Chapter 3

SIGNALS

Section 3.1

SIGNALIZED INTERSECTION FLASHING MODE OPERATION AND FLASHING BEACONS

3.1.1 DEFINITIONS

(1) **Flashing Beacon:** A Flashing Beacon is a highway traffic signal with one or more signal sections that operates in a flashing mode. It can provide traffic control when used as an intersection control beacon or as a warning beacon in alternative uses.

(2) **Flashing Operation of Traffic Control Signals:**

(a) **Non-Programmed Flashing Mode Operation.** The automatic transfer from a signalized intersection's normal mode operation (stop and go, steady red-yellow-green displays) to flashing mode operation (stop or caution, flashing red-yellow, or red indications) caused by a malfunction of the signal controller, a conflict in signal displays or manual selection of the flashing mode operation by maintenance or police personnel.

(b) **Programmed Flashing Mode Operation.** The automatic transfer from a signalized intersection's normal mode operation (stop and go, steady red- yellow-green displays) to flashing mode operation (stop or caution, flashing red-yellow or red indications) during set times during the day.

3.1.2 RECOMMENDATIONS FOR SIGNALIZED INTERSECTIONS

3.1.2.1 Programmed Flashing Mode Operation

Flashing operation is both energy and operationally efficient and is encouraged when consistent with the following recommendations:

(1) Flashing yellow/red operation may be used when two-way traffic volumes on the main street are below 200 vehicles per hour.

(2) Flashing yellow/red operation may be used during any hours of the day or night when ***MUTCD Signal Warrants #1 and #2*** are not met and where the two-way main street volume is greater than 200 vehicles per hour, provided the ratio of main street to side street volume is greater than 4:1.

(3) Signal operation should be changed to regular operation if crash pattern or severity increases or there is an increase in conflicts.

(4) A speedway effect can be avoided and uniform speeds obtained by maintaining sufficient signals cycling through steady red, green and yellow at proper spacing so as to provide signal progression at an appropriate speed.

(5) Traffic signals should be put on flashing operation primarily at simple traffic signal controlled intersections where the side street drivers have an unrestricted view of approaching main street traffic. Intersections with more than four legs, skewed intersections (greater than 15 degrees), or railroad preempted signals should not be considered for flash.

(6) Flashing should be restricted to no more than 3 separate periods in a 24-hour period.

3.1.2.2 Non-Programmed Flashing Mode Operation

All signalized intersections shall automatically transfer to flashing mode immediately (no clearance interval) whenever a malfunction occurs during the normal mode operation of the signalized intersection.

3.1.3 APPLICATION REQUIREMENTS FOR SIGNALIZED INTERSECTION

The signal flashing mode and start-up sequence shall be as follows for:

3.1.3.1 Yellow-Red Flashing Mode:

(1) **Main Street.** Flashing yellow during flashing mode, then steady green on start-up sequence.

(2) **Protected Left Turns.** Flashing red during flashing mode, then steady red on start-up sequence. Protected left turn signals should carry all arrow indications.

(3) **Side Street.** Flashing red during flashing mode, then steady red on start-up sequence.

3.1.3.2 Red-Red Flashing Mode:

(1) **Main Street.** Flashing red during flashing mode, then steady green on start-up sequence.

(2) **Protected Left Turns.** Flashing red during flashing mode, then steady red on start-up sequence. Protected left turn signals should contain all arrow indications.

(3) **Side Street.** Flashing red during flashing mode, then steady red on start-up sequence.

3.1.4 HEADS TO BE FLASHED

Section 4D.30 of the MUTCD requires all signal faces on an approach to be flashed when the signal is in flashing mode operation. Therefore, a left or right turn signal not illuminated during flashing mode operation is unacceptable. ***Section 4D.30 of the MUTCD*** requires the flashing of red or yellow arrow indications.

Pedestrian signal indications (WALK and DON'T WALK) shall not be illuminated during flashing mode operation at signalized intersections.

3.1.5 FLASHING INDICATION COLORS

(1) The color to be flashed, red or yellow circular indication, or arrow indications shall be determined as follows:

(a) Each approach or separately-controlled turn movement that is controlled during normal stop-and-go operation shall be provided with a flashing display.

(b) All signal faces on an approach shall flash the same color, either yellow or red circular or arrow. However, separate signal faces for separately-controlled turn movements may be flashed as described in ***Section 4D.30 of the MUTCD***. Flashing yellow indications for through traffic do not have to be shielded or positioned to prevent visual conflict for drivers in separately-controlled turn lanes; however, shielding for separate protected turn movements shall be in accordance with Sections ***4D.22***, ***4D.23***, and ***4D.24*** of the MUTCD.

(c) When a signal face consisting entirely of arrow indications is to be put on flashing operation, or when a signal face contains no circular indication of the color that is to be flashed, the appropriate red or yellow arrow indication shall be flashed.

(d) When a signal face includes both circular and arrow indications of the color that is to be flashed, only the circular indication of that color shall be flashed. A 5-section head cluster shall be flashed the same color as the approach through lanes. Only circular red or circular yellow indications shall be flashed in a flashing mode operation.

(e) No steady green indication or flashing yellow indication shall be terminated and immediately followed by a steady red or flashing red indication without the display of the steady yellow change indication; however, transition may be made directly from a steady green indication to a flashing yellow indication. This applies to both the circular and arrow indications. The transition from stop-and-go to flashing operation, when the transition is initiated by a signal conflict monitor or by a manual switch, may be made at any time.

(2) **Main Street, Through Traffic.** From flashing yellow to steady green.

(3) **Main Street, Separate Left Turn.** From flashing red to steady red.

(4) **Side Street, Through Traffic.** From flashing red to steady red.

(5) Green arrow indications which are continuously illuminated during normal operations should be continually illuminated during flashing mode operation.

3.1.6 APPLICATION REQUIREMENTS FOR FLASHING BEACONS

(1) All existing flashing beacons are considered to meet the ***MUTCD*** requirements whether they are single or dual indicated.

(2) However, all new or replacement intersection control beacon installations shall be designed and installed with dual indications. Wherever practical, the dual indications shall both be positioned laterally within each approach width to the intersection. For example, a four-way beacon assembly over each side of a divided four-lane highway does not meet this requirement. In no instance shall intersection control beacon indications on an approach be closer than 8 feet apart measured horizontally.

3.1.7 OPERATION OF FLASHING BEACONS

(1) Intersection Control Beacons. Dual indications for intersection control beacons displaying horizontally aligned red indications shall be flashed simultaneously. Alternate flashing of dual horizontally aligned red indications is reserved for highway approaches to a railroad. Two vertically aligned red signal indications shall be flashed alternately. Refer to ***Section 4L.02 of the MUTCD***.

(2) Warning Beacons. Warning beacons typically are installed at obstructions or to emphasize warning signs. These may be singular or dual indications and may be flashed alternately or simultaneously. Refer to ***Section 4L.03 of the MUTCD***.

Section 3.2

GUIDELINES FOR LEFT TURN TREATMENT

3.2.1 PURPOSE

This guideline can be used to determine the selection of the following types of left turn treatments, as defined in ***Section 4D.17 of the MUTCD***:

- Permissive Only Mode
- Protected/Permissive Mode
- Protected Only Mode
- Split Phasing (each direction alternatively has both left turn green arrow and circular green)

Option:

(1) A flashing YELLOW ARROW signal indication may be displayed to indicate a permissive left-turn movement in either a protected/permissive mode or a permissive only mode of operation.

(2) It is not necessary that the left-turn mode for an approach always be the same throughout the day. Varying the left-turn mode on an approach among the permissive only and/or the protected/permissive and/or the protected only left-turn modes, during different periods of the day is acceptable.

3.2.2 LEFT TURN SIGNAL PHASING

(1) If the need for left turn phasing on an intersection approach has been firmly established, the following guidelines should be used to select the type of left turn phasing to provide. Sound traffic engineering judgment should be exercised in applying these guidelines.

(2) A protected/permissive mode should be provided for all intersection approaches that require a left turn phase unless there is a compelling reason for using another type of left turn phasing. If the decision between providing protected/permissive or protected only mode is not obvious, the traffic engineer should initially operate the left turn phase as protected/permissive mode on a trial basis. If satisfactory operations result, the protected/permissive mode should be retained. If unsatisfactory operations result, the protected/permissive mode should be converted to protected only mode.

(3) A protected only mode shall be provided for an intersection approach if any of the following conditions exist:

(a) Two or more left turn only lanes are provided.

(b) Geometric conditions and resulting sight distance necessitate protected only mode.

(c) The approach is the lead portion of a lead/lag intersection phasing sequence.

(d) The use of offset left turn lanes to the degree that the cone of vision requirements in Section 4D.13 of the MUTCD for the shared signal display cannot be met.

(4) A protected only mode may be considered if any of the following conditions exist:

(a) Speed limit of opposing traffic is higher than 45 mph.

(b) Left turn traffic must cross three or more lanes of opposing through traffic.

(c) A protected/permissive mode is currently in use and the number of left turn angle crashes caused by left turn drivers on this approach exceeds six per year.

(d) Unusual intersection geometrics exist that will make permissive left turning particularly confusing or hazardous, such as restricted sight distance.

(5) A permissive/protected mode can be used effectively for some intersection approaches if the traffic engineer feels that the advantage to be gained in better progression, as demonstrated in a traffic signal analysis computer program, is worth the violation of driver expectancy. However, use of this type of left turn phasing should be limited and should be restricted to only the following situations which will not create a left-turn trap:

(a) T-intersections where opposing U-turns are prohibited.

(b) Four-way intersections where the opposing approach has prohibited left turns or protected left turn phasing.

(c) Four-way intersections where the left turn volumes from opposing approaches do not substantially differ throughout the various time periods of a normal day, so that overlap phasing is not beneficial or required.

(6) Split phasing can be used effectively if any of the following conditions apply:

(a) Opposing approaches are offset to an extent that simultaneous left turns from opposing directions would be impossible or hazardous.

(b) Left turn volumes are extremely heavy on opposing approaches and both are nearly equal to the adjacent through movement critical lane volume.

(c) Left turn volume is extremely heavy on an approach that does not include a separate left turn lane.

(d) Drivers are permitted to turn left from more than one lane, but drivers are also permitted to use the right-most left turn lane as a through lane.

3.2.3 LEFT TURN SIGNAL DISPLAYS

The following are the left turn signal displays as referenced in ***Section 4D.17 of the MUTCD*** to be used with the various types of left turn phasing.

(1) **Protected/Permissive Mode.** A 5-section signal display centered over the lane line between the left turn lane and the left-most through lane should be used. The 5-section signal display could serve as one of the two required through traffic signal heads. No supplemental signing should be provided.

(2) **Protected Only Mode with a single left turn lane.** A 3-section vertical signal head from top to bottom -- (or left to right in a horizontally-aligned face) left turn red arrow, left turn yellow arrow, left turn green arrow) should be centered over the left turn lane.

(3) **Protected Only Mode with two or more left turn lanes.** At least two 3-section vertical signal heads (or left to right in a horizontally-aligned face) as described in the paragraph above should be used with one centered over each left turn lane.

(4) **Split phasing.** A 5-section signal display centered over the lane line between the left turn lane and the left-most through lane should be used. The 5-section signal display could serve as one of the two required through traffic signal heads. No supplemental signing should be provided.

3.2.4 SIGNAL DISPLAY FOR EXCLUSIVE LEFT TURN LANE

A 3-section (red, yellow, and green) signal face shall not be placed over, and/or devoted to, an exclusive left turn lane, unless the signal phasing sequence provides a protected left turn movement during the cycle.

3.2.5 LEFT TURN PHASES FOR SEPARATED LEFT AND THRU LANES

(1) Left turn lanes at signalized intersections that are separated from through lanes by raised or painted islands may be operated as protected only mode, as protected/permissive or permissive only mode. If protected/permissive mode is used, the 5-section signal display should be placed overhead on the lane line between the adjacent through lane and the island so as to be obvious that the signal display is shared. In all cases, the cone of vision requirements in ***Section 4D.13 of the MUTCD*** shall be met. Below is an illustrative example using standard lane widths on a 4-lane divided highway. A corresponding table for maximum allowable island width (without shifting the signal head) for the indicated signal head distance from stop line is given.

Figure 3.2-1. Signal Head/Left-Turn Treatment

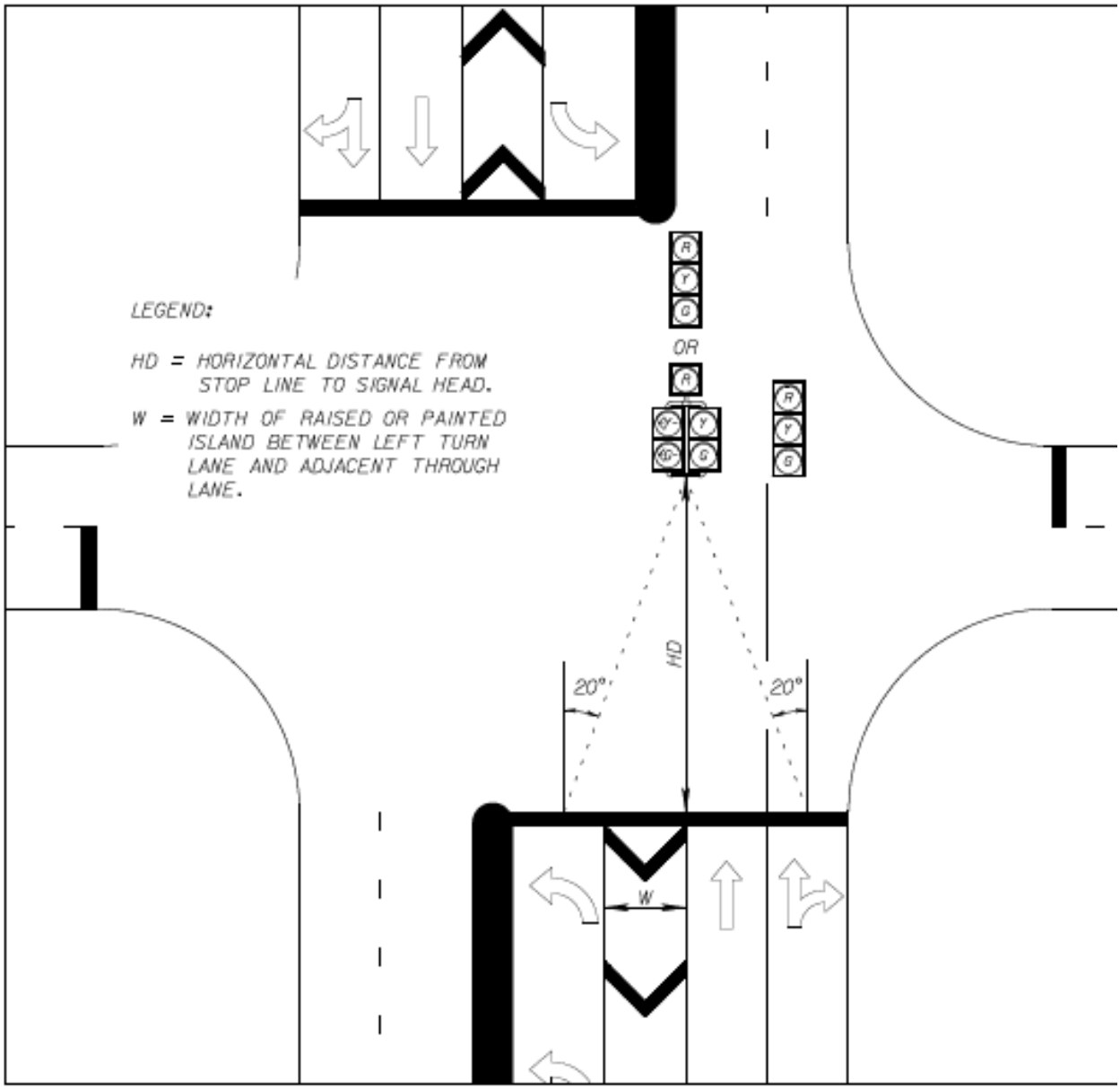


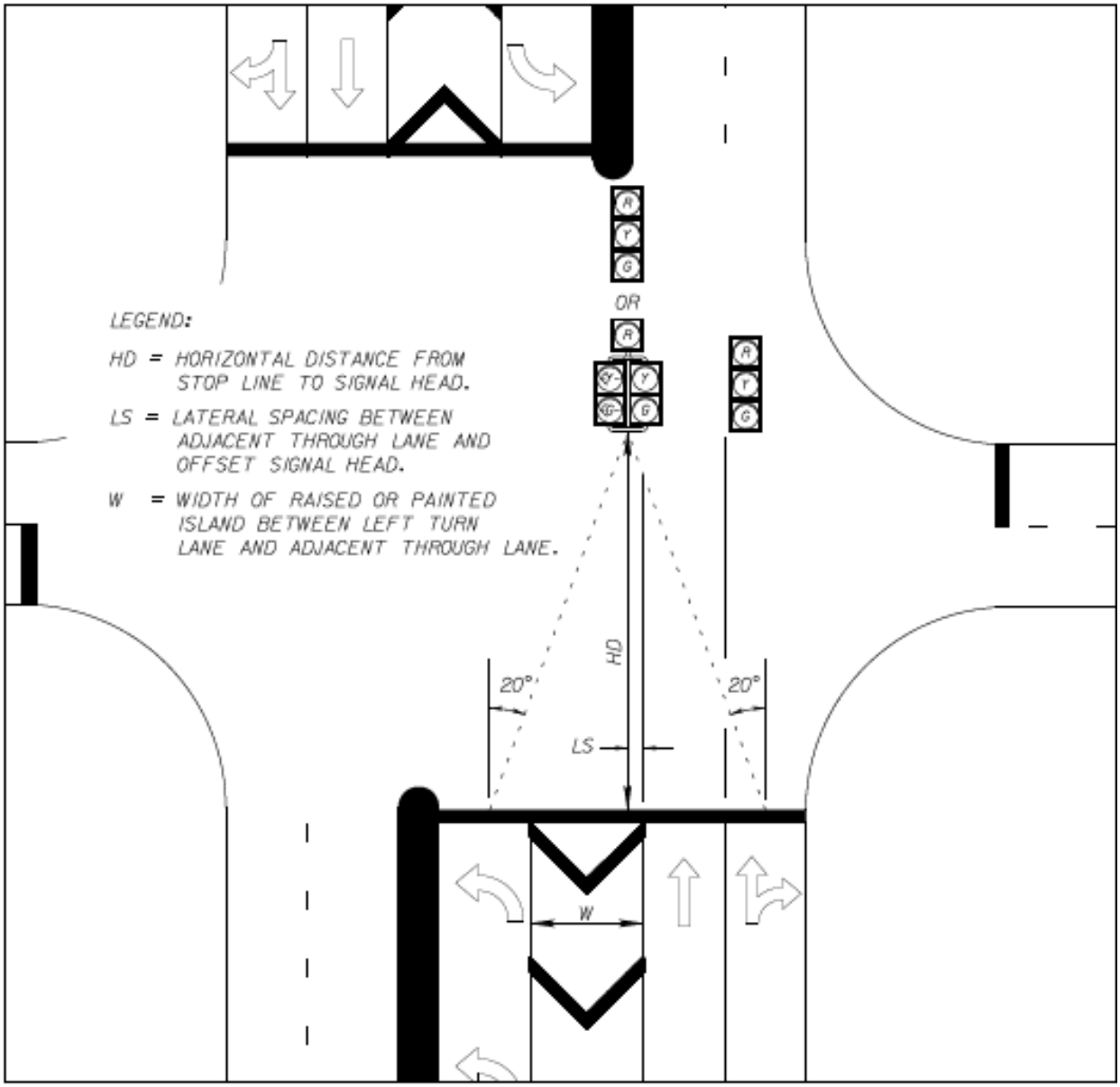
Table 3.2-1. Maximum Width of Hatched-Out Area Without Shifting Signal Head

Horizontal Distance	Width
40	8
50	12
60	15
70	19
80	23
90	26
100	30
110	34
120	37
130	41
140	44
150	48

(2) Signal faces containing circular green signal indication for a permissive only left-turn should not be located above an exclusive left-turn lane or the extension of the lane, nor should they be post-mounted on the far side median in front of the left-turn lane. Permissive only left turn signal displays shall not be provided in an exclusive left turn signal face. If the separation or geometric conditions of the offset left turn lane is such that the cone of vision would not be met with a shared signal head positioned on the lane line adjacent to the nearest through lane, the shared signal face may be offset to the left from the adjacent through lane line such that the required cone of vision is still met for the right most through lane and for the left turn lane. This lateral offset spacing should be used only after other options such as increasing the horizontal distance to the signals heads has been considered and placed so as to be obvious that the signal display is shared. The lateral offset spacing of the shared signal head from the adjacent through lane generally should not be greater than one half the width of the island (½W).

(3) If the lateral shift is too great, the cone of vision may not be adequate for the driver in the right most through lane. Where the cone of vision cannot be met, protected only mode must be used. This may be due to a large parallel offset left turn lane or due to a tapered or curved offset left turn lane.

Figure 3.2-2. Left Turn Lane Signal Head Shift



3.2.6 PERMISSIVE ONLY MODE IN MULTI- LEFT TURN LANE APPROACHES

A permissive green interval for two or more left turn lane approaches shall not be used.

Section 3.3

SCHEDULING INTERSECTION CONTROL EVALUATIONS AND FUNDING ARRANGEMENTS

3.3.1 PURPOSE

To establish criteria for responding to requests for traffic signal installations, for funding and implementation arrangements for warranted signals, and for conducting related studies such as the Intersection Control Evaluation (ICE) to determine the need and type of improvement.

3.3.2 GENERAL

Since the Department is charged with the responsibility to erect and maintain a uniform system of traffic signals and other traffic control devices for regulation, control, guidance, and protection of traffic on the State Highway System, there is need to provide uniformity in responding to requests for signals and in the scheduling and conducting of traffic studies to determine signal needs. If an intersection is determined to meet signal warrants, the procedure as described in the Department's ***Topic No. 750-010-003, Manual on Intersection Control Evaluations*** must be conducted to determine the appropriate intersection control strategy.

3.3.3 RESPONSE TO SIGNAL REQUESTS AND SCHEDULING TRAFFIC SIGNAL STUDIES

(1) The District Traffic Operations Office shall objectively review all requests for traffic signal installations received by the Department against existing information and local knowledge of the intersection before agreeing to commit resources for a detailed traffic study. This initial screening may require a brief site visit to view the field conditions. During the initial screening, all data shall be recorded in writing and kept on file. An attempt shall be made to relate all data and analysis to standards set forth in the ***MUTCD***. If the initial screening results in a decision to conduct a signal warrant study, the appropriate ***District Traffic Operations Office*** should contact the local government traffic engineering agency, advise them of the Department's decision, and obtain their views and input. Also, the appropriate ***District Traffic Operations Office*** should advise the local government traffic engineering agency that should signal warrants be met, an ICE analysis will be required to determine the appropriate intersection control strategy.

(2) If the initial screening results in a decision to not consider signalization or further study, the ***District Traffic Operations Office*** shall document the reasons and advise the requestor of the findings with a copy to the local government traffic

engineering agency. Although local government concurrence is desirable, it is not a prerequisite for committing Department resources to a full signal warrant study and subsequent ICE analysis if the signal is warranted.

(3) The ***District Traffic Operations Office*** shall normally conduct signal warrant studies for proposed signal installations on the State Highway System. However, a local government traffic engineering agency may conduct such studies and submit them to the ***District Traffic Operations Office*** for review. All studies shall be conducted in accordance with the procedure and standards prescribed in this document and shall be signed and sealed by a professional engineer.

(4) If the signal warrant study shows the installation of a new traffic signal is warranted, the ***District Traffic Operations Office*** or local government traffic engineering agency will conduct an ICE analysis to determine the appropriate intersection form.

(5) Formal legal resolutions from local agencies may form the basis of their concurrence in the need for a traffic signal study. However, such documents should not be required by the Department as a prerequisite to scheduling the study. Additionally, the availability of implementation funds should not be a prerequisite to assessing traffic signalization needs (conducting a study).

(6) The ***District Traffic Operations Office*** shall keep a log of requests for traffic signal studies and their disposition. To the extent practical, a priority system utilizing the request date, traffic volumes, accident experience, and the level of local government interest should be used to schedule traffic signal studies.

3.3.4 TRAFFIC SIGNAL STUDIES AND ENGINEERING

(1) Department of Transportation staff, local agency engineers, or qualified consulting engineers may perform traffic signal studies, ICE analyses, and provide any required engineering services for the preparation of implementation plans and specifications for proposed traffic signals and/or alternative intersections on the State Highway System. However, the Department is responsible for requiring and overseeing such work.

(2) Traffic signal studies shall be made in accordance with ***Topic No. 750-020-007, Manual on Uniform Traffic Engineering Studies (MUTS)***, particularly, ***Chapter 2 of the MUTS Manual***, referred therein. ICE analyses shall be made in accordance with ***Topic No. 750-010-003, Manual on Intersection Control Evaluations***. Plans and specifications, if required, shall be prepared in accordance with established Department procedures.

(3) Traffic signal studies, ICE analyses or engineering analyses conducted for new, or proposals to significantly revised, private access points to major traffic generators shall be conducted by qualified traffic engineers at no cost to the Department. Except under unusual circumstances, these studies and/or analyses shall be part of the Driveway Permit Application as per the requirements of ***Rule 14-96***. In accordance with ***Section 2.3(1)(d) in Topic No. 750-010-003, Manual***

on Intersection Control Evaluations, a Driveway Permit Application for Category E, F, and G standard connection categories are required to conduct ICE analysis and have the analysis approved by both the District Design Engineer and the District Traffic Operations Engineer. These studies shall, in addition to evaluating the need for signal control at unsignalized intersections and alternative intersections forms from the ICE analyses, also consider enhanced features at existing upstream and downstream signalized intersections, as appropriate. Such study and report shall be signed and sealed by a Florida registered professional engineer. Likewise, engineering costs associated with the preparation of implementation plans and specifications should also normally be borne by the developer. There may be instances where the Department determines that specific critical design requirements make it essential that the engineering work be performed by Department forces. In such instances, the District Secretary may direct that the engineering work be done by the Department at no cost to the developer.

(4) Studies and engineering at existing private access points which may be required as a result of normal traffic growth are usually made by qualified traffic engineers by the requestor. In extraordinary situations the Department may elect to do so.

3.3.5 FUNDING ARRANGEMENTS FOR WARRANTED NEW SIGNAL INSTALLATIONS

(1) New traffic signal installations and/or alternative intersections from the ICE analysis on the State Highway System may be funded from private, local, state, or federal funds, or any combination of such funds.

(2) The developers shall totally fund the installation of any new traffic signal, any alternative intersection construction, and/or the enhancements of any existing traffic signals when these improvements are requirements specified in a new or revised Driveway Permit or local government Development Order. If proposals to provide signalization or alternative intersection or modify existing signalization is above the minimum required by Permit or Development Order and provides a betterment to the State Highway System substantially beyond mitigation for development impacts, the Department's District Secretary may determine an appropriate financial participation formula and assign percentages of participation to the developer in consideration of the specific conditions at each site.

(3) Although signal installation and/or alternative intersection construction on the State Highway System is the responsibility of the Department, local governments may contribute, on a voluntary basis, a portion, or all of the cost of signal installation and/or alternative intersection construction depending upon specific cooperative arrangements worked out between the Department's District Offices and the local agency. Local funds are most often utilized in these cooperative efforts to advance the implementation schedule of a warranted traffic signal and/or alternative intersection. When local funds are accepted by the Department, a formal joint project agreement executed by both parties is necessary.

(4) Most local governments in Florida's urban areas have qualified traffic engineering organizations with experienced traffic signal field crews and many new signals have been installed on the State Highway System using local agency installation crews with control hardware supplied by the Department. Where the local agency is agreeable to this procedure (most are because of their maintenance and operational involvement in these sites), this technique should be encouraged. No formal agreement is necessary since no money is changing hands; however, a letter from the local agency agreeing to install Department supplied hardware should be obtained.

3.3.6 OTHER CONSIDERATIONS

(1) Prior to purchase, use, or installation, traffic signals must comply with provisions of the ***FDOT Approved Product List Submittal Process***.

(2) Prior to finalizing the agreement of intersection improvement, the study must comply with ***Topic No. 750-010-003, Manual on Intersection Control Evaluations***.

(3) Prior to installation of traffic signals, compliance with ***Topic No. 750-010-022, Traffic Signal Maintenance Agreements***, is necessary.

Section 3.4

EMERGENCY TRAFFIC CONTROL SIGNALS

3.4.1 PURPOSE

To provide guidance for warranting, designing, and operating emergency traffic control signals at locations where emergency vehicles, most commonly fire trucks, need special traffic signal assistance to egress onto the street system.

3.4.2 BACKGROUND

The Department's district offices often receive local public agency requests for traffic signal control for the departure of emergency vehicles. This section was developed to give comprehensive guidance to determine if the signals are warranted.

3.4.3 PROCEDURE

The need for an Emergency Traffic Control Signal shall be considered if an engineering study finds that one of the following warrants are met:

(1) Minimum Traffic Volumes (Both directions of travel, based on signal warrant #2), as shown in Table 3.4-1.

Table 3.4-1. Minimum Traffic Volumes

Roadway	Peak Hour	or	24 Hours
2-Lane	750 VPH		7500 ADT
4-Lane	900* VPH		9000* ADT
6-Lane or more	1200* VPH		12000* ADT
*Values shall be increased by 1/3 when arterial has traffic signal system coordination with signals located within 1000 feet in both directions from the emergency signal location.			

(2) When the geometric design of the arterial and emergency vehicle facility is such that the vehicle when returning must *back in*, and to do so must block traffic when performing this maneuver and the traffic volume and speeds are such that the use of emergency vehicle lights and flaggers have been ineffective in controlling traffic.

(3) When the location of the emergency vehicle driveway consistently conflicts with the normal traffic queue from an adjacent signalized intersection. The use of DO NOT BLOCK INTERSECTION (R10-7) sign should be considered in conjunction with the emergency signal installation.

(4) On all approaches when vertical or horizontal curvature or other obstructions do not provide adequate stopping sight distance for traffic approaching an emergency vehicle driveway.

3.4.4 CONFIGURATION AND OPERATION OF EMERGENCY TRAFFIC CONTROL SIGNALS

(1) ***Section 4G.03 of the MUTCD*** defines the operational requirements for a *mid-block* location of an emergency signal. The MUTCD allows either a steady green or flashing yellow operation of signal heads between emergency vehicle actuations. These choices of operation, combined with limited details for signal configuration requirements have resulted in a lack of uniformity of emergency signal design and operation within the State.

(2) Based on requirements contained in ***Chapter 4G.04 of the MUTCD***, the following criteria for emergency traffic control signals shall be followed for new or reconstructed installations.

(a) Dual indications shall be provided for each roadway approach. A minimum of one signal face shall be installed for the emergency vehicle driveway but two indications are preferable.

(b) If the emergency service is located off the main roadway and emergency vehicles access the main roadway via a public access street, emergency signals may be erected at the intersection of these roadways. If this practice is followed, dual indication shall be used on the public access street, with the signals resting on the flashing red indication.

(c) Mid-block emergency signals shall be operated as flashing yellow between emergency vehicle actuations. Roadway signal head configuration shall consist of three sections and shall be operated as shown in ***Figure 3.4-1***. (The use of special technological signal devices may be selected, i.e., strobe signals, LED, or solar power. These devices may require temporary permitting prior to installation.)

(d) Signal operation at intersections which are pre-empted by emergency vehicles entering the roadway near or at the intersection should be designed on an individual basis.

(3) It is not practical to outline all possible situations which may be encountered in the field. Such factors as emergency vehicle route distance between the

intersection and emergency vehicle driveway, intersection geometrics, number of lanes, normal queue length, traffic volumes, etc., should be considered.

3.4.5 EMERGENCY SIGNAL SIGN (R10-13)

(1) As emergency signals are installed at locations along major arterials where emergency vehicles enter the roadway, the EMERGENCY SIGNAL sign (R10-13), shall be placed on the span wire or mast arm to identify the purpose of the signal to the driver.

(2) The EMERGENCY SIGNAL sign (R10-13) shall always be legible, shall be mounted adjacent to each signal face, and shall be located between the dual signal indications on each roadway approach.

(3) No sign is required for the emergency vehicle driveway approach.

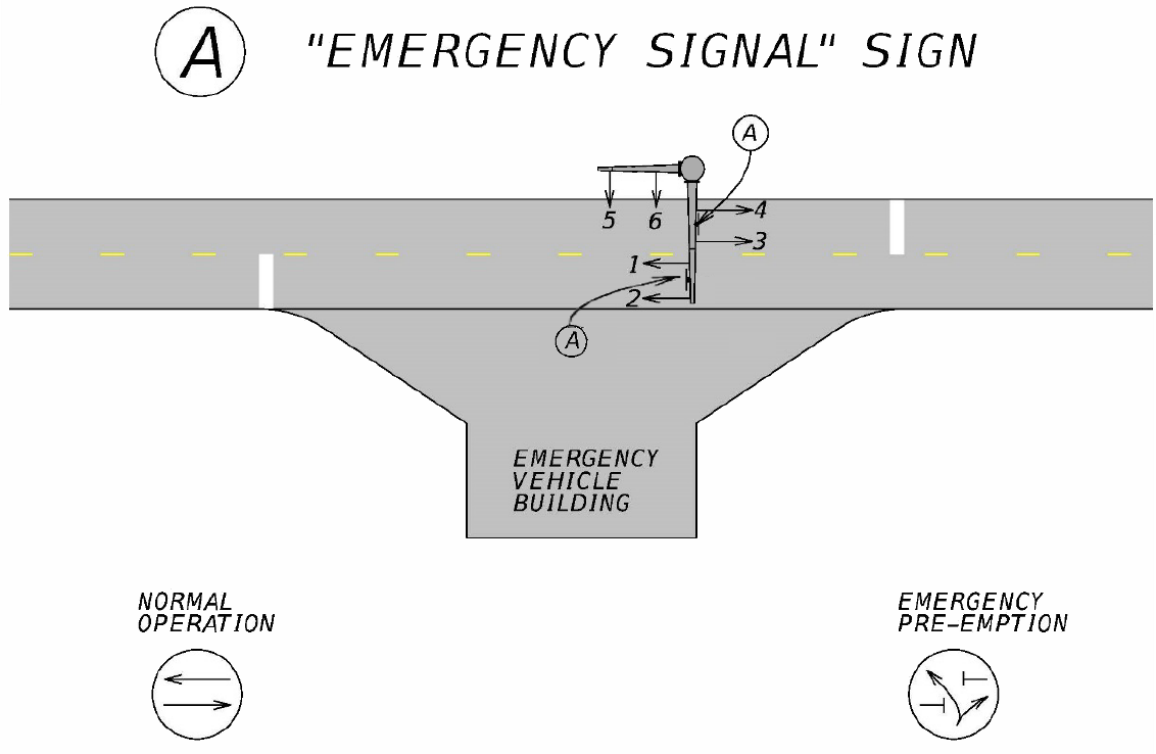
3.4.6 OTHER REQUIREMENTS

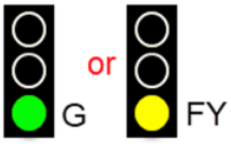
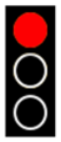
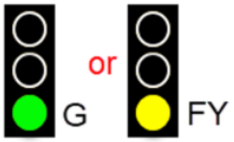
(1) A controller timing chart shall be a part of the contract plans.

(2) A Maintenance Agreement shall be required for all Emergency Signals on the State Highway System.

(3) A signal timing study is required to determine proper clearance intervals.

Figure 3.4-1. Mid-Block Emergency Signal Operation



NORMAL OPERATION	CHANGE TO EMERGENCY PREEMPTION	EMERGENCY PREEMPTION	CHANGE FROM EMERGENCY PREEMPTION	RELEASE
Signal 1,2,3,4 	Signal 1,2,3,4 	Signal 1,2,3,4 	Signal 1,2,3,4 	Signal 1,2,3,4 
Signal 5,6 	Signal 5,6 	Signal 5,6 	Signal 5,6 	Signal 5,6 

Section 3.5

TRAFFIC SIGNAL MAST ARM SUPPORT BOUNDARIES

3.5.1 GENERAL

The ***Department's Plans Preparation Manual, Topic No. 625-000-007, Volume 1 – Chapter 7*** requires that all traffic signals installed on the State Highway System that are within the Mast Arm Structures Boundary shall be supported by mast arms.

3.5.2 IMPLEMENTATION

3.5.2.1 Mast Arm Structures Boundary Maps

The mast arm structures boundary map follows an alignment of state roads that are parallel to an approximate ten mile distance to the coastline. Official mapping of this boundary is maintained on a Map Info-Base by the State Traffic Engineering and Operations Office. Current district maps are provided at this location: ***https://www.fdot.gov/traffic/trafficservices/pdfs/districts***.

Section 3.6

STANDARDIZATION OF YELLOW CHANGE AND RED CLEARANCE INTERVALS FOR SIGNALIZED INTERSECTIONS

3.6.1 PURPOSE

The purpose of the yellow change and red clearance intervals is to provide a safe transition between two conflicting traffic signal phases. The function of yellow change interval is to warn traffic of an impending change in the right-of-way assignment and the function of the red clearance interval is to provide additional time following the yellow change interval to clear the intersection before conflicting traffic is released. The Manual on Uniform Traffic Control Devices (***MUTCD***) states that a yellow change interval should have a minimum duration of 3 seconds and a maximum duration of 6 seconds and a red clearance interval should have duration not exceeding 6 seconds. The intent of this section is to provide a standard for uniform application of yellow and red intervals.

All new signal installations, intersections that have a Traffic Infraction Detectors installed, any signal that has signal phasing changes, geometric changes affecting the timing or phasing, or corridor re-timing projects must comply with these standards immediately upon implementing timing changes. All other existing signalized intersections on the State Highway System must be in compliance with standards of this section by June 30, 2015.

3.6.2 STANDARD

(1) ***Section 316.075(3)(a), F.S.*** states that no traffic control signal device shall be used which does not exhibit a yellow or "caution" light between the green or "go" signal and the red or "stop" signal. The Statute is silent on the yellow clearance interval duration and does not mention nor mandates the use of a red clearance interval.

(2) The Institute of Transportation Engineers (ITE) formula shall be used to calculate yellow change interval. Yellow change intervals shall not be lower than the values shown in Table 3.6-1 for a given posted speed limit (PSL) even if the ITE formula produces a lower value. Yellow change intervals calculated to be lower than 3.4 seconds shall be set at no less than 3.4 seconds. The yellow interval shall not exceed 6 seconds. Any yellow change intervals that are greater than the standard yellow change intervals presented in Table 3.6-1 of this section, for a given PSL, are allowed, but they shall be based on ***MUTCD's Section 4D.26***, engineering practice and the ITE formula. However, for a given PSL, the yellow change intervals shall not be less than the standard values presented in ***Table 3.6-1***.

(3) A Perception Reaction Time (PRT) of 1.4 seconds shall be used. Yellow change and red clearance interval times shall be rounded up to the nearest 0.1 second.

(4) Approach speed used in this section is the PSL for the approach being analyzed.

3.6.2.1 Yellow Change Interval

(1) Recent research has found that the 85th percentile PRT value was 1.33 seconds. Based on the research results, a PRT of 1.4 seconds shall be used.

(2) The Florida yellow change intervals shown in ***Table 3.6-1*** are computed using ***Formula 3.6-1*** (found in ITE's Traffic Engineering Handbook) with a PRT of 1.4 seconds and a grade of 0%. These intervals are the required standard minimum values.

Table 3.6-1. Florida Yellow Change Interval (0.0 % Grade) Standards*

APPROACH SPEED (MPH)	YELLOW INTERVAL (SECONDS)
25	3.4
30	3.7
35	4.0
40	4.4
45	4.8
50	5.1
55	5.5
60	5.9
65	6.0
* For approach grades other than 0%, use ITE Formula.	

Formula 3.6-1

$$Y = t + \frac{1.47v}{2(a + Gg)}$$

Where:

Y = length of yellow interval, sec.
t = perception-reaction time (use 1.4 sec.)
v = speed of approaching vehicles, in mph.
a = deceleration rate in response to the onset of a yellow indication (use 10 ft/sec2)

g = acceleration due to gravity (use 32.2 ft/sec2)
G = grade, with uphill positive and downhill negative (percent grade /100)

3.6.2.2 Red Clearance Interval

A red clearance interval must be used. Providing adequate red clearance intervals can significantly impact intersection safety by reducing the probability of occurrence of right angle crashes, even if drivers run the red signal indication. The red clearance interval shall be determined using engineering practices. The values are typically computed using ***Formula 3.6-2,*** found in ***ITE's Traffic Engineering Handbook***.

Formula 3.6-2

$$R = \frac{W + L}{1.47v}$$

Where:

R = length of red interval, sec.
W = width of the intersection, in feet, measured from the near-side stop line to the far edge of the conflicting traffic lane along the actual vehicle path.
L = Length of vehicle (Use 20 ft.)
v = speed of approaching vehicles, in mph.

The minimum red clearance interval shall be 2.0 seconds and the maximum red clearance interval should normally not exceed 6.0 seconds. Longer red intervals than the minimum 2.0 seconds can be used at the engineer's discretion where width of intersection, sight distance, complex intersections, crash history and any unique conditions exist that may warrant longer red times. The determination shall be based on engineering judgment. The National Cooperative Highway Research Program (NCHRP) Report 731 recommends using a modified ITE formula that allows for 1.0 second reduction due to reaction time delay from the conflicting movement. Therefore, a 1.0 second reduction may be made in the values computed from ***Formula 3.6-2*** and applying engineering judgment. However, the red clearance interval shall be no less than 2.0 seconds.

Section 3.7

ACCESSIBLE PEDESTRIAN SIGNALS

3.7.1 PURPOSE

To establish criteria for the installation and operation of accessible pedestrian signals on the State Highway System that provide information in non-visual formats, such as audible tones, speech messages, and/or vibrating surfaces.

3.7.2 GENERAL

Sections 4E.09 to 4E.13 of the MUTCD establish the standards for accessible pedestrian signals installed on public roadways. ***Section 4E.06 of the MUTCD*** also contains guidance for accessible pedestrian signal installations. The MUTCD must be reviewed and considered with accessible signal installation requests.

3.7.3 PROCEDURE

(1) Accessible pedestrian signals installed on the State Highway System shall be reviewed and approved by the District Traffic Operations Engineer (DTOE) prior to installation.

(2) Requests for accessible pedestrian signal installations received from the public, maintaining agencies, public agencies or support groups for people with visual impairments will be reviewed by the DTOE. The DTOE may request input from public agencies and organizations that support people with visual impairments to determine if accessible pedestrian signals would be effective and safe for users.

(3) An engineering study shall be conducted if the initial DTOE's review supports the installation of the accessible pedestrian signal. The engineering study should consider the needs of all pedestrians and not just those with visual impairments.

(4) The following criteria should be considered when reviewing requests for accessible pedestrian signals:

- **(a)** potential demand for accessible pedestrian signals
- **(b)** right on red movements
- **(c)** free-flow right turn movements
- **(d)** complexity of signal phasing
- **(e)** complexity of intersection geometry
- **(f)** traffic volumes during times when pedestrians might be present
- **(g)** audible tones or sounds that may cause confusion
- **(h)** verbal messages instead of tones or sounds
- **(i)** vibrotactile pedestrian devices

(j) pushbutton or passive pedestrian detectors

(k) sufficient automatic volume adjustment in response to ambient traffic sound level, 100dBa (decibels) maximum

(l) locations with more than four lanes and/or greater than 35 MPH posted speed limit shall be given additional considerations for geometrics, operations, and pedestrian safety

3.7.4 APPROVAL/DENIAL PROCESS

(1) The DTOE shall review all requests for accessible pedestrian signals received by the Department from an engineering study and/or local request before agreeing to approve the installation. The review should consider the needs of all pedestrians and not just those with visual impairments.

(2) The initial review may require site visits to view the field conditions. During the initial screening, all data shall be recorded and maintained. An attempt shall be made to relate all data and analysis to standards set forth in ***Sections 4E.09 to 4E.13 of the MUTCD***.

(3) If the initial review results in a decision not to install accessible pedestrian signals, the DTOE shall document the reasons and advise the requestor of the findings with a copy provided to the local government. Although local government concurrence is desirable, it is not a prerequisite for committing Department resources for an accessible pedestrian signal installation.

Section 3.8

MARKED PEDESTRIAN CROSSWALKS AT MIDBLOCK AND UNCONTROLLED APPROACH LOCATIONS

3.8.1 PURPOSE

To establish criteria for the consistent installation and operation of marked pedestrian crosswalks at midblock and unsignalized intersections on the State Highway System.

3.8.2 GENERAL

(1) Marked crosswalks and pedestrian treatments at uncontrolled approaches are intended to improve pedestrian connectivity and reduce instances of pedestrians crossing at random and unpredictable locations which can create confusion and add risk to themselves and other road users. Crosswalks may be used to facilitate pedestrian access and to concentrate pedestrian crossing activity to a safe and predictable location. Pedestrian crosswalks at uncontrolled approaches may be an appropriate tool where there is a documented pedestrian demand and the distance to the nearest controlled intersection crossing location would result in significant out-of-direction travel for pedestrians. In some locations having Context Classifications C2T, C4, C5 and C6 documented pedestrian demand is not required to install a pedestrian crosswalk.

(2) Marked crosswalks and pedestrian treatments that are well located and thoughtfully designed can serve as a mechanism for improving pedestrian connections, community walkability, and pedestrian safety. However, they are not suitable for all locations. Careful evaluation must be undertaken regarding expected levels of pedestrian crossing demand, safety characteristics of the crossing location, and design considerations for the crossing control type.

3.8.3 DEFINITIONS

(1) **Context Classification** – Description of the land use and transportation context where a roadway is found. Roadways are designed to match the characteristics and demands defined by the appropriate Context Classification. See ***FDOT Design Manual (FDM), Chapter 200*** for additional information.

(2) **In-Roadway Warning Lights** – Special types of highway traffic control devices installed in the roadway surface to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to slow down and/or come to a stop.

(3) **Marked Crosswalk** – Any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface which might be supplemented by contrasting pavement structure, style or color. Marked crosswalks serve to provide guidance, define and delineate crossing paths, define intersections, and designate a stopping location when motorists are required to stop in the absence of a stop line.

(4) **Midblock Crossing** – Any location proposed for a marked crosswalk (signalized or unsignalized) between intersections.

(5) **Passive Pedestrian Detection** – Automated pedestrian detection systems that can detect the presence and direction of pedestrians and activate the traffic control device without any required action by the pedestrian.

(6) **Pedestrian Attractor** – A residential, commercial, office, recreational, or other land use that is expected to be an end destination for pedestrian trips.

(7) **Pedestrian Generator** – A residential, commercial, office, recreational or any other land use that serves as the starting point for a pedestrian trip.

(8) **Pedestrian Hybrid Beacon (PHB)** – A special type of hybrid beacon used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk. It is also known as high-intensity activated crosswalk (HAWK).

(9) **Rectangular Rapid Flashing Beacon (RRFB)** – A traffic control device consisting of two rapidly and alternately flashing rectangular yellow indications having LED-array based pulsing light sources that function as a warning beacon.

(10) **Two-Stage Marked Crosswalk** – A marked crosswalk that is designed to allow pedestrians to cross each half of the roadway independently, using a median refuge island for pedestrians to wait before completing the crossing.

(11) **Uncontrolled Approach** – A portion of the roadway approaching a crosswalk without stop or signal control, including midblock and unsignalized intersections.

(12) **Unmarked Crosswalk** – The legal crossing area at an intersection connecting the lateral lines of the sidewalks on opposite sides of the roadway.

3.8.4 PROCEDURE

(1) Any marked crosswalk proposed for an uncontrolled approach on the State Highway System shall be reviewed and approved by the appropriate District Traffic Operations Engineer prior to installation.

(2) A request from a state agency or local government for a marked crosswalk on an uncontrolled approach shall be submitted to the appropriate District Traffic Operations Engineer. Non-governmental entities wishing to obtain

authorization for a crosswalk at an uncontrolled approach location should do so through the local government.

(3) If the District Traffic Operations Engineer's review of available information supports the installation of a marked crosswalk at an uncontrolled approach location based upon the criteria outlined in ***Section 3.8.5***, then the justification for the marked crosswalk must be documented.

(4) The criteria referenced in ***Section 3.8.5***, as documented in an engineering study, shall be met as a condition for approval of a proposed marked crosswalk at an uncontrolled location. The engineering study must include the following information:

(a) Field data to demonstrate the need for a marked crosswalk based upon minimum pedestrian volumes (except as described in ***Section 3.8.5(2)*** and availability of any alternative crossing locations that satisfy the criteria described in ***Section 3.8.5***.) The ***Department's Manual on Uniform Traffic Studies (MUTS)*** provides additional information on obtaining pedestrian group size and vehicle gap size field data for use in making assessments of opportunities for safe crossings at uncontrolled locations.

(b) Potential links between pedestrian generators and attractors. This information is required for establishing the proposed crossing location or to confirm existing pedestrian crossing patterns.

(c) All safety considerations as described in ***Section 3.8.5(5)*** with respect to stopping sight distances, illumination levels, and proximity to intersection conflict areas.

(d) The proposed crossing location and corresponding signing, marking, and signal treatments (if applicable). A schematic layout should be provided over aerial photography or survey to show locations of signs, markings, and other treatments in proximity to existing traffic control devices. Treatments are dependent upon the site context, vehicle operating speeds, roadway cross-section, pedestrian volumes, and other variables. Treatments may include consideration of traffic signals or other warning devices to support pedestrian visibility and driver yielding. Other treatments such as median refuge areas, curb extensions, raised crosswalks, and supplemental signing and markings may also be applicable at some locations to support reduced crossing distance and enhanced pedestrian safety. See ***Section 3.8.6*** and ***3.8.7*** for discussion of treatment options and guidance on treatment selection.

(e) Any pedestrian-vehicle crash history within the vicinity of the proposed crosswalk that has occurred based upon a minimum of three years of

data. Also, from field observation, document the number and nature of any pedestrian-vehicle conflicts.

(f) Transit stop activity data and the location of transit stops within the vicinity of the proposed crosswalk, as applicable.

(5) If the evaluation results in a decision not to install a requested marked crosswalk or other pedestrian treatment, the District Traffic Operations Engineer shall document the reasons and advise the requestor of the findings. Meeting the minimum criteria outlined in this section does not guarantee approval of a request.

(6) Prior to the approval of a marked pedestrian crossing or other treatment at an uncontrolled approach location, coordination is necessary between the appropriate District Traffic Operations Office and local agencies to determine and document responsibilities for maintenance of any proposed traffic control devices.

3.8.5 INSTALLATION CRITERIA AND CONSIDERATIONS

(1) Placement of marked crosswalks should be based upon an identified need and not used indiscriminately. Important factors that should be considered when evaluating the need for a marked crosswalk include:

(a) Proximity to significant generators and attractors

(b) Pedestrian demand

(c) Pedestrian-vehicle crash history

(d) Distance between crossing locations

(2) To be considered for a marked pedestrian crosswalk, an uncontrolled approach location shall meet all the criteria in ***Sections 3.8.5(3) and 3.8.5(4)***. See ***Section 3.8.5(3)*** for exceptions to the pedestrian volume criteria.

(3) Minimum Levels of Pedestrian Demand

(a) Any uncontrolled location under consideration for a marked crosswalk should exhibit (1) a well-defined spatial pattern of pedestrian generators, attractors, and flow (across a roadway) between them or (2) a well-defined pattern of existing pedestrian crossings. Generators and attractors should be identified over an aerial photograph to illustrate potential pedestrian routes in relation to any proposed marked crosswalk location.

(b) Sufficient demand should exist that meets or exceeds the thresholds for an average day. An average day is generally considered a non-holiday weekday without a special event, or weekend day including Saturday or Sunday. Data collection should be based upon pedestrian volumes observed crossing the roadway outside a crosswalk at or in the vicinity of

the proposed location, or at an adjacent (nearby) intersection. A bicyclist can be counted as a pedestrian if appropriate for the crossing.

The following minimum thresholds should be met when considering a new marked crosswalk at an uncontrolled approach:

- 20 or more pedestrians during a single hour (any four consecutive 15-minute periods) of an average day, or
- 18 or more pedestrians during each of any two hours of an average day, or
- 15 or more pedestrians during each of any three hours of an average day.

The following are exceptions to the minimum pedestrian volume demand criteria:

- Within a school zone there is no minimum pedestrian volume for a school crossing.
- For the following combinations of context class and vehicle speeds, a marked crosswalk may be installed without meeting the minimum pedestrian volume thresholds. Supplemental crossing treatments (See ***Section 3.8.7***) may still be applicable and should be evaluated as part of the engineering study.
    - The roadway falls within a C2T Rural Town Context Classification and the speed limit is 35 MPH or less.
    - The roadway falls within a C4 Urban General Context Classification zone and the speed limit is 35 MPH or less.
    - The roadway falls within a C5 Urban Center Context Classification zone and the speed limit is 35 MPH or less.
    - The roadway falls within a C6 Urban Core Context Classification.

Even when applying pedestrian volume criteria exceptions, a signed and sealed engineering study will still be required to document the crossing need, location, and proposed treatments.

(c) Shared Use Path Crossings

In order to promote the use of shared use paths and reduce the impacts roadway crossings can create for pedestrians and bicyclists, crossing

locations connecting a shared use path on each side of a roadway are not subject to minimum pedestrian volume criteria listed above.

Proposed locations where a trail or shared use path ends on one side of a roadway and a sidewalk or similar facility exists on the other side of the roadway must meet 50 percent of the minimum pedestrian volume threshold for installation. Such crosswalks are subject to removal if pedestrian volumes fall below half of this reduced threshold.

Care should be given to selecting the appropriate location and crossing treatments for shared use paths. The inside dimension for crosswalks on shared use paths need to be at least as wide as that for the shared use paths.

(4) Minimum Location Characteristics

(a) A minimum vehicular volume of 2,000 Average Daily Traffic (ADT) along the roadway segment.

(b) Minimum distance to nearest alternative crossing location is 300 feet per the ***FDOT Design Manual (FDM), Chapter 222 Pedestrian Facility***. An alternative pedestrian crossing location may be considered to be any controlled location with a STOP sign, traffic signal, or a grade-separated pedestrian bridge or tunnel that accommodates pedestrian movement across the subject roadway. A proposed crossing location that falls between 100 and 300 feet from an alternative existing crossing may be considered if more practical for pedestrian use; this justification must be documented in an engineering report.

(c) The proposed location must be outside the influence area of adjacent signalized intersections, including the limits of the auxiliary turn lanes. Where an adjacent intersection is signalized, the design must ensure that the ends of standing queues do not extend to the proposed marked crosswalk location.

(5) Safety Considerations

For any proposed marked crosswalk, the location should be conducive to providing a sufficient level of pedestrian safety. The following conditions should be satisfied for existing crosswalks or, if not, should be achieved in conjunction with any implementation of the proposed marked crosswalk:

(a) The location for a marked crosswalk must provide adequate stopping sight distance. The ***FDOT Design Manual (FDM), Chapter 222 Pedestrian Facility*** provides additional information for identifying appropriate stopping sight distance. Parking restrictions in the vicinity of the marked crosswalk may be necessary to meet required sight distance. Other optional treatments, including curb extensions, may also be considered for improving sight distance and reducing pedestrian crossing distance.

(b) If sidewalks connecting the crosswalk to established pedestrian generators and attractors are not already present, they should be provided. The ***FDOT Design Manual (FDM), Chapter 222 Pedestrian Facility*** provides additional sidewalk design considerations.

(c) Crosswalk illumination shall be provided at all newly constructed uncontrolled approach crosswalks in accordance with ***FDOT Design Manual (FDM), Chapter 231 Table 231.2.1***. However, there may be locations such as environmentally-sensitive areas or crosswalks serving facilities that are open only during daylight hours, where lighting may be omitted.

(d) At uncontrolled approach locations with vehicular volumes greater than 12,000 ADT or where crossing distances exceed 60 feet, a refuge island or raised median should be considered to facilitate a two-stage crossing. Provide documentation where physical constraints prevent the accommodation of a median refuge. Roadway and safety conditions shall be taken into consideration in identifying whether the location is appropriate for a marked crosswalk. Median refuge areas shall meet Americans with Disabilities Act (ADA) requirements and the ***Department's Standard Plans, Index No. 522-002***.

(e) Consideration should be given to the location of nearby bus stops when locating a proposed pedestrian crossing. Marked crosswalk placement should seek to minimize conflicts with transit vehicles. Bus stops on the far side of a marked crossing are preferred. If feasible, bus stops can be relocated to better align with a proposed pedestrian crossing.

3.8.6 SELECTION GUIDANCE FOR PEDESTRIAN TREATMENTS

(1) An engineering study should be performed before a marked crosswalk is installed at a location away from a traffic control signal or an approach controlled by a STOP or YIELD sign. The treatment to be provided at a particular location should be selected in consideration of pedestrian volumes and crossing difficulty:

(a) For high volume pedestrian crossings, traffic signal control may be appropriate provided that ***Signal Warrant 4 of the MUTCD*** is satisfied. Alternatively, a PHB may be utilized if the applicable ***MUTCD*** warrants are satisfied and requirements for a traffic signal are not met. For additional guidance on these control options see ***Section 3.8.6(3)***.

(b) For locations meeting the criteria under ***Section 3.8.5***, but do not have sufficient pedestrian volume to meet ***Signal Warrant 4 of the MUTCD*** or PHB volume requirements, other pedestrian-actuated warning device options are available including RRFB, flashing beacons, and in-roadway warning lights. Decisions about which additional treatment elements to include (if any) should be made with sound engineering judgment. For guidance on supplemental warning device options that are exempt from warrants, see ***Section 3.8.7(3)*** for details.

(c) ***Section 3.8.7(4)*** provides additional guidance regarding other crosswalk design treatments that could be considered to support pedestrian visibility and safety. Examples include supplemental signing, refuge islands, curb extensions, lighting, and raised crosswalks. Some treatments may be used in combination with implementation of a traffic control signal or other warning beacon devices.

(2) The charts shown in ***Figure 3.8-1*** and ***Figure 3.8-2*** were developed using information from ***Figure 4C-7***, ***Figure 4F-1,*** and ***Figure 4F-2 of the MUTCD***. The charts herein are intended for use as a quick-check guidance for selecting the appropriate pedestrian traffic control device for a particular set of hourly vehicular and pedestrian volumes for low and high-speed roadways.

(3) Selection Guidance for Warranted Signals

For a location with high pedestrian demand, signal control may be appropriate provided an ***MUTCD*** signal warrant is satisfied and a new pedestrian signal is compatible with the remaining signal system along the arterial. For a mid-block crossing within a coordinated signal system, if the ***Signal Warrant 4*** criteria is not met but PHB criteria is met, a PHB installation could be upgraded to a pedestrian traffic signal. Consideration should be given to cycle length, signal spacing, and available gaps to reduce pedestrian delay and promote signal compliance.

Figure 3.8-1. Guidelines for the Installation of Pedestrian Treatments on Low-Speed Roadways

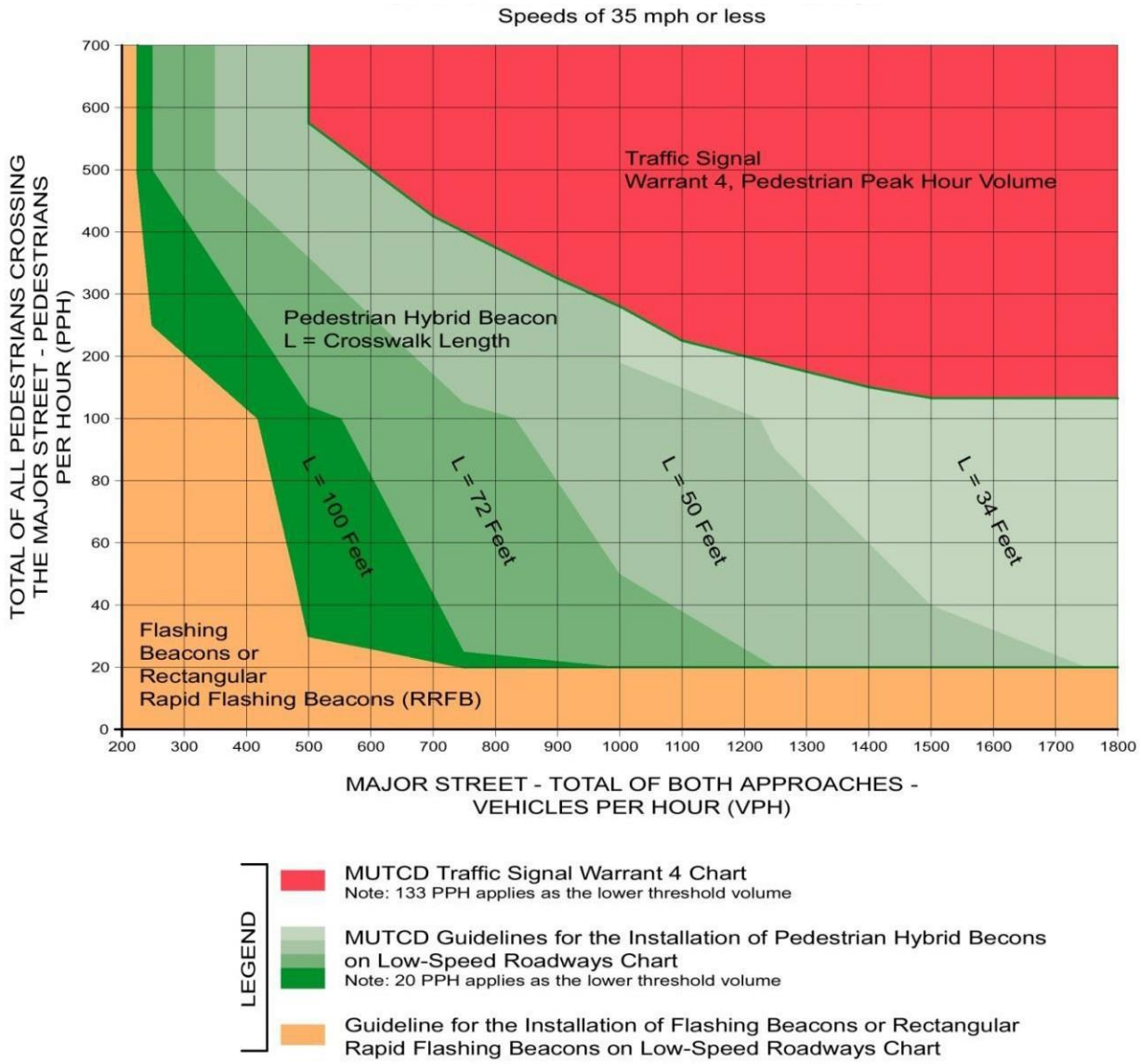
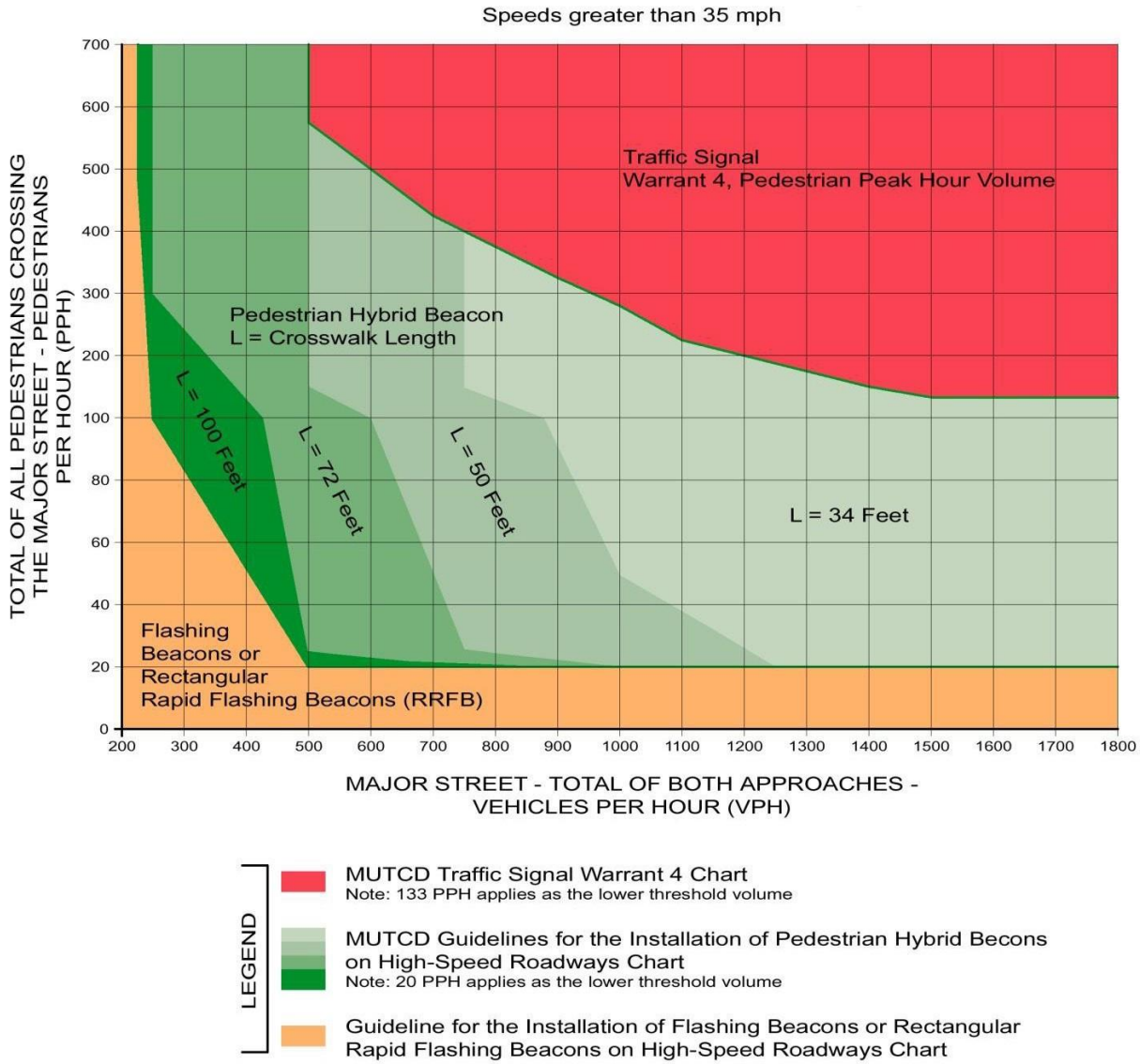


Figure 3.8-2. Guidelines for the Installation of Pedestrian Treatments on High-Speed Roadways



3.8.7 PEDESTRIAN CROSSING TREATMENTS

(1) The minimum requirement for a pedestrian crossing treatment is the following:

(a) Ten-foot wide minimum Special Emphasis Crosswalk markings shall be used for all marked crosswalks at uncontrolled approaches, as shown in the ***FDOT Design Manual (FDM), Chapter 230 Signing and Pavement Marking.*** The design of marked crosswalks at uncontrolled approaches should follow the ***FDOT Design Manual (FDM), Chapter 222 Pedestrian Facility***. The ***FDOT Design Manual (FDM)*** provides three possible configurations for a midblock crossing.

(2) Signal Treatments (Requiring Warrant Analysis)

(a) Traffic Control Signal

- When pedestrian volumes are of a sufficient level to meet the ***Signal Warrant 4 of the MUTCD***, a traffic control signal may be installed to serve this demand. Applicable pedestrian signal warrants and installation guidelines are identified in ***Section 4C.05 of the MUTCD***. For mid-block crosswalks that are greater than 300 feet from the nearest signalized intersection, considerations for a traffic control signal at a new location should include distance to adjacent signals and availability of adequate gaps for pedestrians to cross the roadway. In some cases, a pedestrian signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the roadway. The ***Department's Manual on Uniform Traffic Studies (MUTS)*** provides additional guidance on conducting Pedestrian Group Size and Vehicle Gap Size studies.

- Some locations experience challenges related to pedestrians with slower crossing speeds. In those cases, ***Chapter 4C.05 of the MUTCD*** allows the pedestrian volume crossing the major street to be reduced as much as 50 percent if the 15th percentile crossing speed is less than 3.5 feet per second.

- For locations where signalized control is selected for the pedestrian crossing, additional coordination for the crossing location is recommended with the District Access Management Review Committee and the District Traffic Operations Engineer.

- For six-lane divided roadways or crossing distances exceeding 80 feet, a two-stage pedestrian crossing with median refuge island should be considered where a warranted pedestrian signal will control the proposed crossing. A two-stage pedestrian crossing may have a lesser impact to vehicle delay (compared to a single crossing) since the signal serves each direction independently while the median serves as a refuge area for pedestrians to wait prior to completing their crossing.

- At locations where pedestrian compliance is of concern, feedback devices may be installed with the pedestrian signal button to provide pedestrians with confirmation of the call.

(b) Pedestrian Hybrid Beacon (aka HAWK)

- A possible alternative to the traffic signal is the Pedestrian Hybrid Beacon. ***Chapter 4F of the MUTCD*** provides volume guidance (this guidance is treated as warrants in Florida) on the use of Pedestrian Hybrid Beacons where pedestrian volumes do not meet the pedestrian warrants for a traffic signal under ***Section 4C.05 of the MUTCD***. This device is not intended for use at intersections or driveways, as ***MUTCD*** recommends maintaining a distance of 100 feet from side streets or driveways controlled by stop or yield signs. An example of the pedestrian hybrid beacon treatment is shown in ***Figure 3.8-3***.

- For six-lane roadways or crossing distances exceeding 80 feet, a two-stage pedestrian crossing with a median refuge island should be considered where a warranted pedestrian hybrid beacon will control the proposed marked crossing. A two-stage pedestrian crossing may have a lesser impact to vehicle delay (compared to a single crossing) since the beacon serves each direction independently while the median island serves as a refuge area for pedestrians to wait prior to completing their crossing.

- In an urban corridor, a location featuring a coordinated signal system and meeting the PHB warrants, a PHB installation could be upgraded to a pedestrian traffic signal. In such cases, consideration should be given to cycle length, signal spacing, and available gaps to reduce pedestrian delay and promote signal compliance.

Figure 3.8-3. Pedestrian Hybrid Beacons

(c) For locations where signal warrants are met, consideration may be given to providing a pedestrian bridge or tunnel in lieu of an at-grade marked crossing.

(3) Pedestrian-Actuated Warning Treatments (Not Requiring Warrant Analysis)

For locations where pedestrian traffic signals or PHBs are not warranted, alternative pedestrian- actuated warning devices presented in this section may be considered to provide additional emphasis of the marked crosswalk and the presence of pedestrians.
Additional treatments, not included in this section, may also be appropriate depending upon the individual site characteristics.

Each of the treatments presented in this section must be pedestrian actuated using approved detectors. This must include a pedestrian pushbutton with the option of adding a passive pedestrian detector to enhance the activation of the ped phase within the traffic control device cycle.

(a) Rectangular Rapid Flashing Beacons (RRFB)

- FHWA issued ***Interim Approval 21, Rectangular Rapid-Flashing Beacons at Crosswalks (IA-21)*** on March 20, 2018 which specifies the intended use and design requirements for RRFB devices. FDOT has received FHWA approval to install RRFBs on the State Highway System. Local agencies must receive FHWA approval to install RRFBs on their local roads.

- The rectangular beacons are provided in pairs below the PEDESTRIAN CROSSING warning sign (***W11-2***) and operate in a flash pattern in accordance with ***IA-21*** upon activation by the pedestrian. When used, the beacons must be pedestrian activated, using approved detectors (such as pushbuttons or passive detection devices) that meet ADA requirements for accessibility. An example of the rectangular rapid flashing beacon treatment is shown in ***Figure 3.8-4***. Detailed conditions of use, including sign/beacon assembly, dimensions and placement, and flashing rates are provided in ***IA-21***.

- ***Department's Standard Plans, Index No. 654-001*** provides design details for the installation of post mounted RRFBs.

- Use of RRFBs should be limited to roadways with four or fewer through lanes.

- Any new RRFB on a multilane undivided roadway should be installed overhead unless design constraints or engineering documentation preclude overhead installation. Overhead RRFBs improve visibility for approaching drivers and are consistent with the installation of overhead school zone warning signs on multilane roadways. Consideration should be given to installing advanced warning signs with RRFBs on multilane approaches, especially those with higher traffic volumes and speeds.

- When overhead RRFBs are used, they should be combined with ground mounted devices. Overhead RRFBs should feature an internally illuminated pedestrian crossing sign which is continuously lit at night.

Figure 3.8-4. Rectangular Rapid Flashing Beacons

(b) Flashing Yellow Warning Sign Beacons

- The use of flashing yellow warning beacons may provide additional emphasis of the crossing location by supplementing the appropriate marked crossing warning or regulatory signs where pedestrian signals are not warranted. These devices are still allowable in the ***MUTCD***, although newer devices such as RRFBs have increased in popularity. When used, beacons shall meet the requirements of ***Chapter 4L of the MUTCD***. Any flashing yellow warning beacons installed at a new crosswalk at an uncontrolled location must use pedestrian actuation, as to elicit a more effective response from motorists than continuously flashing beacons.

- Beacons may be configured either overhead or side mounted; however, the preferred configuration is a side, post-mounting to avoid drivers confusing the beacons for a flashing traffic signal.

- When post mounted, a configuration of two vertically aligned warning beacons is recommended. These beacons should be operated in an alternating flash pattern.

- When beacons are overhead mounted, an internally illuminated pedestrian crossing sign should be used in conjunction with the beacons. This sign should be continuously lit at night.

(c) In-Roadway Warning Lights

- ***Section 4N.02 of the MUTCD, In-Roadway Warning Lights at Crosswalks*** establishes federal standards by which lighted (illuminated) pedestrian crosswalk edge lines can be installed and operated. Additional guidance and support are provided in ***Section 4N.02 of the MUTCD*** which may be used for the installation and operation of lighted in-roadway pedestrian crosswalks. These additional provisions may be reviewed and considered on a lighted pedestrian walkway.

- In-roadway warning lights shall not be used where YIELD or STOP signs, or traffic signals are present.

- In-roadway warning lights may be installed in conjunction with overhead or LED roadside highlighted signs or Flashing Yellow Beacons as long as the flashing rates are identical and flash in unison. Engineering judgment should be exercised.

(4) Additional Treatment Options for Midblock and Uncontrolled Intersections

(a) STOP HERE FOR PEDESTRIANS sign ***(R1-5 series)***

- To provide additional emphasis of the requirement to stop for pedestrians in the marked crosswalk, a stop line and associated STOP HERE FOR PEDESTRIANS sign ***(R1-5 series)*** may be used. The R1-5 sign is not to be used in combination with the pedestrian traffic signal or the Pedestrian Hybrid Beacon.

- If used, the stop line should be placed 40 feet in advance of the marked crosswalk. See the ***FDOT Design Manual (FDM), Chapter 230 Signing and Pavement Marking***. Where a stop line is used, parking should be prohibited in the area between the stop line and the marked crosswalk. Use a solid lane line between the stop line and crosswalk.

- If a stop line is provided, the corresponding STOP HERE FOR PEDESTRIANS (R1-5 series) sign shall be provided. ***The FDOT Design Manual (FDM), Chapter 230 Signing and Pavement Marking*** illustrates the placement of these signs. ***Section 2B.11 of the MUTCD*** provides additional guidance on the placement of the R1-5 series sign.

- An ADVANCE PEDESTRIAN CROSSING warning sign ***(W11-2)*** with supplemental AHEAD plaque shall be used in combination with the R1-5 series sign. ***The FDOT Design Manual (FDM), Chapter 230 Signing and Pavement Marking*** shall be used for mounting locations of advance W11-2 signs as related to approach speeds.

(b) IN-STREET PEDESTRIAN CROSSING sign ***(R1-6 or R1-6a)***

- IN-STREET PEDESTRIAN CROSSING sign ***(R1-6 or R1-6a)*** may be used on low speed roadways to remind road users of laws regarding right-of-way at an unsignalized pedestrian crosswalk. An IN-STREET PEDESTRIAN CROSSING sign should not be placed in advance of a marked crosswalk to educate road users about the State law prior to reaching the marked crosswalk, nor should it be installed as an educational display along the highway that is not near any crosswalk. Additional information is provided in ***Section 2B.12 of the MUTCD***.

- If used, the IN-STREET PEDESTRIAN CROSSING signs shall be placed in the roadway at the marked crosswalk location on the center line, on a lane line, or on a median island. The IN-STREET PEDESTRIAN CROSSING sign shall not be post-mounted on the left-hand or right-hand side of the roadway.

(c) Other treatments

To improve visibility, support pedestrian travel and increase awareness the following treatments can be incorporated for pedestrian crossings. Further information on design criteria of these treatments can be found in the ***FDOT Design Manual (FDM), Chapter 222 Pedestrian Facility***.

- Pedestrian Refuge Islands or raised median
- Curb extensions
- Raised crosswalks
- Speed reduction treatments (See ***FDOT Design Manual (FDM), Chapter 202 Speed Management***)
- Overhead lighting (See ***FDOT Design Manual (FDM), Chapter 231 Lighting***)

Section 3.9

COUNTDOWN PEDESTRIAN SIGNAL APPLICATIONS

This section was rescinded on 11/1/17.

Section 3.10

FLASHING YELLOW ARROW SIGNAL APPLICATION

3.10.1 PURPOSE

To establish criteria for the installation and operation of left and right turn flashing yellow arrow (FYA) signals. Also, to provide guidelines and best practices for installation of FYA signals at new and existing intersections consistent with ***Section 4D.20 of the MUTCD***.

3.10.2 BACKGROUND

(1) For many years, some engineers have had concerns that drivers turning left on a permissive circular green signal indication might inadvertently mistake that indication as implying the left turn has the right of way over opposing traffic, especially under some geometric conditions.

(2) To date, research studies and guidelines have only been conducted for left turning FYA treatments. However, the use of right turn FYA treatments is permissible in accordance with the MUTCD and this section. Further guidance for right turn FYA treatments will be included upon research findings, implementation, and case studies.

(3) In 2003, National Cooperative Highway Research Program (NCHRP) completed research for the “Evaluation of Traffic Signal Displays for Protected/Permissive Left-Turn Control” and published the ***NCHRP Report 493***. The key findings of the research are as follows:

(a) The FYA was found to be a good overall alternative to the circular green as the permissive signal display for a left-turn movement.

(b) The FYA was found to have a high level of understanding and correct response by left-turn drivers, and a lower fail-critical rate than the circular green.

(c) The FYA display in a separate signal face for the left-turn movement offers more versatility in field application. It is capable of being operated in any of the various modes of left-turn operation by time of day, and is easily programmed to avoid the "yellow trap" associated with some permissive turns at the end of the circular green display.

(4) The FHWA crash modification factor (CMF) Clearinghouse is reporting a CMF of 0.857 for installation of left turn flashing yellow arrow signals and supplemental traffic signs.

3.10.3 OPERATIONAL REQUIREMENTS

In accordance with ***Section 4D.20 of the MUTCD***, the following design and operational requirements shall apply when 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.

(1) Mode(s) of Left-Turn Operation:

(a) The flashing YELLOW ARROW signal indication may be displayed to indicate a permissive left-turn movement in either a protected/permissive mode or a permissive only mode of operation.

(b) Varying the left-turn mode of operation from the permissive only and/or the protected/permissive and/or the protected only left-turns during different periods of the day is allowed when:

- The Critical Gap is calculated to be 7 seconds at minimum during non-peak hours. Refer to ***Section 8.3, Vehicular Critical Gap of the Manual on Uniform Traffic Studies***.
- The Left-turn volume routinely is less than 240 vehicles per hour on average or the product of opposing through and left-turn hourly volumes is less than 50,000 (one opposing through lane), or 100,000 (two opposing through lanes).
- There are no fatalities and less than three left turn crashes per year that are attributed to permissive left turning movements.

(2) **Signal Face Arrangement**: At least one separate four-section signal face, in addition to the minimum of two signal faces for other traffic on the approach, shall be provided for the left-turn movement. The separate left-turn signal face shall be capable of displaying, from top to bottom (or left to right in a horizontally-aligned face), the following set of signal indications: Steady left-turn RED ARROW, steady left-turn YELLOW ARROW, flashing left-turn YELLOW ARROW, and steady left-turn GREEN ARROW.

(3) **Signal Face Location**: Within an exclusive left-turn lane that has a left-turn signal face mounted over the roadway, that left-turn signal face should be centered over the left-turn lane or the extension thereof. If centering of the overhead left-turn signal face is not practical, it shall not be positioned any further to the right than the lane line (or the extension of the lane line) between the left-

turn lane and the adjacent through lane, nor shall it be positioned any further to the left than the left edge of the left-turn lane (or extension thereof.)

(4) Signal Displays: Signal head displays shall meet the following requirements:

(a) Must 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.

(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. The flashing left-turn YELLOW ARROW signal indication (i.e. permissive phase) may be omitted when the pedestrian phase is activated. This is a strategy to address either a documented conflict or history of left turn vehicles not yielding to pedestrians.

(f) A flashing left-turn YELLOW ARROW signal indication shall be permitted to display 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) Before the FYA begins, provide a start-up delay (2 seconds) for all opposing through movements to establish position in the intersection.

(h) When changing phase from permissive left-turn movement 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 signal indication and the display of the steady left-turn GREEN ARROW signal indication. See ***Section 3.10.4*** for further guidance.

(i) 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. Prior to the use of three section signal face, where space limits a four-section signal face, concurrence and approval from the District Traffic Operations Engineer will be required.

(j) 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.

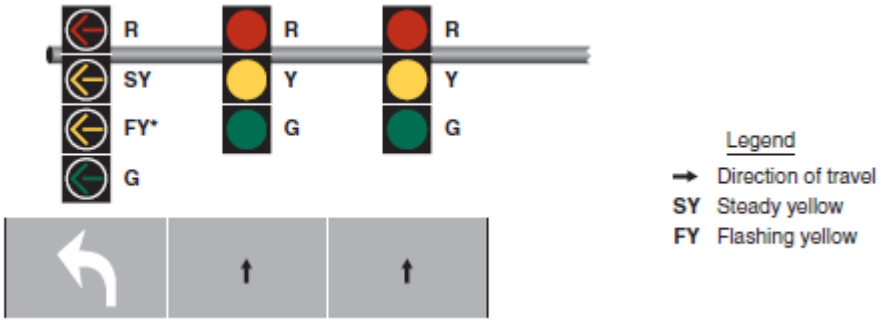
(k) During flashing mode operation (see ***Section 4D.30 of the MUTCD***), the display of a flashing left-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady left-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.

(5) **Yellow Trap**: FYA can be used to reduce the risk of a left turn yellow trap condition. Signal timing sequence must allow the permissive left-turn phase (FYA) to continue until the opposing traffic's through phase terminates, even if the adjacent through phase has already terminated. When implementing FYA designers and engineers should review all potential sequencing combinations, including when phases are skipped due to lack of demand and special patterns such as preemption, to determine if a yellow trap situation could occur. If there is a possibility of a yellow trap, modifications to sequencing and controller programming parameters should be incorporated into design as necessary to eliminate the yellow trap. Primary responsibility lies with the design engineer to include adequate information in design plans for others who may be establishing sequences and controller programming.

(6) The Four-Section Signal Protected-Permissive Left Turn Mode (***Figure 3.10-1***), is illustrated in ***Figure 4D-12 of the MUTCD***.

Figure 3.10-1. Four-Section Signal Protected-Permissive Left Turn Mode

A – Typical Position



B – Typical Arrangements

3.10.4 INSTALLATION GUIDE

(1) The FYA is an option for permissive/protected left turn phasing. However, as with protected/permissive operation in general, careful consideration is needed when deciding where to install the FYA.

(2) Prior to implementing FYA at signalized intersections, it is recommended that the Districts obtain concurrence from the Local Agencies and provide them with information on where the FYA(s) are being proposed.

(3) The following guidelines are provided to ensure statewide consistency during the installation of the FYA:

(a) Four-section FYA signal displays for new signal installations and candidate retrofit locations that meet the criteria below should be considered and prioritized based on the following:

- Corridors where changing to lead/lag rather than lead/lead left-turn phasing would improve progression.

- Locations where left-turn demand is low during off-peak periods and variable modes of left-turn phasing will improve safety and operations.

- Locations where crash patterns involve left-turning vehicles and could be attributed to driver misunderstanding of shared signal indications.

- Locations with frequent railroad or emergency vehicle preemption activations which result in higher risk of a left-turn trap condition.

- Locations undergoing signal upgrades.

(b) For new and retrofit FYA installation, the signal display for the left-turn movement should be centered over the corresponding exclusive left-turn lane.

(c) For locations with a high 65 years and older population or intersections located in a ***Safe Mobility for Life Coalition Priority County***, careful and comprehensive intersection operations and crash history evaluation shall be conducted prior to implementation.

(d) It is optional use of the supplemental LEFT TURN YIELD ON FLASHING YELLOW ARROW sign during the initial implementation of FYA across the state to educate motorists on FYA operations.

The ability to install the supplemental LEFT TURN YIELD ON FLASHING YELLOW ARROW sign depends on whether the structural loading capacity meets the minimum requirements to withstand the wind loading under the Department's established design event. Please see Section 3.10.4 (f) for further guidance on loading.

(e) FYA use for permissive-only, protected/permissive, permissive/prohibited phasing should consider time-of-day applications.

(f) Phasing out the existing 5-section head by adding a separate 4-section FYA indication for the left-turn lane and 3-section indication for the inside through-lane. The Department will follow the ***Traffic Operations Bulletin 01-12, Adding Signal Heads and/or Backplates to Existing Traffic Signals*** to address reduced wind load requirements to facilitate the installation of the FYA signals in the most expedient manner.

3.10.5 INSTALLATION CRITERIA

(1) Typically, isolated locations or sections of corridors with signalized intersections that have the following characteristics may be considered for installation of protected/permissive left turn operation FYA:

(a) Opposing left turn paths do not conflict.

(b) Existing intersection geometry and traffic operations characteristics facilitate the installation of the FYA including:

- Left turn crossing distance.
- Available sight distance must be greater than required site distance based on approach speeds and left turn lane offset conditions.
- Use when the approach has only one left turn bay.
- Use when there are two opposing through lanes. Three opposing through lanes may be considered on a case-by-case basis.

(c) There is already an existing protective/permissive operation in place and less than three left turn related collisions per year recorded over a three-year period susceptible to correction by protected-only phasing.

(d) Use the FYA when the left-turn volume is less than 240 vehicles per hour on average or the product of opposing through and left-turn hourly volumes is less than 50,000 (one opposing through lane), or 100,000 (two opposing through lanes).

(e) Signal coordination plans indicate operational improvement with the installation of FYA permissive-protected operation based on volume criteria and crash pattern during peak periods.

(2) While it is desirable to be consistent in the application of left turn treatment along a corridor for driver expectation, it may not be practical to install FYA left turn protected/permissive mode in a consistent manner along a corridor. For example, FYA left turn operation requires a separate left turn signal face. Signalized intersections along a corridor equipped with shared signal faces that would require installation of new signal poles with longer mast-arms may be cost prohibitive to convert to FYA left turn operation.

(3) There are existing implementations of FYA that have resulted in a mix of FYA and 5-section green ball protected/permissive operation. However, it would be appropriate to install the FYA at a new signalized intersection meeting the criteria for protected/permissive left turn mode operation on the corridor without

immediately modifying the other existing intersections along the corridor. Preferably, the intersection should not be within view of other intersections with the 5-section green ball.

(4) Consider using a FYA protected/permissive mode at a location that previously operated in protected mode only after careful study of the intersection. Do not remove protected-only left turn phasing if opposing sight distance is inadequate for permissive left turns, operating speed is too great, roadway geometry is complicated or there are too many opposing through lanes. For more information on sight distance refer to the ***Department's Design Manual - 212 Intersections***.

3.10.6 VARIABLE MODE OF OPERATION

(1) Variable mode operation, changing between protected only to protected/permissive mode, or between protected/permissive to permissive only operation by time of day is possible with the 4-section FYA signal face where an engineering study shows this type of operation will improve safety and operations. However, it is important to ensure that the traffic signal controller is capable of switching between modes in a manner such that the flashing yellow arrow indication and the opposing through movement indication terminate together.

(2) When switching between protected/permissive to permissive only, ensure that the controller is capable of reassigning the left turn detectors to call the associated through phases by time of day.

3.10.7 PUBLIC NOTIFICATION

Installation of a FYA left turn operation should be coordinated with the District Public Information Office. Consider providing press releases with specific details on when the public can expect to see the new indications. Press releases should be prepared and sent out (approximately two weeks or more in advance of conversion).

3.10.8 EDUCATION

(1) The Department has developed a FYA tip card (Figure 3.10-2) to inform and educate the public about this new traffic control device. The tip card was developed using human factors studies to help the public simply understand what to do when encountering a FYA on the roadway system. This FYA tip card can be used by the District staff for public outreach where these traffic control devices will be installed. To obtain electronic and/or print copies of the current version of the Flashing Yellow Arrow tip card, visit ***SafeMobilityFL.com***.

(2) Location-specific education with Portable Changeable Message Signs (PCMS). This should be done for a short duration prior to implementation and a longer

duration after implementation (ex. 1 week/6 weeks) to display the following alternating messages:

(a) Phase 1: NEW SIGNAL DISPLAY

(b) Phase 2: YIELD ON FLASHING ARROW

Figure 3.10-2. Flashing Yellow Arrow Tip Card

3.10.9 SIGNAL RETROFIT CHECKLIST

Before FYA signal is set up in the field, the following checklist can be used to examine the existing hardware conditions at the intersections. Full awareness of the existing hardware conditions can facilitate a smooth implementation of FYA PPLT.

(1) Check replacement head size/mounting. Sometimes, installation of four-section vertical signal head (to replace five-section doghouse) may need to raise wire spans.

(2) Check if the number of available cables is sufficient to enable FYA signals. A common installation of PPLT phasing using a green ball for the permissive interval makes use of the green through phase to illuminate the green ball. Due to the flashing indication, additional cabling may be necessary in order for the flashing display to be controlled by its own circuit.

(3) Check if the mast arm is long enough to center the FYA signal head over the exclusive left-turn lane.

(4) Check status of signal equipment. Before implementing FYA signals, the equipment to be used should be checked, e.g., a malfunctioned load switch or a bad load switch socket may lead to problems during the implementation of FYA.

(5) Confirm with signal equipment manufacturers about the applicability and programming method of the controller and management malfunction unit (MMU). Most leading signal equipment manufacturers have developed new models of controllers and MMUs that support FYA signal operations. Controllers must have the correct firmware to enable FYA operations.

(6) Check if cabinet modification is required. Controller manufacturers have not standardized on FYA operation. Cabinet modification will depend on controller make and model. An MMU capable of FYA operation is required. Install a new MMU recommended by the controller manufacturer. A modification to the cabinet flash programming is required. Contact the manufacturer representative.

(7) The MUTCD does not include a standard sign for FYA installation since it considers that FYA display is intuitively obvious in meaning to drivers and that an explanatory sign was unnecessary. However, the Department has designed a 36 x 30 inch white background and black lettering LEFT TURN SIGNAL – YIELD ON FLASHING ARROW (***FTP-85-13***) sign as shown in ***Figure 3.10-3***. The specific sign detail is shown in the ***Department's Standard Plans, Index 700-102*** and can be installed adjacent to the new head for additional clarification. If the FYA face is to be installed at an existing location with a 5-section face, verify the sign can be installed and ensure any conflicting signs such as the LEFT TURN YIELD ON GREEN (R10-12) sign is removed if in place.

Figure 3.10-3. Flashing Yellow Arrow Sign

Section 3.11

LEADING PEDESTRIAN INTERVAL SIGNAL APPLICATION

3.11.1 PURPOSE

To establish criteria for implementing leading pedestrian interval (LPI) signal applications at new and existing signalized intersections.

3.11.2 BACKGROUND

(1) LPI is a low-cost countermeasure for pedestrian and vehicular traffic control at signalized intersections. LPI is also known as “pedestrian head start” or “delayed vehicle green” that gives pedestrians an advance “Walk” signal indication before a concurrent green signal is provided to vehicles. This will allow pedestrians to establish a presence in the crosswalk, thereby increasing the visibility of pedestrians to drivers and potentially reducing conflicts with turning vehicles.

(2) LPI has been recommended as a countermeasure to reduce pedestrian–vehicle crashes at signalized intersections. Research has shown a 59% reduction in pedestrian–vehicle crashes at treated intersections.

3.11.3 LPI IMPLEMENTATION

(1) LPI signal applications shall comply with ***Section 4E.06 of the MUTCD***.

(2) The following criteria shall be used for LPI signal applications on the State Highway System:

(a) LPI signal application is allowed in the following FDOT Context Classifications, in accordance with ***FDOT Design Manual (FDM), Chapter 200, Context Classifications, Table 200.4.1*** without the need for a traffic engineering study:

- C4- General Urban
- C5- Urban Center
- C6- Urban Core

(b) An engineering study shall be required for LPI signal application in the following FDOT Context Classifications:

- C1- Natural
- C2- Rural
- C2T- Rural Town
- C3R – Suburban Residential
- C3C – Suburban Commercial

(3) When required, the engineering study shall include the following conditions:

(a) Failure to Yield Study: A vehicular yielding compliance condition is intended for applications at an approach to a signalized intersection where vehicular compliance yielding-to-pedestrian is the principal reason to consider LPI.

(4) LPI timing should allow pedestrians to clear the width of one lane in the direction of moving traffic, including the width of a parking and/or bicycle lane, to increase the visibility of pedestrians to turning traffic. A minimum of 3-second LPI duration is required by the ***MUTCD***. The ***Formula 3.11.3-1*** may be used to design LPI duration:

Formula 3.11.3-1

LPI= ML/W

Where:

LPI = number of seconds (rounded value) between onset of "Walk" signal for pedestrians and green indication for vehicles

ML = distance on crosswalk to clear width of one through lane from the edge of curb, in feet. (Should consider distance for large corner radius as per ***Section 4E.06.22 of the MUTCD***)

W = walking speed (3.5 ft/s for pedestrian clearance calculation suggested by the ***MUTCD***, or 3.0 ft/s)

3.11.4 CONSIDERATIONS

(1) An electronic blank-out "NO TURN ON RED" sign should be considered to enhance LPI implementation.

(2) Extended LPI should be considered at approaches with large portions of users with slower crossing speeds (children, older adults, persons with physical disabilities), or at approaches where the pedestrian detector location is not immediately adjacent to the curb (or, if no pedestrian detector is present, a location 6-feet from the face of the curb or from the edge of the pavement may be considered for calculating extended LPI).

(3) The use of an Accessible Pedestrian Signal (APS) (***Sections 4E.09–4E.13 of the MUTCD***) should be considered if an LPI is used, as vision-impaired pedestrians use the sound of moving traffic to start crossing.

(4) Education about LPI operation should be considered—for example, using a different background color (other than white) for a pushbutton sign plate with a short message such as “Ped Head Start” for crosswalks with the LPI feature.

(5) Conducting field observations and safety improvement evaluations after LPI implementation should be considered, and potential further adjustments in signal timing and coordination could be applied based on engineering judgment.

(6) Lengthy traffic signal cycles should be avoided to reduce pedestrian wait time and increase pedestrian compliance behavior with pedestrian signals.