



September 10, 2001

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

Refer to: HOTO-1

Mr. Jihad El Eid  
Director, Broward County  
Traffic Engineering Division  
2300 W. Commercial Blvd.  
Ft. Lauderdale, FL 33309

Dear Mr. El Eid:

Thank you for your August 1 letter to the Office of Transportation Operations concerning your request to experiment with the flashing yellow arrow for permissive left turn movements.

We approve your Request to Experiment with the flashing yellow arrow as part of the NCHR-P 3-54 Research Study. We understand this experiment could last until Broward County has access to 2 years of crash data after implementation. Therefore, the experiment is approved for 3 years. Please note that we are requesting regular progress' reports every 6 months and a copy of the final results within 3 months following completion of the experiment.

Good luck with the project. We look forward to the results and the promise of a new traffic control operation that will improve the mobility and safety of our roads. If you have any questions, please call Mr. Ernest Huckaby at 202-366-9064. Please note that we have assigned your request the following official experimentation number and title: "4-219(E)--NCHRP 3-54, Flashing Yellow Arrow." Please refer to this number in future correspondence.

Sincerely yours,

Shelley J. Row  
Director, Office of Transportation  
Operations

cc: Jim Baron, ATSSA



August 1, 2001

Public Works Department — Office of Transportation  
**Traffic Engineering Division**  
2300 W. Commercial Blvd.  
Fort Lauderdale, FL 33309  
(954) 484-9600 • FAX (954) 735-8564

Shelley J. Row, P.E., Director  
Office of Transportation Operations  
HOTO Room 3401  
400 7<sup>th</sup> Street, SW.  
Washington, D.C. 20590

Dear Ms. Row:

Enclosed is a request for FHWA to approve experimentation by Broward County, Florida, with the Flashing Yellow Arrow display for the permissive indication of the protected-permitted mode of the left turn signal. Broward County is one of several volunteer agencies planning to participate in the field experimentation phase of research being conducted by Kittelson and Associates under their contract for NCHRP Project 3-54 (02).

As you may be aware, this NCHRP research was requested by the National Committee on Uniform Traffic Control Devices, Signals Technical Committee, due to continuing concerns among various jurisdictions around the U.S. about the safety of the circular green display for the permissive left turn indication. There have been a variety of different displays proposed as alternatives to the green ball display by various states and other jurisdictions, but this definitive NCHRP research is necessary to scientifically evaluate the safety benefits, if any, versus the standard green ball display for the permissive interval.

We believe this request for experimentation approval to be in accordance with the provisions in the MUTCD governing experimentation with traffic control devices. If there are any questions, please feel free to give me a call at 954-484-9600 extension 200.

Because of the NCHRP contractor's required time frame, it is urgent that this experimentation request be given priority for your staff's review and action. Anything you can do to expedite this would be sincerely appreciated.

Thank you in advance for your cooperation in this important research project.

Jihad El Eid, P. E.  
Director

JEE/dle

Enclosure

cc: Mark Plass, P.E., FDOT, District IV  
Lee Billingsley, P.E., Director, Office of Transportation  
Jack Brown, State Traffic Operations Engineer  
Chung Tran, FHWA, Florida ITS Office  
Kent Kacir, Kittelson & Assoc.

**Request to the Federal Highway Administration For Experimentation by  
Implementation of the Flashing Yellow Arrow Display**

By Broward County, Florida

A participant in the NCHRP Project 3-54 Project, Evaluation of  
Traffic Signal Displays for Protected Permitted Left Turn Control

August 1, 2001

# **Request to Experiment by Implementation of the Flashing Yellow Arrow Display**

## **Preface**

The research project, NCHRP 3-54, Evaluation of Traffic Signal Displays for Protected Permitted Left Turn Control conducted by Kittelson and Associates, Inc. (KAI) as the prime contractor, has reached the field implementation phase for testing the flashing yellow arrow display for the permissive indication at protected/permitted left turns. Broward County is submitting to FHWA a request for approval for experimental use of this test display.

## **Statement of the problem**

The objective of the NCIW 3-54 project is to evaluate the safety and effectiveness of different signal displays and phasing for protected/permissive left-turn control (PPLT). Many agencies have sought alternatives to the green ban indication used in PPLT since the green bar can produce yellow trap situations if not used properly (i.e., lead/lag phasing schemes). NCIW 3-54 has conducted several studies of both the green ball permissive display and several other displays. The flashing yellow arrow appears to be the most promising alternative display to the green ball display.

The NCIW 3-54 Project Panel has asked that additional field data on flashing yellow arrow installations be obtained. That data is needed to further evaluate the effectiveness of the flashing yellow arrow and to confirm results of earlier tests.

## **Description of the Proposed Change**

The proposed change would allow the use of a flashing yellow arrow indication as the permissive interval associated with the protected/permissive left-turn control. The proposed flashing yellow display is recommended for experimental testing based upon the results of several studies conducted within the NCBRP 3-54 project. Research has demonstrated that driver understanding is lower with the green ball permitted display as compared to other permitted displays being used in various parts of the country. The flashing yellow arrow display is better understood than the green ball display and has few fail critical errors (drivers turning left without the right-of-way).

The flashing yellow arrow provides versatility in application. The flashing yellow arrow display enables all of the following turning movement modes of operation:

- Protected/permissive
- Protected only
- Permissive only
- Prohibited (No Left Turn)

The flashing yellow arrow can be used for left- or right-turn treatments; although it is recognized that the left-turn treatment will be the most predominant use.

The flashing yellow arrow display eliminates the left turn "trap". The protected phase can operate as a leading or lagging movement without regard for the type of operation and phase sequence in the other direction, and can change between leading and lagging sequences during the day. Side street phases can be skipped and a leading left turn safely re-introduced (sometimes called "backing up"). The protected turn phase can be vehicle actuated and skipped in the absence of demand, regardless of the phase sequence.

### Proposed Flashing Yellow Arrow Display Arrangements

The research team, in partnership with project panel and technical advisory, group members, has identified several display arrangements that demonstrate good motorist understanding. Different display arrangements are recommended for an exclusive left turn display and shared display.

### Exclusive Display Arrangements

There are at least four possible PPLT signal displays that are recommended for installation of the flashing yellow arrow display at a location where there is an exclusive left-turn lane and the left-turn display is a separate display (not used by the adjacent through movements). Those alternative displays are shown in Figure I below. Broward County Traffic Engineering Division (BCTED) requests FHWA approval to test display number 1 shown in Figure 1.

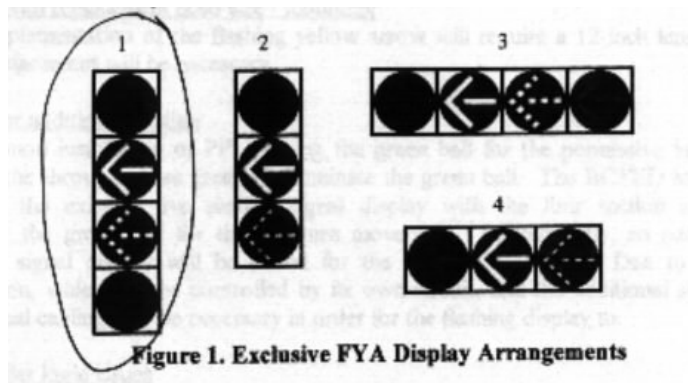


Figure 1. Exclusive FYA Display Arrangements

It is noted that the basic signal arrangement is a four-section arrangement. The signal arrangement can be mounted either vertically or horizontally.

One, and only one, of the four arrows are illuminated at all times. The flashing yellow arrow is illuminated when traffic can safely turn by Yielding to Opposing through traffic and/or pedestrians (permissive operation). The other three arrows are used as in the non-nal three-color exclusive left turn display. The red arrow is displayed when it is unsafe to make a left turn movement. The green arrow is displayed when the left turn

movement can be made with no conflicting simultaneous vehicle or pedestrian movement (protected operation). The steady yellow arrow is illuminated for a few seconds as a clearance indication following both the green arrow and the flashing yellow arrow.

## **Proposed Work Plan**

Broward County will staff the flashing yellow arrow display at a minimum of three signal approaches (to be identified later in this document) within its jurisdictional control.

Each location will be considered a typical intersection containing no unique geometric or operational features. The proposed PPLT intersection should have right angle relationships to all intersecting approaches. The approach for which the FYA will be Failed will have an exclusive left-turn lane. The horizontal grade will be relatively flat. All lanes will meet current design standards, as much as possible (12-foot travel lanes). The existing left-turn treatment (before implementation of the FYA) will be protected permitted using the green ball permissive display. Three (3) additional intersections will be selected that will not receive any improvements during the study period. These intersections will act as control sites. Therefore, a minimum of six study sites are required.

## **Anticipated Changeover Implementation Issues**

Past experience with implementing flashing indications has identified various obstacles or issues that may be a factor in future implementations.

### Issues with replacement head size / Mounting

The implementation of the flashing yellow arrow will require a 12-inch lens. No 8-inch lens replacement will be necessary.

### Need for additional cabling

A common installation of PPLT using the green ball for the permissive interval makes use of the through phase green to illuminate the green ball. The BCTED has selected to replace the existing five section signal display with the four section signal display without the green ball for the left turn movement. Subsequently, an additional three section signal display will be added for the through movement. Due to the flashing indication, which will be controlled by its own circuit, and the additional signal display, additional cabling may be necessary in order for the flashing display to.

### Controller logic issues

In a typical PPLT situation, it is possible for the green ball display and green arrow display to illuminate simultaneously. However, by converting to the flashing Yellow arrow display, the flashing yellow arrow and green arrow displays cannot illuminate simultaneously.

In unusual situations, additional or different phases could serve as parent phases to drive the flashing yellow arrow overlap. The same overlap logic can also be used to drive right turn arrows where appropriate.

If existing controller software cannot be modified to provide this functionality, the same effect can be achieved using external logic, although with less flexibility. It is assumed that new controller software and any significant upgrade of existing controller software will include this functionality, so that over time, external logic will no longer be needed.

### Conflict monitor issues

Past applications of flashing indications have required the use of special external logic units to prevent the conflict monitor from detecting a signal malfunction.

### **Length of Experimentation**

The experiment is proposed to last until the Broward County has access to two-years of crash data after implementation, which could be up to 3 years

### **Evaluation Plan**

Broward County will obtain the most recent 3 years of "before" crash data and will send that data to the NCHRP 3-54 Contractor for later analysis. "After" crash data will be collected and sent to the NCHRP (in care of this project) for later follow up analysis. The NCHRP project completion time frame is too early for proper review and analysis of "before" and "after" crash data. It is noted that a thorough analysis of crash data was conducted in earlier study tasks as part of this research project, including the flashing yellow displays currently in use. No abnormal or unsafe crash histories were identified.

Broward County's responsibilities are:

- Identifying a minimum of three intersections for Calling the flashing yellow arrow display on at least one intersection approach.
- Install or retrofit the appropriate signal arrangements (head).
- Make the necessary modifications, if any, to the existing signal controller and controller conflict monitor.
- Provide intersection data sheets for each location. See below.
- Provide three years of before crash data and one year after crash data. It is requested that volunteer agency supply a total of three years of after data and this data would be forwarded directly to NCHRP for further study at a later date.
- Track and report change-over costs and implementation issues.
- Submit overall qualitative statement on the flashing yellow arrow operation.

NCHRP 3-54 Contractor responsibilities are:

- Assist the agency in identifying good candidate installation locations.
- Provide assistance to the agency to resolve issues related to installing the flashing yellow arrow display.
- Review and analyze the before and after videotape data.
- Summarize and analyze the crash data.
- Analyze field operational data.
- Analyze field conflict data.

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### Site Restoration

Broward County agrees to restore the experiment site to a state coMP4\* with the provisions of the MUTCD:

- within 3 months following the end of the time period of the experiment, or

at any time that Broward County determines that significant hazards are directly or indirectly attributable to the experimentation, or

- if requested to do so by the Office of Traffic Operations.

If, as a result of experimentation, a request is made that the Manual be changed to include flashing yellow arrow permissive indications, then the experimental device may remain in place until an official rulemaking action has occurred.

## Reporting

Initially, reporting will be done by Kittelson & Associates under NCBRP 3-54. After the first year of experimentation, Broward County will provide semi-annual progress reports until the experiment is completed. A copy of the final results will be sent to FHWA, HHS-10, within 3 months following completion of experimentation. All reports will be submitted to:

Shelley J. Rowe, P.E.,  
Director, Office of Transportation Operations  
HOTO Room 3401  
400 7h Street, S.W.  
Washington, D.C. 20590

Kittelson & Associates, Inc. has requested to be copied on aU correspondence between Broward County and FHWA. Their mailing address is:

Kent Kacir, P.E., Principal Investigator  
Kittelson & Associates, Inc.  
61 0 SW Alder Street, Suite 700  
Portland Oregon, 97205  
(503) 228-5230 TEL

## Project Administration

Initially the experimentation will be overseen by Kittelson & Associates under NCHRP 3-54. When that contract is complete, Broward County will be responsible for administering this experiment under the direction of Henk Koomstra, P.E., Assistant Director, located at 2300 West Commercial Boulevard, Fort Lauderdale, Florida 33309.

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## Test Locations and Control Sites

The Broward County Traffic Engineering Division in conjunction with the Florida department of Transportation has selected three test sites and three control sites.

The test sites and turn movement, which will be retrofitted to the Flashing Yellow Arrow configuration, are:



Sample Road and Riverside Drive, Westbound left turn.  
Coral Springs Drive and Wiles Road, Southbound left turn  
Broward Boulevard and SW 69 Avenue, Eastbound left turn

The control sites are:

Sample Road and Rock Island Road  
University Drive and Wiles Road  
Broward Boulevard and SW 70 Avenues

Definitions

BCTED: Broward County Traffic Engineering Division

Intersection Data Sheets: Technical information concerning the intersection available in the files of the BCTED.