



2009 MUTCD PART 4 – HIGHWAY TRAFFIC SIGNALS



SCOPE

**Application, Design, Operations,
Maintenance, etc.:**

- **Typical Traffic Control Signals**
- **Pedestrian**
- **Hybrid Beacons**
- **Emergency Vehicle**
- **One-Lane/Two-Way Facilities, Freeway Entrance Ramps, and Movable Bridges**
- **Toll Plazas**
- **Flashing Beacons**
- **Lane-Use Control**
- **In-Roadway Lights**

SOME CONTENT (1 of 3)

- Signal and Signal Indication Use, Applications, Placement, Size, Meaning, etc.
- Installation/Removal
- Nine Signal Justification Warrants
- Provision for Pedestrians
- Operation & Maintenance
- Indications (Meaning, Design, Illumination, Color, Shape, Size, Position, Number, etc.)

SIGNAL WARRANTS*

- Warrant 1: Eight-Hour Vehicular Volume
- Warrant 2: Four-Hour Vehicular Volume
- Warrant 3: Peak Hour
- Warrant 4: Pedestrian Volume
- Warrant 5: School Crossing
- Warrant 6: Coordinated Signal System
- Warrant 7: Crash Experience
- Warrant 8: Roadway Network
- Warrant 9: Intersection Near a Grade Crossing

Satisfaction of One or More Warrants Shall not
in itself Require Installation

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume

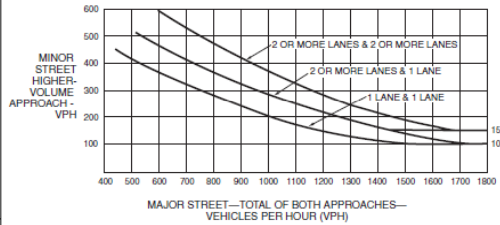
Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	50% ^d	100% ^a	80% ^b	70% ^c	50% ^d
1	1	500	400	300	200	150	100	100	80
2 or more	1	600	480	400	300	150	100	100	80
2 or more	2 or more	600	480	400	300	200	160	140	110
1	2 or more	500	400	300	200	200	160	140	110

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor street approach (one direction only)			
Major Street	Minor Street	100% ^a	80% ^b	70% ^c	50% ^d	100% ^a	80% ^b	70% ^c	50% ^d
1	1	750	600	525	400	75	60	53	40
2 or more	1	900	720	630	504	75	60	53	40
2 or more	2 or more	900	720	630	504	100	80	70	50
1	2 or more	750	600	525	400	100	80	70	50

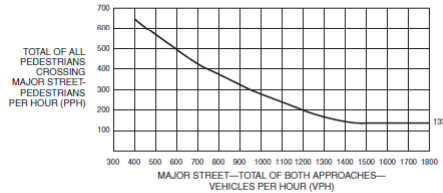
^a Basic minimum hourly volume.
^b Used for combination of Conditions A and B after adequate trial of other remedial measures.
^c May be used when the major street speed exceeds 40 mph or in an isolated community with a population of less than 10,000.
^d May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major street speed exceeds 40 mph or in an isolated community with a population of less than 10,000.

Figure 4C-3. Warrant 3, Peak Hour



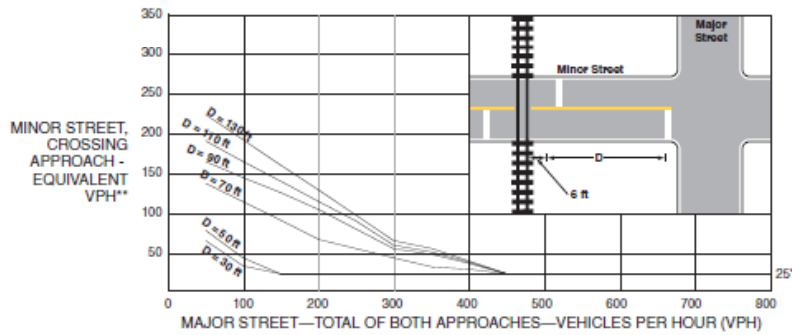
*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-7. Warrant 4, Pedestrian Peak Hour



*Note: 133 pph applies as the lower threshold volume.

Figure 4C-9. Warrant 9, Intersection Near a Grade Crossing (One Approach Lane at the Track Crossing)



* 25 vph applies as the lower threshold volume

** VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate

...MORE CONTENT (2 of 3)

- Visibility, Aiming, and Shielding of Signal Faces
- Lateral & Longitudinal Positioning, Mounting Height, and Clearance of Signal Faces
- Permissive, Protected/Permitted, and Protected Turn Indications
- Yellow Clearance & Red Clearance Intervals

Table 4D-1. Recommended Minimum Number of Primary Signal Faces for Through Traffic on Approaches with Posted, Statutory, or 85th-Percentile Speed of 45 mph or Higher

Number of Through Lanes on Approach	Total Number of Primary Through Signal Faces for Approach ¹	Minimum Number of Overhead Mounted Primary Through Signal Faces for Approach
1	2	1
2	2	1
3	3	2 ^{**}
4 or more	4 or more	3 ^{**}

NOTES: ¹A minimum of two through signal faces is always required. (See Section 4D.11.)
²These recommended numbers of through signal faces may be exceeded. Also, side zones of vision requirements otherwise indicated in Section 4D.13.
^{**}If practical, all of the recommended number of primary through signal faces should be located overhead.

Table 4D-2. Minimum Sight Distance for Signal Visibility

85 th -Percentile Speed	Minimum Sight Distance
20 mph	175 feet
25 mph	215 feet
30 mph	270 feet
35 mph	335 feet
40 mph	390 feet
45 mph	440 feet
50 mph	540 feet
55 mph	625 feet
60 mph	715 feet

Note: Distances in this table are derived from stopping sight distance plus an assumed queue length for shorter cycle lengths (60 to 75 seconds).

Figure 4D-3. Recommended Vehicular Signal Faces for Approaches with Posted, Statutory, or 85th-Percentile Speed of 45 mph or Higher

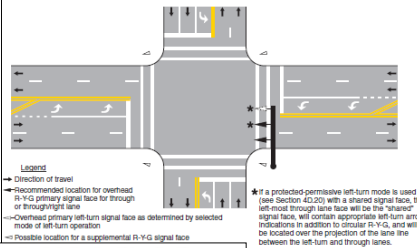
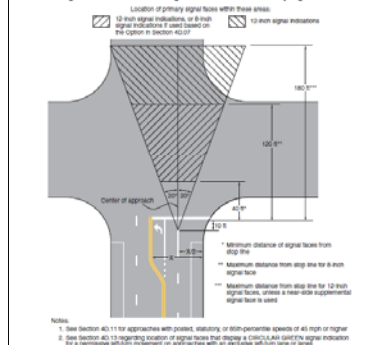
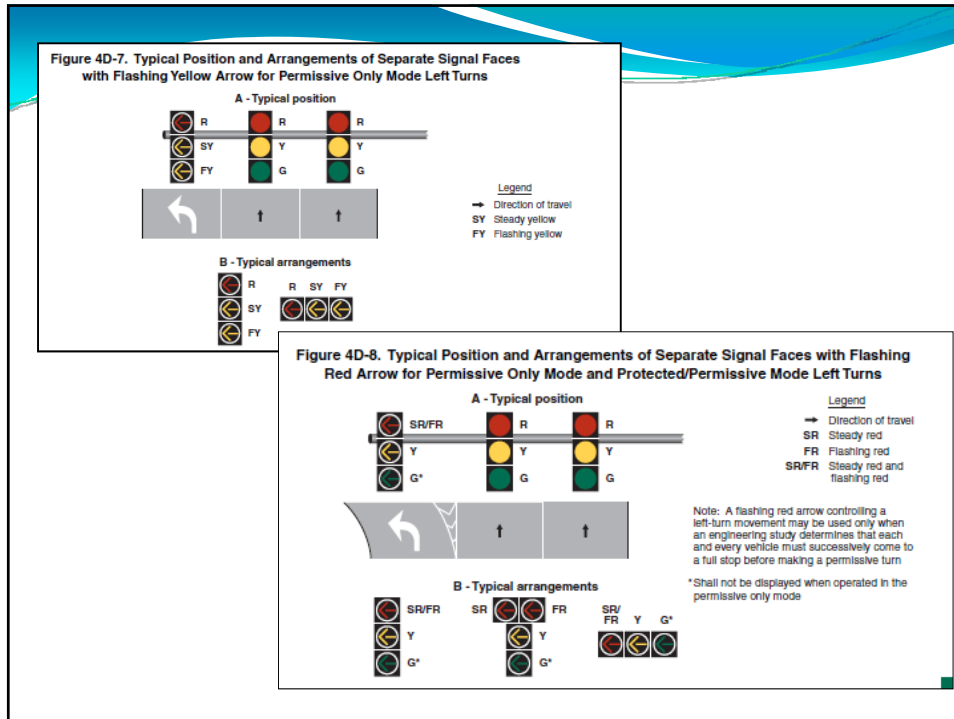


Figure 4D-4. Lateral and Longitudinal Location of Primary Signal Faces



Section 4D.17 through 4D.24, should be overhead and considered, based on the geometrics of the



SOME SIGNAL HARDWARE AND TIMING STD. STATEMENTS

- If a Signalized Through Movement exists on an Approach, a Minimum of Two Primary Signal Faces Shall be Provided for the Through Movement
- Except as provided in Section 4D.07, 12-Inch Signal Indications Shall be Used in New Signal Faces
- Yellow Change Interval and Red Clearance Interval (if Used) Shall be Determined Using Engineering Practices

...MORE CONTENT (3 of 3)

- **Pedestrian Control: Intervals and Phases, Countdown Signals, Detectors, and Accessible Pedestrian Signals**
- **Flashing Beacons: Intersection Control, Warning Beacon, Speed Limit Sign, and Stop Beacon**
- **In-Roadway Lights: Application at Crosswalks**

Figure 4E-1. Typical Pedestrian Signal Indications

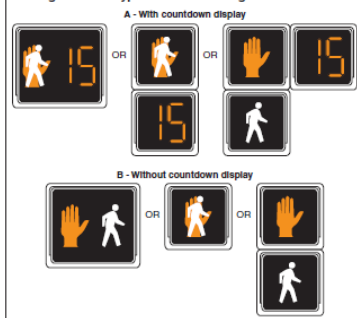
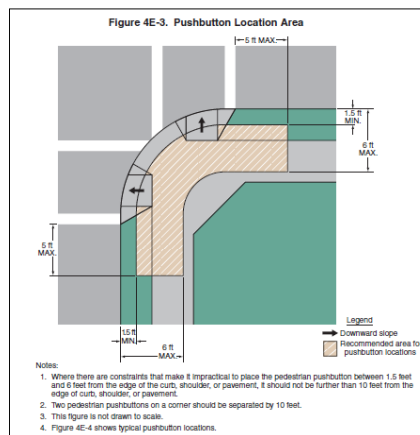


Figure 4E-3. Pushbutton Location Area

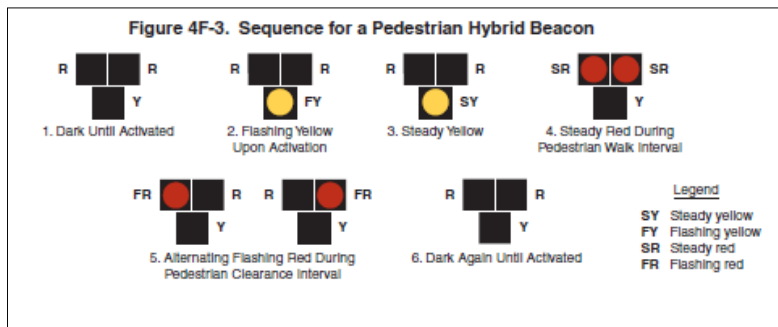



SOME PED-RELATED SIGNAL STANDARD STATEMENTS

- Design and Operation of Traffic Control Signals Shall take into Consideration the needs of Pedestrian as well as Vehicular Traffic
- New Pedestrian Signal Head Indications Shall be Displayed within a Rectangular Background and Shall consist of Symbolized Messages (See Figure 4E-1),...
- All Pedestrian Signal Heads used at Crosswalks where the Pedestrian Change Interval is more than 7 Seconds Shall Include a Pedestrian Change Interval Countdown Display....

PEDESTRIAN HYBRID BEACON STANDARD STATEMENT*

- If Used, Pedestrian Hybrid Beacons Shall be used in Conjunction with Signs and Pavement Markings to Warn and Control Traffic at Locations where Pedestrians Enter or Cross a Street or Highway. A Pedestrian Hybrid Beacon Shall only be Installed at a Marked Crosswalk. (Chap. 4F, Emergency-Vehicle Hybrid Beacon also Discussed in Chap. 4G)





**PART 4 – HIGHWAY
TRAFFIC SIGNALS
REVISIONS
(A Sample)**



Section 4C.04

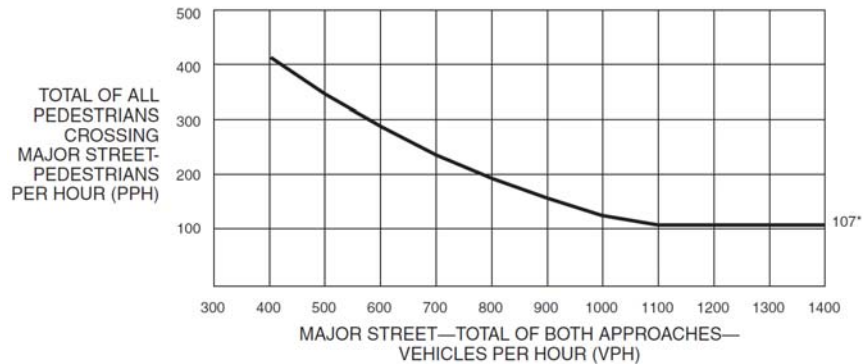
New Guidance in Warrant 3 (Peak hour)

- **Signals Installed under Warrant 3 (Peak Hour):**
 - **Should be Traffic-Actuated, and**
 - **May be Operated in Flashing Mode during Off-Peak Hours**

Section 4C.05

Revisions to Warrant 4 (Pedestrian Volume)

Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume

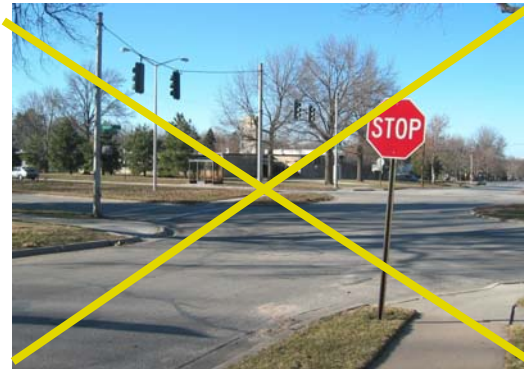


*Note: 107 pph applies as the lower threshold volume.

Sections 4C.05 & 4C.06

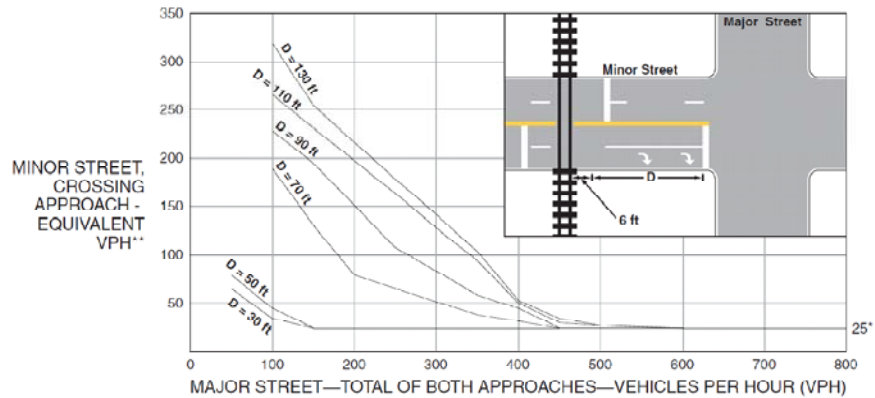
Signals Based only on Warrant 4 (Ped Volume) or Warrant 5 (School Crossing) should also Control the Minor Street or Driveway

- No “Half-Signals”



Section 4C.10 – New Warrant 9 for Intersections Near Grade Crossings

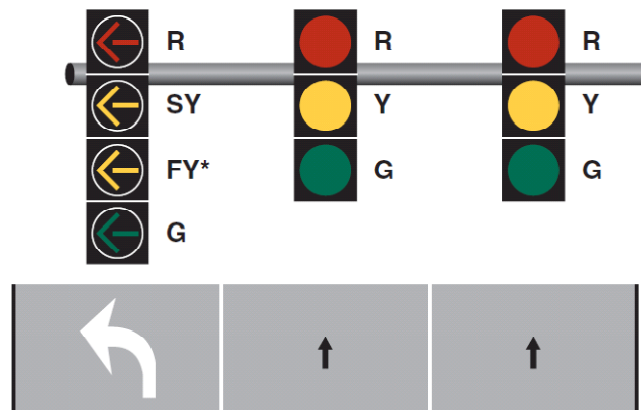
Figure 4C-10. Warrant 9, Intersection Near a Grade Crossing (Two or More Approach Lanes at the Track Crossing)



* 25 vph applies as the lower threshold volume
 ** VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate

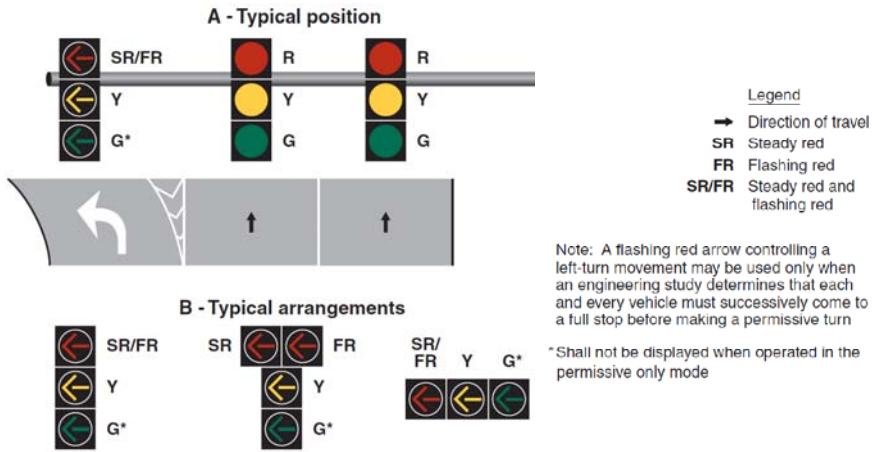
Chapter 4D

Optional Use of Flashing Yellow Arrow for Permissive Turns*



Chapter 4D

Optional Use of Flashing Red Arrow for Permissive Turns



Section 4D.07

12-Inch Indications Required for all New Traffic Control Signal Faces*



Six Options for Using New 8-Inch Indications in Special Circumstances

(Incl. ≤ 30 mph <120 ft from Stop Line)

Section 4D.11 – Minimum Two Signal Faces Required for Straight-Through Movement if it Exists, even if not the Major Movement on Approach

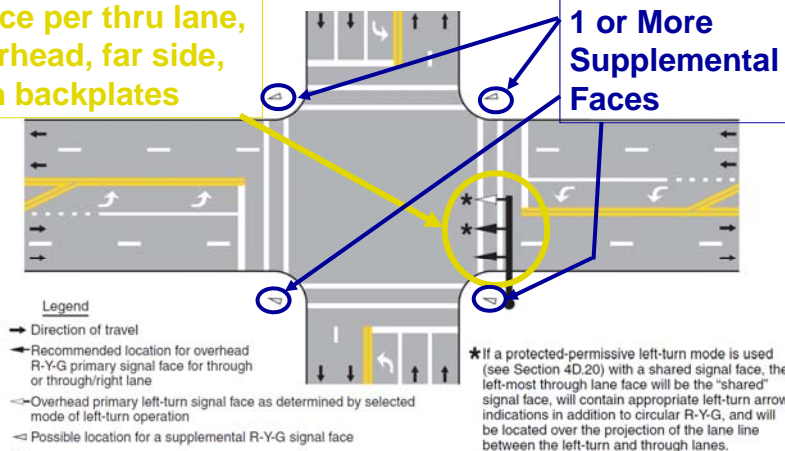


**2nd Face
Required
for
Through
Movement**

Section 4D.11 – Recommended Number, Location, and Design of Signal Faces for Approaches with Speeds ≥ 45 mph

**- Face per thru lane,
overhead, far side,
with backplates**

**1 or More
Supplemental
Faces**



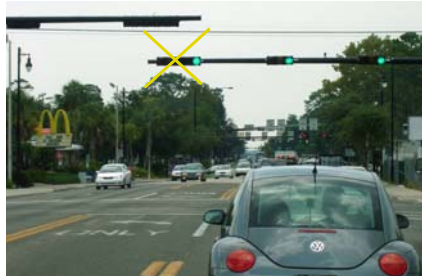
Section 4D.12 – Optional Yellow Retroreflective Borders around Backplates



Section 4D.13 – Positioning of Overhead Separate Signal Faces for Turn Movements

- If Installed Overhead for a Dedicated Turn Lane, the Separate Turn Face Shall be Located over the Turn Lane (Not Necessarily Centered over the Lane)





Section 4D.13
Circular Green
Indications for
Permissive LTs Should
not be Located over or
in Front of the LT lane

Section 4D.19 – Protected-Only Mode Left-Turn Faces Must use Red Arrow, not Circular Red

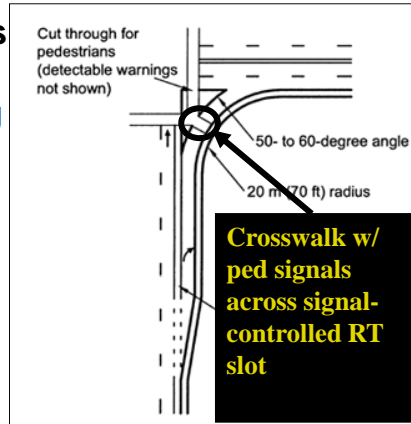
- **Applies to Left-Turn Signals but not to Right-Turn Signals**



Section 4E.06

Pedestrian Intervals and Signal Phases

- If a Walking Person or a Flashing Upraised Hand is Displayed...
 - A Steady Red or Flashing Red Must be Displayed to any Conflicting Vehicular Movement that is Perpendicular or Nearly Perpendicular to the Crosswalk

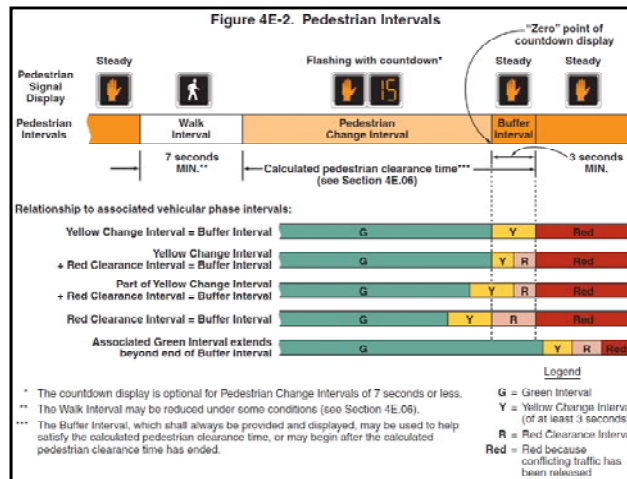


Section 4E.06 - Relationship of Pedestrian Clearance Time to Vehicular Intervals in the 2009 MUTCD

Ped Change Interval (flashing DW):

- Shall not Extend into the Red Clearance Interval
- Shall be Followed by Min. 3 sec. Buffer Interval

Compliance Date Dec. 31, 2014 or when Timing Adjustments are Made (Whichever occurs First)



Section 4E.06 – Slower Walking Speed for Calculating Pedestrian Clearance Time (Guidance)

~~4.0 feet per
second~~

Ped. Clearance Time
based on 3.5 feet / sec

[Exception allows 4.0 ft /sec if extended button press
or passive ped detection allows slower peds to
request additional crossing time]

Sum of Walk time + Ped. Clearance Time
based on 3.0 feet per second for
distance from ped detector to far side

Section 4E.07

Countdown Pedestrian Displays*

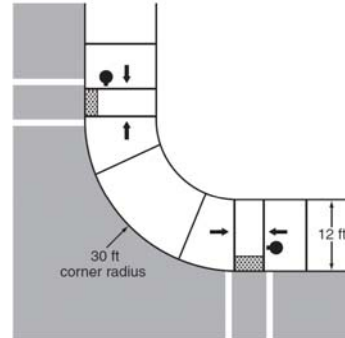
- Required for all Ped Signals Except where Ped Change Interval is ≤ 7 Sec.
- No Specific Compliance Date for Retrofitting Existing Ped Signals (Can Remain w/o Countdown until Ped Heads Replaced)
- May be Used even if Ped Change Interval is 7 sec. or Less



Section 4E.08 – New Guidance and Figures for Locations of Pedestrian Pushbuttons for a Variety of Conditions



A - Parallel ramps with wide sidewalk



Sections 4E.09 through 4E.13 – APS Revised Provisions

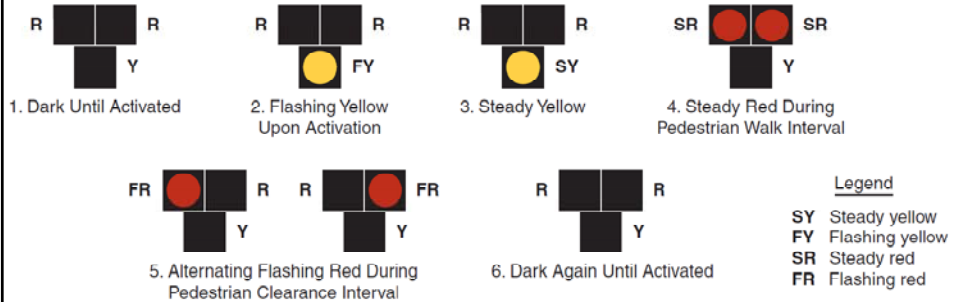
Design Features, Extended Button Presses, Audible Beacons, Special Requirements if Two Buttons Must be Located on One Pole



Chapter 4F

New Pedestrian Hybrid Beacon

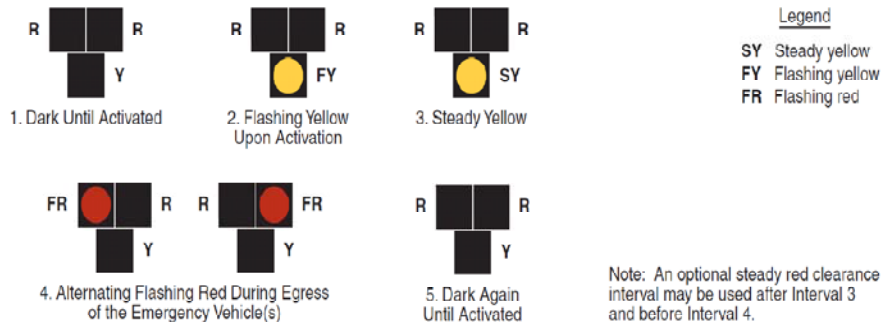
Figure 4F-3. Sequence for a Pedestrian Hybrid Beacon



Section 4G.04

New Emergency-Vehicle Hybrid Beacon

Figure 4G-1. Sequence for an Emergency-Vehicle Hybrid Beacon



Section 4L.02 – Intersection Control Beacons using Two Red Lenses

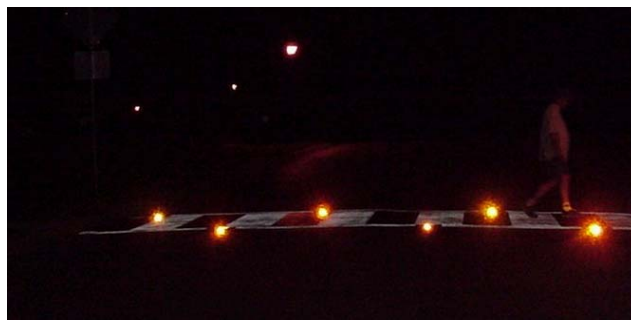
Horizontally Aligned –
Flash Simultaneously



Vertically Aligned –
Flash Alternately

Chapter 4N – In-Roadway Lights

Shall be Used Only at Marked Crosswalks
Across Uncontrolled Approaches



New Sign Required if Lights are
Actuated by Push Buttons

CONCLUSIONS

- **New Signal Warrants**
- **New Guidance about Signal Placement, Number, and Size**
- **New Information about Flashing Arrows, Pedestrian Signals, Countdown Signals, and Accessibility**
- **New Information about Hybrid Beacons and In-Roadway Lights**

COMPLIANCE DATES

4D.01	General	Location of signalized midblock crosswalks	December 22, 2013 (b)
4D.26	Yellow Change and Red Clearance Intervals	New requirement in the 2009 MUTCD that durations of yellow change and red clearance intervals shall be determined using engineering practices	December 31, 2014, or when timing adjustments are made to the individual intersection and/or corridor, whichever occurs first
4D.31	Flashing Operation—Transition Out of Flashing Mode	Duration of steady red clearance interval in change from red-red flashing mode to steady (stop-and-go) mode (2003 MUTCD Section 4D.12)	December 22, 2013 (b)
4E.06	Pedestrian Intervals and Signal Phases	New requirement in the 2009 MUTCD that the pedestrian change interval shall not extend into the red clearance interval and shall be followed by a buffer interval of at least 3 seconds	December 31, 2014, or when timing adjustments are made to the individual intersection and/or corridor, whichever occurs first
4E.07	Countdown Pedestrian Signals	Pedestrian countdown hardware requirements	December 22, 2013 (b)



QUESTIONS?