Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Guidance for Left-Turn Flashing Yellow Arrow (FYA) Implementation in Nebraska

Research Objectives

This study will investigate the effect on safety and traffic operation of upgrading the permissive left-turn indication from CG to FYA at signalized intersections in Nebraska. Guidelines will be developed to provide NDOT and city traffic engineers with knowledge for safer and more efficient application of left-turn FYA signal configuration and arrangement in Nebraska. Specifically, the objective of this project will be to:

1. Develop an evaluation framework for the effectiveness of the left-turn FYA indication at signalized intersections to assess both safety and operational performance and investigate if the display arrangement (e.g., supplemental sign, lead/lag phasing) has a significant effect.
2. Identify significant factors (e.g., geometric, speed, volume, signal design) that cause an increase in crashes at a particular location after conversion to left-turn FYA to assess the suitability of lead/lag phasing and develop safety improving mitigation measures for existing locations with lead/lag phasing that may be experiencing higher than expected crashes, while retaining the lead/lag operation.
3. Develop a guideline for efficient utilization and implementation of left-turn FYA indication at signalized intersections for comparing efficiency (e.g., delay reduction) and safety of left-turn FYA given different left-turn FYA settings.

Research Benefits

The insights gained from this research will improve the safety and efficiency of operations at signalized intersections in Nebraska. There are three main benefits from this project.

1. Identify the efficacy of the left turn FYA indication at intersections under different types of protocols.
2. Provide guidance for the appropriate implementation of left-turn FYA displays (e.g., supplemental sign, lead/lag phasing) and safety improving measures for locations with lead/lag phasing experiencing higher than expected crashes.
3. Development and consistent usage of the FYA guidelines for Nebraska.

In summary, the results of this project may be used by Nebraska transportation agencies to make informed decisions on future installations of the FYA indication and improve existing FYA signalized intersections that may be experiencing higher than expected crashes.

Background

In recent years, various municipalities in Nebraska have transitioned to the use of the flashing yellow arrow (FYA) for permissive left-turns in accordance with MUTCD guidelines. A preliminary study conducted by the University of Nebraska Lincoln and City of Lincoln (S 27th & J-St, S 33rd & Pioneer, S 84th & Firethorn, Wedgewood & O-St) during 2019-2020 provided some evidence that the new protocols are working well. The FYA provides safety benefits while providing more flexibility and versatility in field operation (e.g., phasing sequences, modes, and displays). However, the best practice of FYA arrangement (e.g., phasing, signing) remain unclear. Inappropriate combinations of the FYA display mode may lessen the effectiveness of the FYA application.

This study will examine before-after safety of a sample of signalized intersections where changes from solid green ball to FYA installations were made for left turns. Cross-sectional field study on FYA operations will be conducted to evaluate the effectiveness of the left-turn FYA indication at signalized intersections. Specially focus on the investigation if signal display arrangement (e.g., lead/lag phasing, supplemental signing, varying time-of-day operations) had a significant effect. Guidelines on optimal implementation of the FYA considering different traffic conditions (e.g., turning movement, intersection geometry, driver comprehension, etc.) will be developed for transportation agencies.

Conclusion

This research evaluates flashing yellow arrow (FYA) safety performance and driver behavioral response in Nebraska using data from 456 FYA intersections to develop evidence-based implementation guidance. The study addresses critical knowledge gaps regarding local driver acceptance patterns, the effectiveness of phasing configurations, and a comprehensive safety assessment integrating crash and conflict analyses. The methodology employed four complementary analyses: (1) negative binomial crash frequency modeling of 845 crash events (2015-2023) across Lincoln and Omaha; (2) binary logistic regression of 948 gap acceptance decisions across 43 intersections; (3) linear regression of post-encroachment time for 613 completed left turns; and (4) detailed video investigation of 18 crashes at three Omaha intersections with lead-lag FYA phasing. Results demonstrate an 18.8% higher crash frequency post-FYA installation (β=0.1893, p=0.001), primarily driven by inappropriate site selection at high-volume (AADT>100,000) and geometrically complex locations. However, lag phasing produced a 55% reduction in crashes (β = -0.80, p = 0.027) compared to lead phasing. Video analysis revealed a “Perceived Yellow Trap” (PYT) phenomenon, where lead phasing created perceptual confusion, accounting for 72% of observed crashes. Gap acceptance analysis showed lag phasing associated with 10% shorter critical gaps (3.85s vs. 4.28s), enabling higher operational efficiency. Recommended operational thresholds include mandatory lag phasing, restriction to AADT<100,000 and less than equal to 2 opposing lanes, signal timing optimization, and time-of-day operation. When properly implemented and following the recommended operational thresholds, FYA installation should improve operational intersection safety.

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Interested in finding out more?
Final report is available:
HERE

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NDOT Recommendations Based Off Research Project – 2026 – RRL4

This research provided operational threshold recommendations to improve safety at left-turn flashing yellow arrow (FYA) intersections. The research provided Nebraska-Specific implementation standards based on eight factors: traffic exposure, installation symmetry, intersection size, performance monitoring, phasing type, "perceived yellow trap" prevention, signal timing, and time-of-day operation. The NDOT already implements the listed recommendations for many of those factors, such as having lag phasing and applying FYA at intersections with standard geometry, and this research validated those existing practices. The NDOT will also consider the other recommendations and determine whether they should be implemented.

The City of Omaha has partially or fully implemented seven of the eight recommendations from the report. The City will continue to refine its left turn policies as it considers additional factors related to Vision Zero initiatives. The City of Lincoln will take the research and recommendations into account as they review their signal timing practices concerning left-turn FYA phasing during future retiming efforts and in design of new facilities.

- *As provided by Alan Swanson and Scott Sorensen, NDOT; Bryan Guy, City of Omaha; and Andrew Jenkins, City of Lincoln; Lead TAC Members*

Research Readiness Level (RRL) Assessment

RRL 4

Level 4: Development with Implementation
Re-visit with NDOT and Cities of Lincoln and Omaha in 2 years.

Technology Transfer

Webinars/Presentations

- Dzawu, Frank Selase, Li Zhao, and Aemal J. Khattak. Driver Gap Acceptance at Flashing Yellow Arrow Intersections: Critical Gap Estimation and Probability Modeling by Signal Phase. To be presented at the 105th Annual Meeting of the Transportation Research Board, Washington, DC, January 2026 (TRBAM-26-04109).
- Dzawu, Frank Selase, Li Zhao, and Aemal J. Khattak. Post-Encroachment Time Analysis of Left-Turn Conflicts at Flashing Yellow Arrow Intersections: A Conflict Severity Assessment. To be presented at the 105th Annual Meeting of the Transportation Research Board, Washington, DC, January 2026 (TRBAM-26-04074).
- Zhao, Li, Frank Selase Dzawu, Aemal J. Khattak, Bryan Guy, Nicholas Gordon, and Garret Schram. Are flashing yellow arrow signals effective in eliminating yellow traps for lead lag left turns? Presented at the 104th annual meeting of the Transportation Research Board, Washington DC, January 2025 (TRBAM-25-05151)

This brief summarizes Project SPR-FY24(037)
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