycle(s):	90.0
Natural Cycle(s):	100.0
Max v/c Ratio:	0.66
Intersection Delay (s):	13.0
Intersection LOS:	B
ICU:	0.68
ICU LOS:	C
Offset (s):	76.0
Referenced to:	TS2 - 1st Green
Reference Phase:	2+6 - NBSB NBSB
Master Intersection:	☐
Yield Point:	Single
Mandatory Stop On Yellow:	☐

TIMING SETTINGS	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	PED	HOLD
Lanes and Sharing (#RL)													—	—
Traffic Volume (vph)	74	170	153	65	133	82	181	1101	114	56	891	58	—	—
Turn Type	D.P+P	—	—	D.P+P	—	—	D.P+P	—	Perm	D.P+P	—	Perm	—	—
Protected Phases	7	4	—	3	8	—	5	2		Split	6			
Permitted Phases	8		—	4		—	6		2	Perm		6	—	—
Permitted Flashing Yellow	☐	—	—	☐	—	—	☐	—	—	Prot	—	—	—	—
Detector Phases	7	4	—	3	8	—	5	2	2	pm+pt	6	6	—	—
Switch Phase	0	0	—	0	0	—	0	0	0	Reserved	0	0	—	—
Leading Detector (ft)	20	100	—	20	100	—	20	100	20	D.Pm	100	20	—	—
Trailing Detector (ft)	0	0	—	0	0	—	0	0	0	D.P+P	0	0	—	—
Minimum Initial (s)	5.0	10.0	—	5.0	10.0	—	5.0	10.0	10.0	5.0	10.0	10.0	—	—
Minimum Split (s)	10.5	38.8	—	10.5	37.8	—	10.6	36.0	36.0	10.7	33.0	33.0	—	—
Total Split (s)	12.0	20.0	—	12.0	20.0	—	20.0	46.0	46.0	12.0	38.0	38.0	—	—
Yellow Time (s)	3.2	3.6	—	3.2	3.6	—	3.2	4.3	4.3	3.2	4.3	4.3	—	—
All-Red Time (s)	2.3	2.2	—	2.3	2.2	—	2.4	1.7	1.7	2.5	1.7	1.7	—	—
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	—	—
Lagging Phase?	☐	☑	—	☐	☑	—	☑	☑	☑	☐	☐	☐	—	—
Allow Lead/Lag Optimize?	☑	☑	—	☑	☑	—	☑	☑	☑	☑	☑	☑	—	—
Recall Mode	None	None	—	None	None	—	None	C-Max	C-Max	None	C-Max	C-Max	—	—
Speed limit (mph)	—	30	—	—	30	—	—	40	—	—	45	—	—	—
Actuated Effct. Green (s)	16.0	10.9	—	16.0	10.8	—	52.9	49.4	49.4	53.9	38.1	38.1	—	—
Actuated g/C Ratio	0.18	0.12	—	0.18	0.12	—	0.59	0.55	0.55	0.60	0.42	0.42	—	—
Volume to Capacity Ratio	0.34	0.66	—	0.38	0.50	—	0.49	0.63	0.13	0.25	0.66	0.08	—	—
Control Delay (s)	30.5	25.6	—	31.9	26.3	—	12.2	7.0	0.3	7.2	12.8	1.1	—	—
Queue Delay (s)	0.0	0.0	—	0.0	0.0	—	0.0	0.0	0.0	0.0	0.0	0.0	—	—
Total Delay (s)	30.5	25.6	—	31.9	26.3	—	12.2	7.0	0.3	7.2	12.8	1.1	—	—
Level of Service	C	C	—	C	C	—	B	A	A	A	B	A	—	—
Approach Delay (s)	—	26.5	—	—	27.6	—	—	7.1	—	—	11.8	—	—	—
Approach LOS	—	C	—	—	C	—	—	A	—	—	B	—	—	—
Queue Length 50th (ft)	37	53	—	32	42	—	31	72	0	9	227	1	—	—

BRADLEY RESEARCH

- Literature Review
- Driver Survey
- Gap Acceptance
- Crash Analysis

COMPARATIVE SURVEY RESULTS

- If you want to turn left, and you see the traffic signal below, what would you do?

Phase 1

GO – 4 %

YIELD – 91%

STOP – 4%

Phase 2

GO – 3 %

YIELD – 94%

STOP – 3%

COMPARATIVE SURVEY RESULTS

- If you want to turn left, and you see the traffic signal below, what would you do?

Phase 1

GO – 4 %

YIELD – 73%

STOP – 23%

Phase 2

GO – 5 %

YIELD – 73%

STOP – 22%

COMPARATIVE SURVEY RESULTS

- If you want to turn left, and you see the traffic signal below, what would you do?

Phase 1

GO – 1 %

YIELD – 97%

STOP – 2%

Phase 2

GO – 0 %

YIELD – 98%

STOP – 2%

B&A CRASH FREQUENCY RESULTS

- 164 FY Approaches

	FINAL RESULTS			
Crash Type	Before	After	% Reduction	Significant?*
Total crash frequency	328	324.00	1.20%	No
Injury crash frequency	97	86.00	11.30%	No
LT related crash frequency	125	96.00	**23.20%**	**Yes**
LTOT crash frequency	90.33	68.67	**24.00%**	**Yes**

**Based on Poisson test at 95% LOC Data Through June 2014*

B&A CRASH FREQUENCY RESULTS

- 92 FYA Approaches with supplemental signage

	FINAL RESULTS			
Crash Type	Before	After	% Reduction	Significant?*
Total crash frequency	182	166.67	8.40%	No
Injury crash frequency	55.33	46.33	16.30%	No
LT related crash frequency	72.33	50.00	**30.90%**	**Yes**
LTOT crash frequency	49.67	35.33	**28.90%**	**Yes**

**Based on Poisson test at 95% LOC Data Through June 2014*

B&A CRASH FREQUENCY RESULTS

- 72 FYA Approaches without supplemental signage

	FINAL RESULTS			
Crash Type	Before	After	% Reduction	Significant?*
Total crash frequency	146.67	159.00	-8.40%	No
Injury crash frequency	41.67	40.00	4.00%	No
LT related crash frequency	52.67	46.67	11.40%	No
LTOT crash frequency	40.67	34.00	16.40%	No

**Based on Poisson test at 95% LOC Data Through June 2014*

Crash Type	B&A - Intersection				EB - Intersection			
	Before	After	% Reduction	Significant?*	Expected	Actual	% Reduction	Significant?*
Total crash frequency	554	548.33	1.02%	No	560.74	548.33	2.21%	No
Injury crash frequency	154.33	139	9.94%	No	161.5	139	**13.93%**	**Yes**
LT related crash frequency	158.33	123	**22.32%**	**Yes**	159.27	123	**22.77%**	**Yes**
LTOT crash frequency	99.67	78	**21.74%**	**Yes**	99.05	79	**20.25%**	**Yes**

*Based on Poisson test at 95% LOC
Data Through June 2014

Crash Type	B&A - Approach				EB - Approach			
	Before	After	% Reduction	Significant?*	Expected	Actual	% Reduction	Significant?*
Total crash frequency	328	324	1.20%	No	327.66	342	1.12%	No
Injury crash frequency	97	86	11.30%	No	97.23	86	11.55%	No
LT related crash frequency	125	96	**23.20%**	**Yes**	125.16	96	**23.30%**	**Yes**
LTOT crash frequency	90.33	68.67	**24.00%**	**Yes**	91.34	68.67	**24.82%**	**Yes**

B&A CRASH FREQUENCY RESULTS

- Older Driver Crashes

	INTERSECTION			APPROACH		
Crash Type	Before	After	% Reduction*	Before	After	% Reduction*
Total crash frequency	105.67	115.67	-9.46%	68.67	74.67	-8.74%
Injury crash frequency	31.33	30	4.36%	20.67	21	-1.61%
LT related crash frequency	34.67	35.33	-1.92%	27.33	28.67	-4.88%
LTOT crash frequency	20.67	24.33	-17.74%	18	22.67	-25.93%

No significant results – No change in older driver crashes due to FYA

**Based on Poisson test at 95% LOC*
Data Through June 2014

YOUNGER DRIVER

Table 7.4 Younger Driver Analysis Results

Crash Type	Aggregated on an Intersection-Level				Aggregated on an FYA Approach-Level			
	Avg. Annual Before Crashes	Avg. Annual After Crashes	% Reduction	Significant?* (p-value)	Avg. Annual Before Crashes	Avg. Annual After Crashes	% Reduction	Significant?* (p-value)
Total crashes	160.33	139.67	**12.9%**	**Yes (0.05)**	98.67	82.33	**16.6%**	**Yes (0.05)**
Injury crashes	43.33	28.67	**33.9%**	**Yes (0.02)**	31.00	18.00	**41.9%**	**Yes (0.01)**
LT related crashes	52.00	34.33	**34.0%**	**Yes (0.01)**	43.33	26.67	**38.5%**	**Yes (0.01)**
LTOT crashes	35.33	25.00	**29.3%**	**Yes (0.05)**	32.33	20.67	**36.1%**	**Yes (0.03)**

* Based on Poisson Test of crash frequencies at 95% LOC and significance level $\alpha = 0.05$

BENEFIT COST RATIO

Table 8-3. Resulting Annual Benefits and Costs of FYA

FYA EUAB	**$1,630,060**
FYA EUAC	**$82,460**
B/C Ratio	**19.8**

Lessons Learned

- Challenges

WHAT DID THE CHANGE TO FYA INVOLVE

- New signal heads
- Additional cable
- New controller – Maybe
- New cabinet – Maybe
- Rewire cabinet
- Reprogram Controller
- New MMU

CHALLENGES

- Controller Eagle/Econolite.
- Software
- MMU
- Conduit
- Training
- Vehicle Code
- Pedestrian Crossings
- Signs
- Left turn lane configuration

SIGNS


LEFT TURN
YIELD
ON
FLASHING

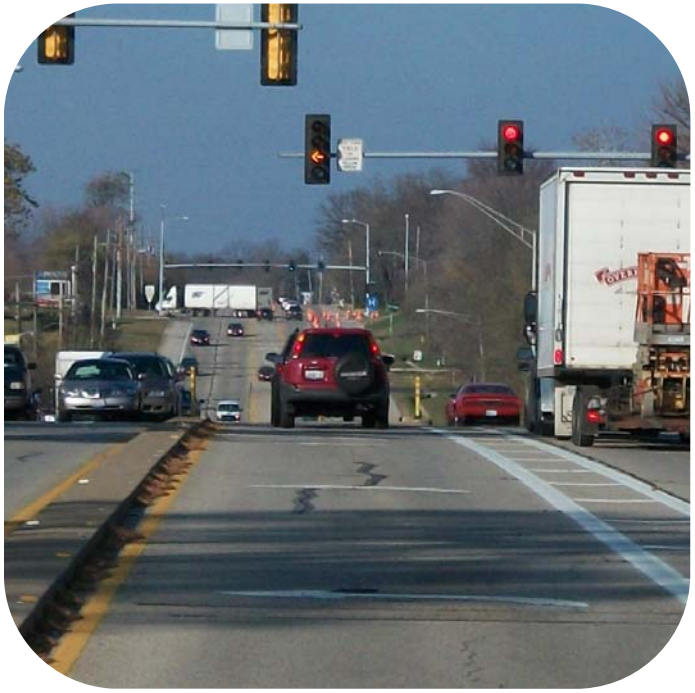

LEFT TURN
YIELD
ON
FLASHING
YELLOW
ARROW

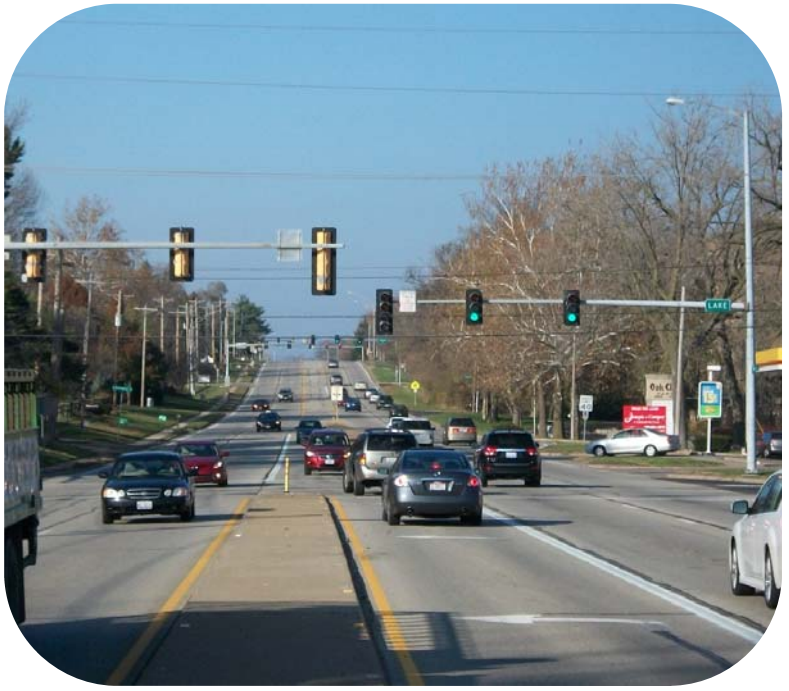
PASADENA CALIFORNIA

LEFT TURN TRAP

- Lead - Lag Lefts
  - Progression – Great results
  - Crashes - Lake St. Left Turn crashes 3 to 14
    - Louvers?
    - Patience?
    - Left turn sight distance?

LEFT TURN BAY TREATMENTS





QUESTIONS?

Thank You!

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