

JOINT TRANSPORTATION RESEARCH PROGRAM

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Evaluation of Flashing Yellow Arrow Traffic Signals in Indiana

Introduction

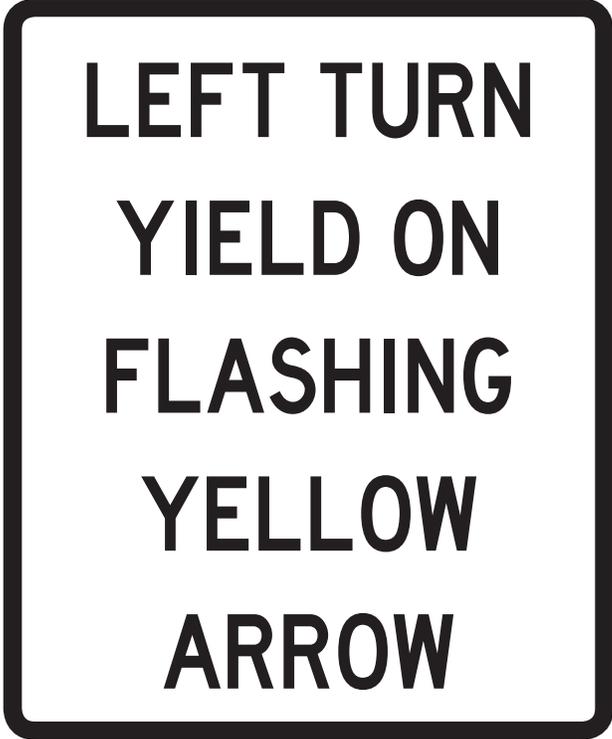
The evaluation of the use of a flashing yellow arrow (FYA) for permissive left turns in Indiana was undertaken to provide guidance to the Indiana Department of Transportation on this topic. These signal types have been shown by other states and studies to reduce crashes and improve mobility at the same time. This win-win opportunity is the result of increased driver awareness during the permissive left-turn phase at a signal where a driver must yield the right-of-way to oncoming traffic. Increased mobility results from the elimination of the yellow trap, thus allowing lead/lag signal phasing. This can be particularly important for signal coordination projects along corridors so that green bands can be better aligned.

In the state of Indiana, most traffic signal support systems installed on the state highway system are span and catenary style instead of cantilevered mast arms. This is notable because typical FYA signal head arrangements consist of a vertical stack of four signal sections (from top to bottom: solid red arrow, solid yellow arrow, flashing yellow arrow, solid green arrow), instead of being three sections in the case of both a protected only signal, or a protected-permissive five-section “doghouse” style signal head. These signals only attach to the catenary wires at the ends of the signal head, and the addition of an extra section in vertical height could create a vertical clearance issue. The only way to resolve this clearance issue would be to then raise the catenary wires. However, not all vertical support poles have enough extra vertical space to permit such a raising, and this would require increased installation time. A possible solution for such a situation was evaluated in Vincennes, Indiana, whereby the four-section FYA signal head was installed in a horizontal orientation, while the other signal heads remained in a vertical orientation.

Findings

A comparative analysis was conducted between a typical installation in Centerville, Indiana, and the modified setup in Vincennes. Data was collected at both intersections to study driver behavior when a solo vehicle was approaching a flashing yellow arrow and would have to yield for the permissive left turn. Additional control locations at five section doghouse signals in each city were selected. The result was that there was not any statistical difference observed in driver acceleration/deceleration between any of the four sites.

To supplement the driver behavior data, surveys were conducted in both Vincennes and Richmond (neighboring city to Centerville). The survey participants



LEFT TURN
YIELD ON
FLASHING
YELLOW
ARROW

were asked if they would go, yield, or stop when shown various images of left-turn scenarios. The result of the survey data showed that a majority of drivers surveyed understood what to do in various situations or did not give a fail-critical response. A fail-critical response was one that would likely lead to a crash, such as proceeding with the right-of-way on a red indication, or stopping on a solid green arrow. The only concerning case was when a vertical flashing yellow signal head displayed a solid yellow left-turn arrow while the adjacent through lanes had a solid circular green signal indication. In this case the fail-critical response rate was 11%.

A national review of media reports was also conducted, and it was identified that if proactive communications are not provided by INDOT, misinformation can be perpetuated by the media. Members of the Study Advisory Committee developed tools to help provide INDOT with tools ready to be deployed to local media outlets.

Crash data was requested for these intersections from 2009 through the present. It is first important to note that in the before condition, left turns were protected only, and then when the FYA signals were installed, this introduced a permissive left turn. The literature suggested that the crash rate would increase due to this increase in mobility. The actual crash data showed that when compared to previous trends, the flashing yellow signals did produce an increase in projected crash rates. However, the increase was either below or within guidance provided by the literature. The post-installation crashes at each site were carefully scrutinized, and eleven total had occurred through July 2014.

Implementation

In looking at costs to install FYA at intersections, there are several key parameters. The first is the signal control cabinet hardware. For this hardware expense, as long as the malfunction management units are of the MMU2 specification, they can be upgraded for little to no cost by means of a firmware update. This could be done

as part of the routine annual recertification process. If a controller is not compliant with the MMU2 specification, then a possibly significant expense may be incurred. The second cost is that for an extra section to be added to a signal head. The third cost would be to upgrade existing field wires to have a minimum of eight conductor wires. The cost of pulling additional wires through the signal conduit would be dwarfed by any costs related to collapsed or damaged conduit needing replacement. Based on the AASHTO 2010 Highway Safety Manual, the comprehensive cost of a signal property damage only crash is \$7,400 and \$44,900 for a possible injury crash. The reduction of at least one possible injury crash or a combination of several property damage only crashes is all that would be required to have a positive return on investment in the first year alone. Continued crash reductions into the future would significantly increase the benefit received by the State.

Therefore, as a result of this research, it is clear that a larger scale implementation of FYA signal heads should be considered. There was also no reason to believe that, given proper engineering judgment, the placement of a FYA signal head in a horizontal configuration adjacent to vertical through lane signal heads would reduce the safety and mobility benefits provided by the FYA signal head.

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