Development of Guidelines for the Deployment of Flashing Yellow Arrow (FYA) Traffic Signals in Indiana – SPR#3725

Robert A. Rescot, Ph.D., P.E.

Purdue University
Calumet
Study Advisory Committee

- Joe Bruno
- Shuo Li
- Brad Stecklet
- Mike Holowatty
- Bill Smith
Establishing a Purpose

• “Crashes at the intersection of two or more roadways in Indiana produce
  • one in four of all severe outcome crashes
  and about
  • one in five fatal crashes.”
Intersection Crash Statistics

![Bar Chart]

- **2004**: 54 Injury Crashes, 54 Fatal Crashes
- **2005**: 56 Injury Crashes, 56 Fatal Crashes
- **2006**: 60 Injury Crashes, 60 Fatal Crashes
- **2007**: 50 Injury Crashes, 50 Fatal Crashes
- **2008**: 53 Injury Crashes, 53 Fatal Crashes
- **2009**: 54 Injury Crashes, 54 Fatal Crashes

Legend:
- **Black**: Injury Crashes
- **Red**: Fatal Crashes

Indiana 2010 Strategic Highway Safety Plan
Problem Statement

Providing a consistent driver expectation has been a fundamental principal of modern traffic engineering, and is the foundation for the *Manual on Uniform Traffic Control Devices* (MUTCD). However, traffic signals routinely provide mixed messages at locations having protected/permissive left turns.
Conflicting Signal Messages

Left Turn Lane

Not the Same Meaning!

Through Lane
Existing Research

Average Percent Change in Total Crashes at Intersections Converted from Protected LT Control to FYA PPLT

- Average Difference in Crash Frequency
- Number of Intersections

Percent Reduction in Total Crashes

Number of Intersections Meeting Criteria

Minimum Number of Months of Crash Data After Implementation
Operational Benefits

- Unlocks signal timing options
- Provides more flexibility for signal design
- Removes yellow trap
- Lagging lefts now possible!
Alignment with INDOT / FHWA Goals

- Improve Efficiency
- Reduce Injuries & Fatalities
- Reduce Crashes

Flashing Yellow Arrow
Flashing Yellow in Action
Study Objectives

- Identify best practices,
- Identification of INDOT related guidelines/publications.
- Calculate costs (if any) to upgrade signal controller hardware.
- Conducting a benefit-cost analysis
- Determine allowable sequences of signal phasings, signal controller hardware limitations
- Proactively communicate with strategic partners (Police/BMV)
- Develop public communications about expected driver reaction
Options

• Into which signal phases to should be allow FYA to be installed

• Signal head options
  • Vertical/Horizontal 4-section
  • Vertical/Horizontal 3-section (Bi-modal)

• Red options
  • Red ball
  • Red arrow

• Auxiliary sign options
Options!

<table>
<thead>
<tr>
<th>Area Used</th>
<th>Lens Color and Arrangement</th>
<th>Left-Turn Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maryland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington, WA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delaware</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cupertino, CA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area Used</th>
<th>Lens Color and Arrangement</th>
<th>Left-Turn Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seattle, WA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sparks, NV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reno, NV</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Green or Yellow Bi-modal Lens*
More PPLT Options

<table>
<thead>
<tr>
<th>Area Used</th>
<th>Lens Color and Arrangement</th>
<th>Left-Turn Indication</th>
<th>Protected Mode</th>
<th>Permitted Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Section</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used in Texas, Nebraska, and Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Section</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used in Texas, Nebraska, and Others</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Section</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used in Texas and most Western States</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Section Cluster</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area Used</th>
<th>Lens Color and Arrangement</th>
<th>Left-Turn Indication</th>
<th>Protected Mode</th>
<th>Permitted Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maryland</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washington State</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO LONGER IN OPERATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delaware</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sparks, NV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cupertino, CA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reno, NV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Green or Yellow Bi-modal Lens
Other Implementations
Other 4 Section Heads for PPLTs

Bourbonnais, Illinois
States with signalized intersections operating with left-turn Flashing Yellow Arrows (2013)
Neighboring State Locations
Neighboring States

- **Michigan**
  - Livingston County, was expected to install the first flashing yellow arrow signals in Michigan at five intersections within Livingston County in 2004, and more may be coming.

- **Illinois**
  - Peoria, installed dozens of new signals with flashing yellow arrows in 2011.
  - Galesburg, The Illinois Department of Transportation has been busy installing flashing yellow arrow signals at major intersections in Galesburg since late September, 2012.

- **Kentucky**
  - Covington County, started to install FYA since the beginning of 2010.

- **Ohio**
  - Dayton, started to install FYA since October, 2012

- **Wisconsin**
  - Madison, the FYA started to appear since late January, 2012.
  - Brookfield, started to install FYA since April, 2013, and a lot of more of it is coming.
  - Wauwatosa, the FYA started to appear since 2010.
Indiana Implementations
**WARNING** - This signal is running a flashing yellow arrow.

- The MMU **must** be a Reno MMU-1600GE.
- When changing the MMU, accept the programming from the **CARD** and hold the reset button until a series of 5 beeps are heard.
- This will program the new MMU to run the FYA.
WARNING - This signal is running a flashing yellow arrow.

- The MMU **must** be a Reno MMU-1600GE.
- When changing the MMU, accept the programming from the CARD and hold the reset button until a series of 5 beeps are heard.
- This will program the new MMU to run the FYA.
Indiana Implementations
Notice a Difference?
Driver Behavior Research

• How do motorists respond to the signal?
  • Crash records
  • Survey of drivers
  • Behavioral observations
    • Startup lost time
    • Queue lengths
    • Behavior in dilemma zone
INDOT Resources

- [http://www.in.gov/indot/3202.htm](http://www.in.gov/indot/3202.htm)
Comments