Guidelines for Implementing Pedestrian Hybrid Beacons (PHB)

PURPOSE

These Guidelines for Implementing Pedestrian Hybrid Beacons (PHB) provide direction for considering installation of PHBs on the California State Highway System.

The guidance is specifically prepared for use by Caltrans and is also available for local agencies and tribal governments. Its purpose is to assist engineers and planners when evaluating design options and determining suitable locations for PHBs on the State Highway System. This guidance should be used with engineering judgement and is not a substitution for engineering judgement. No warranty is made regarding the results of this guidance or that this guidance will accurately and reliably test construction designs for compliance with any Federal, State or industry standards, or that this guidance will predict or test the safety or other feature or a structure.

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Guidelines for Implementing Pedestrian Hybrid Beacons (PHB)

INTRODUCTION

PHBs aim to improve the safety of pedestrians and other road users. PHBs address the Strategic Highway Safety Plan (SHSP) Pedestrian Safety Challenge Area and supports the Director's Policy for Road Safety (DP-36) including its' commitment to reducing fatal and serious injuries in California. Additionally, PHBs support the multi-modal vision in the Director's Policy for Complete Streets (DP-37).

PHBs are one of the Proven Safety Countermeasures (PSCs) as determined and promoted by the Federal Highway Administration (FHWA) – the costs and safety benefits of which are described below.

Guidelines for Implementing Pedestrian Hybrid Beacons (PHB)

WHAT IS A PEDESTRIAN HYBRID BEACON (PHB)?

A PHB, formerly also known as a High-Intensity Activated Crosswalk (HAWK), is a traffic control device that separates the crossing movement of the pedestrians and other road users such as skateboarders and wheelchair users from the vehicular through traffic movement. In doing so, it prioritizes the movement of pedestrians and other road users over vehicular traffic. These crossings commonly take place at midblock locations, or at uncontrolled intersections. The PHB differs from a traffic signal in that at a PHB the vehicular signal heads remain dark (unlit) unless a pedestrian and other road user activates a "call" button. After activation, the PHB and pedestrian indications will progress through a timed sequence of flashing and solid yellow and red lights for the motor vehicle lanes to prompt vehicles to stop before a "walk" indication is displayed for pedestrians and other road users.

The PHB's intended function is to minimize interruptions in traffic flow because it is activated only when pedestrians and/or other road users need to cross the roadway and lets motorists go forward once the pedestrian and/or the other road user has cleared their side of the travel lane(s), thus reducing vehicular delay. Implementing a PHB at an intersection requires use of the Intersection Safety and Operational Assessment Process (ISOAP) used to evaluate forms of traffic control to determine the most appropriate treatment.

Figure 1: PHB Photo
Source: FHWA
https://highways.dot.gov/safety/proven-safety-countermeasures/pedestrian-hybrid-beacons

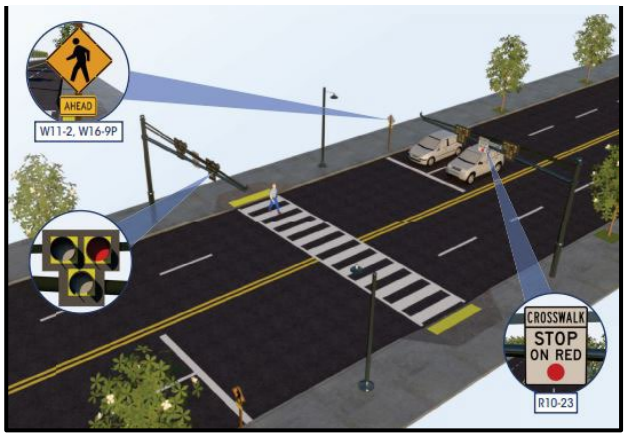


Figure 2: Example PHB Layout
Source: FHWA
https://safety.fhwa.dot.gov/ped_bike/step/resources/docs/fhwasa18064.pdf

CALIFORNIA MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (CA MUTCD)

The CA MUTCD (see Reference 2) is published by Caltrans to provide uniform standards for official traffic control devices under Section 21400 of the California Vehicle Code and Title 23, Code of Federal Regulations, Part 655, Subpart F. The CA MUTCD shall be referenced for design and operational guidance. Please refer to the CA MUTCD section on PHBs for details on usage and installation applications for PHBs.

PHB OPERATION OVERVIEW

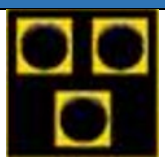
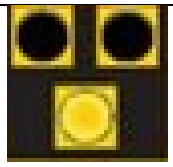
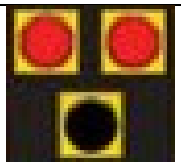
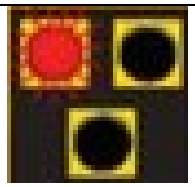
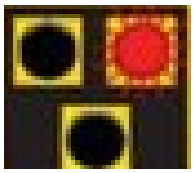
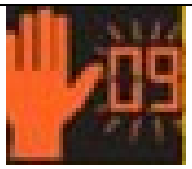
Where to use them: PHBs are used at marked crosswalks at uncontrolled intersections or midblock crossing locations, at marked crosswalks at multi-lane roundabouts, and at marked crosswalks at intersections with free right turns or freeway ramps with free right turns.

Refer to CA MUTCD Chapter 4F for information on the application, design, and operation of PHBs.

How they work: Figure 3 presents an overview of the operational sequence for a PHB.

Guidelines for Implementing Pedestrian Hybrid Beacons (PHB)

Pedestrian Hybrid Beacon Operation

	Drivers		Pedestrians	
	Will see…	Will Do…	Will See…	Will Do…
1		Proceed with caution.		Push the button to activate the system.
2		Proceed with caution. A pedestrian has activated the system.		Wait.
3		Stop if safe to do so.		Continue to wait
4		STOP. Pedestrian is in the crosswalk.		Start crossing when all vehicles are stopped.
5	 **FLASHING** 	STOP. Proceed with caution if the crosswalk is clear.		Continue crossing; the signal will count down.

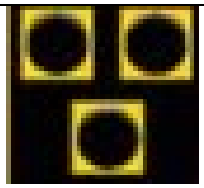
6		Proceed if the crosswalk is clear.		Push the button to activate the system.

Figure 3: PHB Operation
Source: Modified, based on State of Wisconsin Department of Transportation
https://wisconsindot.gov/Pages/safety/safety-eng/ped-beacon.aspx
(Note: This figure is similar to Figure 4F-3 in the CA MUTCD, however, this figure also shows what pedestrians see and do in addition to the drivers. Reflective backplates shall not be used on PHBs.)

Guidelines for Implementing Pedestrian Hybrid Beacons (PHB)

A PHB system is a traffic control device and not a traffic signal. The following describes the operations and actions of a PHB:

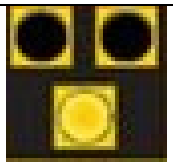
1. The PHB signal heads are DARK for the vehicular traveled way until activated by pedestrians and other road users, meaning right-of-way is assigned to vehicles. Pedestrians and other road users approaching the crosswalk receive a steady DON'T WALK indication.

	Drivers		Pedestrians	
	Will see…	Will Do…	Will See…	Will Do…
1		Proceed with caution.		Push the button to activate the system.

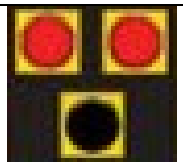
2. When pedestrians and other road users activate the beacon, motorists will see a FLASHING YELLOW indication for a set amount of time, signaling that the beacon has been activated. Pedestrians and other road users will continue to receive a DON'T WALK indication. This will provide warning to approaching motorists about the presence of pedestrians and other road users while allowing vehicles to continue traveling safely through the location without risking sudden stops and rear-end crashes.

2		Proceed with caution. A pedestrian has activated the system.		Wait.

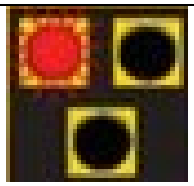
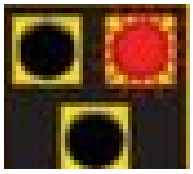
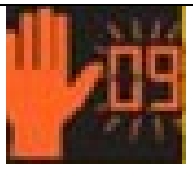
3. The FLASHING YELLOW is followed by a SOLID YELLOW indication for motorists that communicates a pending SOLID RED indication. Pedestrians and other road users will continue to receive a DON'T WALK indication. This will provide warning to motorists approaching the location about the ensuing red signal and the need to come to a safe stop. The duration of the FLASHING YELLOW and SOLID YELLOW are typically equal and dependent on the speed of traffic per the CA MUTCD.

3		Stop if safe to do so.		Continue to wait

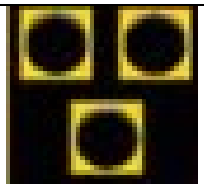
4. The SOLID YELLOW is followed by double SOLID RED indications for motorists. Pedestrians and other road users receive a WALK indication typically 5 to 7 seconds in duration. The double solid red emphasizes the activation of the PHB, requiring motorists to stop before pedestrians cross the roadway.

4		STOP. Pedestrian is in the crosswalk.		Start crossing when all vehicles are stopped.

5. The double SOLID RED is followed by alternating FLASHING RED indications (the last configuration in the sequence). Motorists are required to STOP, or remain stopped, and move forward subject to the rules applicable after making a stop at a stop sign (see Reference 3). Pedestrians and other road users already in the crosswalk continue crossing and will receive a numerical indication counting down the time remaining to finish crossing the roadway. Newly approaching pedestrians and other road users will see a DON'T WALK indication.

5	 **FLASHING** 	STOP. Proceed with caution if the crosswalk is clear.		Continue crossing; the signal will count down.

6. The PHB heads then go DARK again until activated by another pedestrian and other road user. Motorists may move forward through the crosswalk if it is clear. Pedestrians and other road users receive a steady DON'T WALK indication.

6		Proceed if the crosswalk is clear.		Push the button to activate the system.

The Intersection Safety and Operational Assessment Process (ISOAP) Guide has provided a video on the operation of a PHB provided here for your additional reference.

COSTS AND SAFETY BENEFITS

The physical construction and features for a PHB are similar to a traffic signal, such as having poles with mast arms, lighting, APS and advance vehicle detection. The cost of PHB projects varies widely, from about $300,000 to $1.5 million, depending on the amount of pavement work, utility work, or median reconstruction required.

PHBs have been shown to reduce pedestrian-vehicle crashes at marked and uncontrolled pedestrian crossings by about 55%, total crashes by up to 29%, and fatal and serious injury crashes by up to 15% (see Reference 4).

Pedestrians and other road users may benefit from additional measures to help cross roadways with high traffic volumes, multiple lanes, and high vehicle speeds. However, not all locations meet traffic signalization warrants, which require certain pedestrian and vehicular volume thresholds. PHB use may be considered as a measure to address such locations (ref. CA MUTCD Section 4F.01 Application of Pedestrian Hybrid Beacons).

CALTRANS IMPLEMENTATION GUIDANCE

Caltrans can implement PHBs as a countermeasure at locations, based on engineering studies and judgement. Please refer to the table below to determine when a PHB should be used in comparison to other countermeasures.

Guidelines for Implementing Pedestrian Hybrid Beacons (PHB)

TABLE 1. Application of pedestrian crash countermeasures by roadway features

Roadway Configuration	Posted Speed Limit and AADT																	
	Vehicle AADT < 9,000						Vehicle AADT < 9,000 - 15,000						Vehicle AADT > 15,000					
	≤ 30 mph			35 mph			≥ 40 mph			≤ 30 mph			35 mph			≥ 40 mph		
2 lanes	❶	2		❶			①			❶			❶			①		
(lane in each direction)	4	5	6		5	6		5	6	4	5	6		5	6		5	6
				7		9	❼		❾				7		9	❼		❾
3 lanes with raised median	❶	2	3	❶		❸	①		❸	①		3	①		❸	①		❸
(lane in each direction)	4	5			5			5		4	5			5			5	
				7		9	❼		❾	7		9	❼		❾	❼		❾
3 lanes w/o raised median	❶	2	3	❶		❸	①		❸	①		3	①		❸	①		❸
(1 lane in each direction with a two-way left turn lane)	4	5	6		5	6		5	6	4	5	6		5	6		5	6
	7		9	7		9			❾	7		9	❼		❾			❾
4+ lanes with raised median	❶		❸	❶		❸	①		❸	①		❸	①		❸	①		❸
(2 or more lanes in each direction)		5			5			5			5			5			5	
	7	8	9	7	8	9		8	❾	7	8	9	❼	8	❾		8	❾
4+ lanes w/o raised median	❶		❸	①		❸	①		❸	①		❸	①		❸	①		❸
(2 or more lanes in each direction)		5	6		5	❻		5	❻		5	❻		5	❻		5	❻
	7	8	9	7	8	9		8	❾	7	8	9	❼	8	❾		8	❾

Given the set of conditions in a cell

\# Signifies that the countermeasure is a candidate treatment at a market uncontrolled crossing location.

● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgement at a marked uncontrolled crossing location.

○ Signifies that crosswalk visibility enhancements should always occur in conjuction with other identified countermeasures. *

1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs

2 Raised crosswalk

3 Advance Yield Here To (Stop Here For) Pedestrian sign and yield (stop) line

4 In-Street Pedestrian Crossing sign

5 Curb extension

6 Pedestrian refuge island

7 Rectangular Rapid-Flashing Beacon (RRFB) **

8 Road Diet

9 Pedestrian Hybrid Beacon (PHB)**

**Refer to Chapter 4, 'Using Table 1 and Table 2 to Select Countermeasures,' for more information about using multiple countermeasures.*

***It should be noted that the PHB and RRFB are not both installed at the same crossing location.*

This table was developed using information from: Zegeer, C.V., J.R. Stewart, H.H. Huang, P.A. Lagerwey, J. Feaganes, and B.J. Campbell. (2005). Safety effects of marked versus unmarked crosswalks at uncontrolled locations: Final report and recommended guidelines. FHWA, No. FHWA-HRT-04-100, Washington, D.C.; FHWA. Manual on Uniform Traffic Control Devices, 2009 Edition. (revised 2012). Chapter 4F, Pedestrian Hybrid Beacons. FHWA, Washington, D.C.; FHWA. Crash Modification Factors (CMF) Clearinghouse. http://www.cmfclearinghouse.org/; FHWA. Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE). http://www.pedbikesafe.org/PEDSAFE/; Zegeer, C., R. Srinivasan, B. Lan, D. Carter, S. Smith, C. Sundstrom, N.J. Thirsk, J. Zegeer, C. Lyon, E. Ferguson, and R. Van Houten. (2017). NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. Transportation Research Board, Washington, D.C.; Thomas, Thirsk, and Zegeer. (2016). NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways. Transportation Research Board, Washington, D.C.; and personal interviews with selected pedestrian safety practitioners.

Vehicular, Pedestrian and Other Road User Volumes, and Speeds

Pedestrian and other road user volumes as well as vehicle volumes should be analyzed when considering a PHB. Location specific conditions, such as moderate vehicular volumes and high volumes of pedestrians and other road users or high vehicular volumes and moderate volumes of pedestrians and other road users, should be evaluated to assess appropriateness of a PHB. Also, AM, midday, and PM peak hour travel patterns should be evaluated separately to evaluate high levels of pedestrian and other road user activity during specific hours of the day. If there is a planned development expected as a major high pedestrian and other road user traffic generator, the engineering study needs to consider forecast volumes.

For guidelines for the installation of PHBs on low-speed roadways (35 mph or less) and on high-speed roadways (over 35 mph), refer to Figures 4F-1 and 4F-2 of the CA MUTCD. The determination whether the roadway is low-speed or high-speed is based on either the posted speed, statutory speed limit, or 85th-percentile speed. Pedestrians and other road users could be included in the pedestrian volumes for the warrants.

PHBs are most cost-effective for locations with multilane approaches and higher speeds. FHWA provides the following chart for guidance on the installation of PHBs (see Reference 6) based on vehicle volume, speed limit, and roadway configuration. The guidance may be used for one-way roadways, including freeway ramps. The guidance also addresses use of RRFBs in less complex and/or slower speed highway settings with fewer expected pedestrian crossings. The following chart shows methods of identifying potential crosswalk improvements.

Collision History

A review of at least 3 years and up to 5 years of collision data for correctable severe injury and fatal crashes can help prioritize implementation of PHBs. The information from conflict analysis (see Reference 7) can also be used to supplement crash data. The purpose of conflict analysis is to determine severity of different conflicts between motorized vehicles and pedestrians and other road users. Collision history helps measure, based on engineering judgment, the operational history of an intersection; repeated collisions between pedestrians/bicyclists and vehicles may justify installation of a PHB.

Guidelines for Implementing Pedestrian Hybrid Beacons (PHB)

PHB DESIGNS

The PHB shares several design features with traffic signals, such as poles with mast arms, APS, vehicle and pedestrian detection, and lighting. When PHBs are installed at intersections, the minor legs have no vehicular signal heads, and the drivers on the minor legs cannot directly observe what phase the PHB is operating other than by observing the pedestrian indications and actions of other drivers. Based on engineering judgment, PHBs installed at intersections should be designed to allow reconfiguration into a traffic signal without major reconstruction.

- **Beacon heads:** At least two beacon heads are required per approach. Multilane approaches shall have one beacon head mounted over the center of each through lane on the far side of the crosswalk stop line for both directions.

- **Accessible pedestrian signals:** Accessible pedestrian signals (APS) shall be installed for activation of the beacon heads along with countdown pedestrian signal heads.

- **Lighting:** Luminaires should be installed to enhance visibility of pedestrians in marked crosswalks.

- **Crosswalk markings:** Marked crosswalks should have high-visibility pavement delineation and signing. The continental pattern is preferred for new crosswalk installations. The ladder crosswalk pattern can be used where existing transverse crosswalk markings are in place.

- **Advance detection**: Advance vehicular detection should be included as part of the system to ensure adequate response time for motorists to stop before the crossing.

- **Controller and battery backup:** A PHB installed on a corridor with signalized intersections should use a 2070 controller and communications to a central system. A battery backup system should be included with all PHBs.

- **Medians:** Raised medians with a pedestrian refuge area should be considered where allowed by the median width. Pedestrian activation buttons are required in pedestrian refuge areas.

- **Intersection visibility:** Parking should be prohibited before the marked crosswalks, for at least 20 feet or greater for visibility of pedestrians entering the crosswalk. Also consider any potential visibility obstruction caused by buses upstream of crosswalks. Curb extensions should be considered to increase visibility to pedestrians and shorten crossing distances.

- **PHB and signal spacing:** PHBs should not be placed closer than 300 feet from adjacent signalized intersections. PHBs should be interconnected to traffic signals closer than 1000 feet.

- **Other factors:** Other factors to be considered when implementing PHBs include sight distance and visibility, and presence of school zones, as well as community input and concurrence.

A Standard Plan, standard specifications and guidance for design and operation of Pedestrian Hybrid Beacons is in development.

PUBLIC INFORMATION OUTREACH UPON IMPLEMENTATION

Public outreach to educate road users and law enforcement on the operation of the PHB is recommended in areas where the first PHB is being introduced. Pedestrians, bicyclists, and motorists should understand the sequences in PHB operation and how it applies to their movement. Sample educational videos are on Caltrans's Proven Safety Countermeasures web page (see Reference 8).

MAINTENANCE AGREEMENT

An electrical maintenance agreement should be executed with the local agency for the maintenance and operations of PHBs similar to traffic signals. The typical cost-sharing distribution is 50%/50%.

REFERENCES

1. Zegeer et al. NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. TRB, 2017.

2. California Department of Transportation, California Manual of Uniform Traffic Control Devices, Revision 8 (CA MUTCD), https://dot.ca.gov/programs/safety-programs/camutcd 2024.
3. California Vehicle Code, Division 11, Chapter 2, Article 3, Section 21257, https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=VEH&sectionNum=21457.
4. Federal Highway Administration (FHWA), Pedestrian Hybrid Beacons, https://safety.fhwa.dot.gov/provencountermeasures/ped_hybrid_beacon.cfm.
5. Federal Highway Administration (FHWA), Synthesis of Methods for Estimating Pedestrian and Bicyclist Exposure to Risk at Areawide Levels and on Specific Transportation Facilities, January 2017.
6. Federal Highway Administration (FHWA), Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossing Locations, 2018.
7. Federal Highway Administration (FHWA), Traffic Conflict Techniques for Safety and Operations: Observers Manual, Report No. FHWA-IP-88-027, January 1989.
8. California Department of Transportation, Proven Safety Countermeasures Web Page: https://dot.ca.gov/programs/safety-programs/proven-safety-countermeasures.