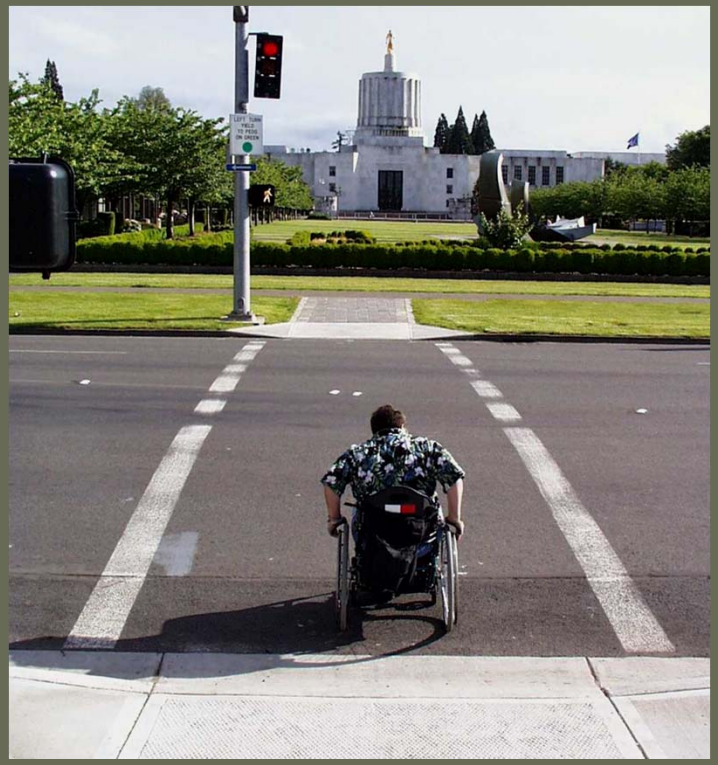


SIGNALIZED INTERSECTIONS

Module 6

Learning Outcomes

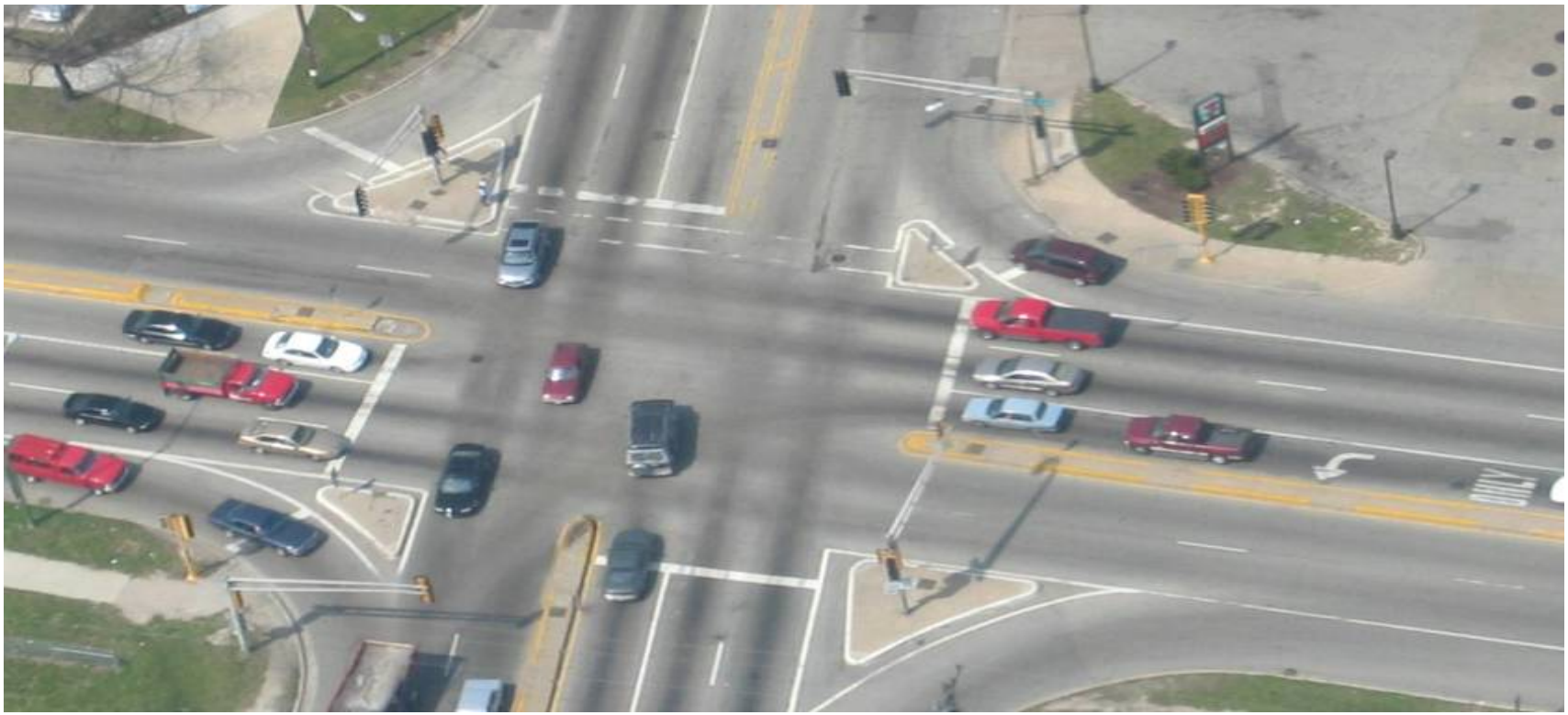
1. At the end of this module, you will be able to:
2. Explain why traffic signals don't "guarantee" safety: they assign the right of way
3. Identify signal timing techniques that favor ped crossings
4. Identify major conflicts: concurrent turn movements
5. Select protected turns to improve ped safety

Signalized Intersections Can Be Improved For Pedestrians By:

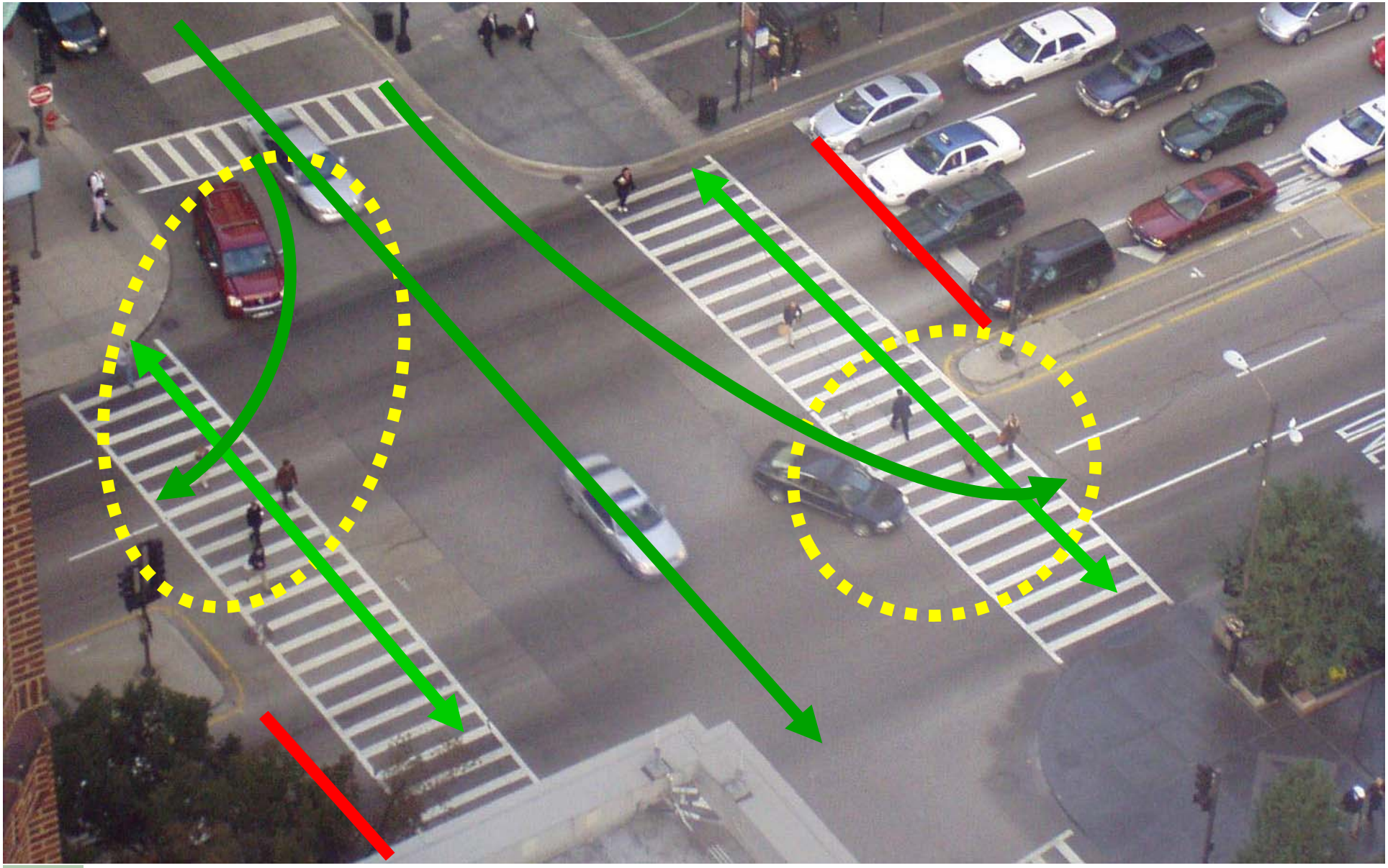
1. Using good geometric design
2. Placing islands to break up complex crossings
3. Placing crosswalks in logical locations
4. Improving convenience and ease of use of pedestrian pushbuttons and signals
5. Using techniques to reduce conflicts with turning vehicles

1, 2 & 3 addressed in earlier module

Traffic signals assign the of right of way, regulate the flow of traffic and create gaps



Traffic signals do not guarantee safety – in fact, signalized intersections have more crashes than non-signalized



Turn movements often result in conflicts

Traffic signals don't ensure protection

6-6 **Washington DC**

Peds routinely ignore the light (usually quite safely)

Traffic signals don't ensure protection

Pedestrians will cross where it's convenient

Traffic signals don't ensure protection

6-8 Corvallis OR New York NY

Pedestrians are at risk when crossing with the light

Lucky Escape

Improving convenience and ease of use of pedestrian signals

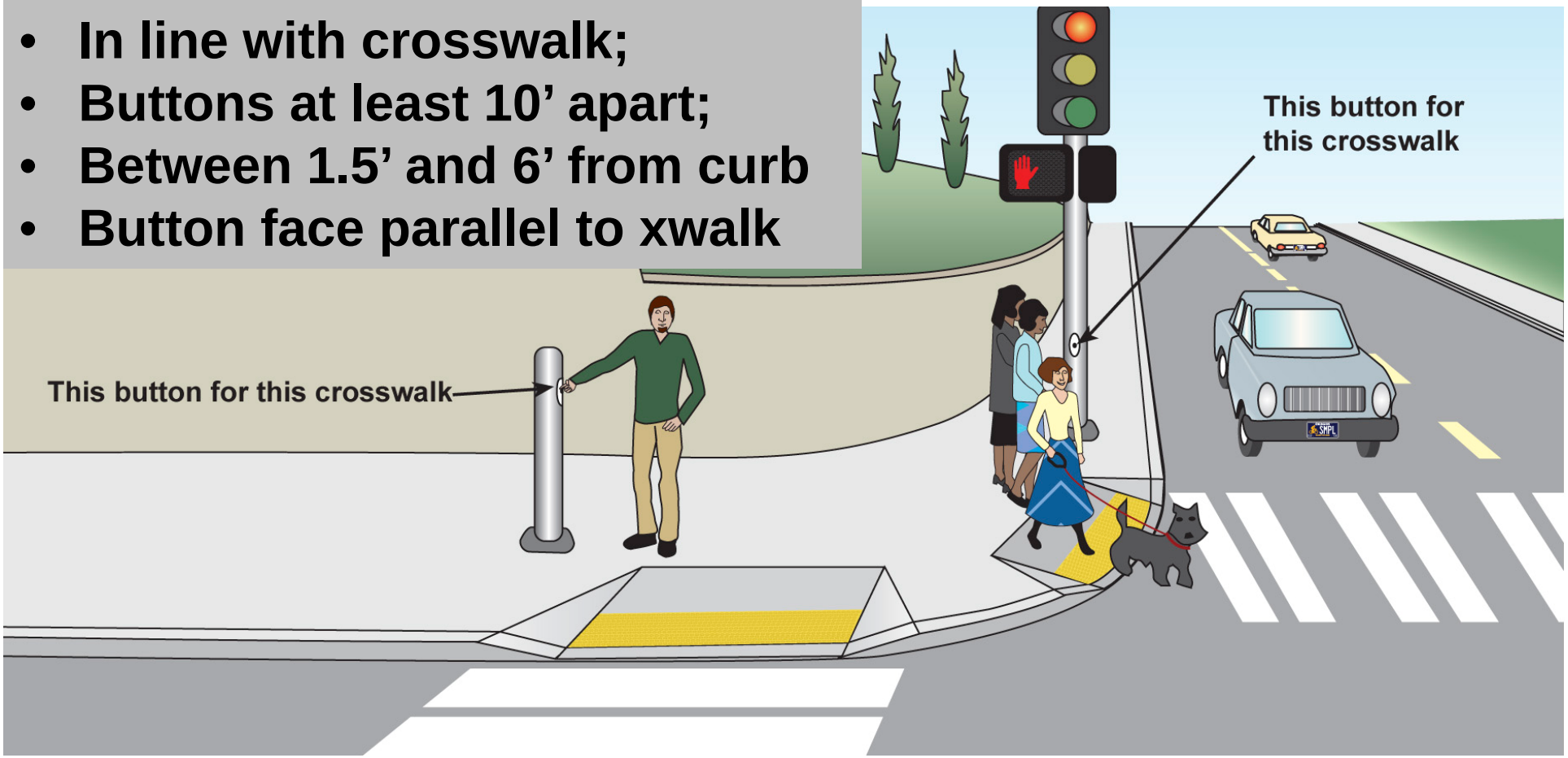
- Proper pushbutton placement
- Need and placement of pedestrian signal heads
- Signal timing for pedestrians
- Countdown Signals
- Intelligent Transportation Systems (ITS)

Proper Pushbutton Placement

6-11

MUTCD Recommendations:

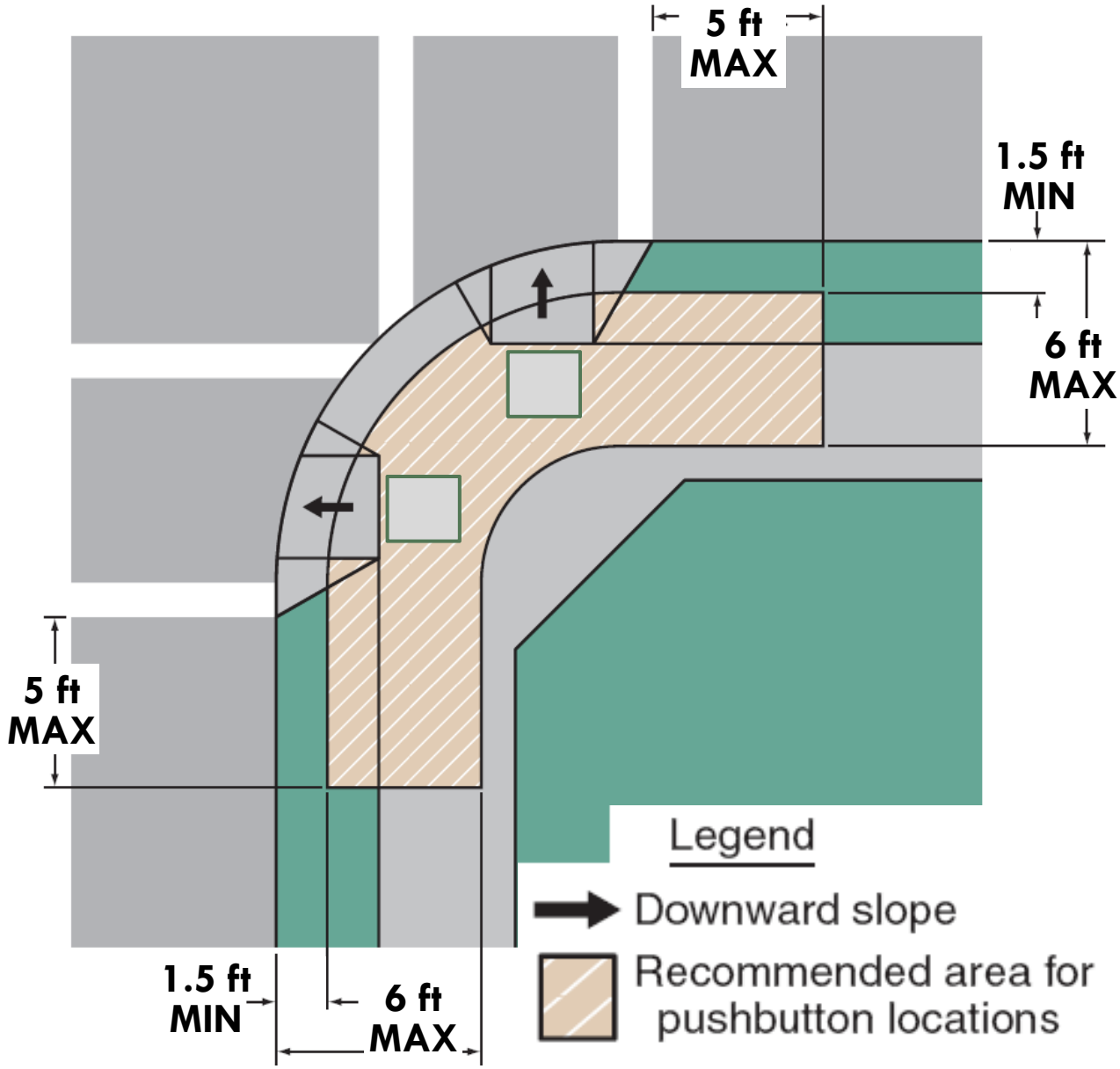
- **In line with crosswalk;**
- **Buttons at least 10’ apart;**
- **Between 1.5’ and 6’ from curb**
- **Button face parallel to xwalk**



MUTCD Sec. 4E.08

Proper Pushbutton Placement

The MUTCD recommends these dimensions



MUTCD Figure 4E-3

Poor Pushbutton Placement

Inconspicuous

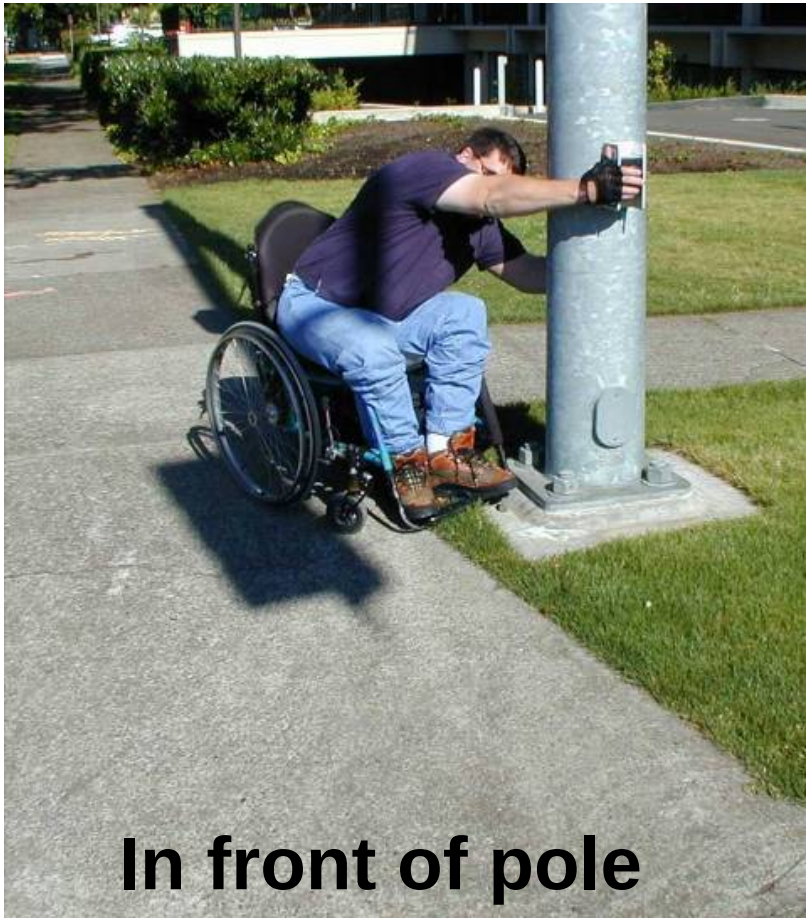
Too far from ramp

Poor Pushbutton Placement

Behind guardrail

Behind vegetation

Poor Pushbutton Placement



Portland OR Salem OR

Poor Pushbutton Placement

6-16 **Hillsborough Co. FL**

All of the Above?

Proper Pushbutton Placement

On side of pole

At top of ramp

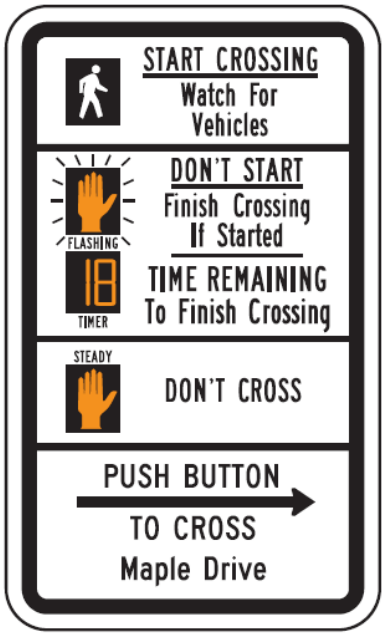
Communicate With Pedestrians

LED tells peds the button works and the signal has received the call *(like an elevator)*

Tactile arrow gives direction to blind and sighted pedestrians

Requirement in the 2009 MUTCD

- Combination of sign legends and pushbutton placement shall clearly indicate which crosswalk signal is activated by each pushbutton

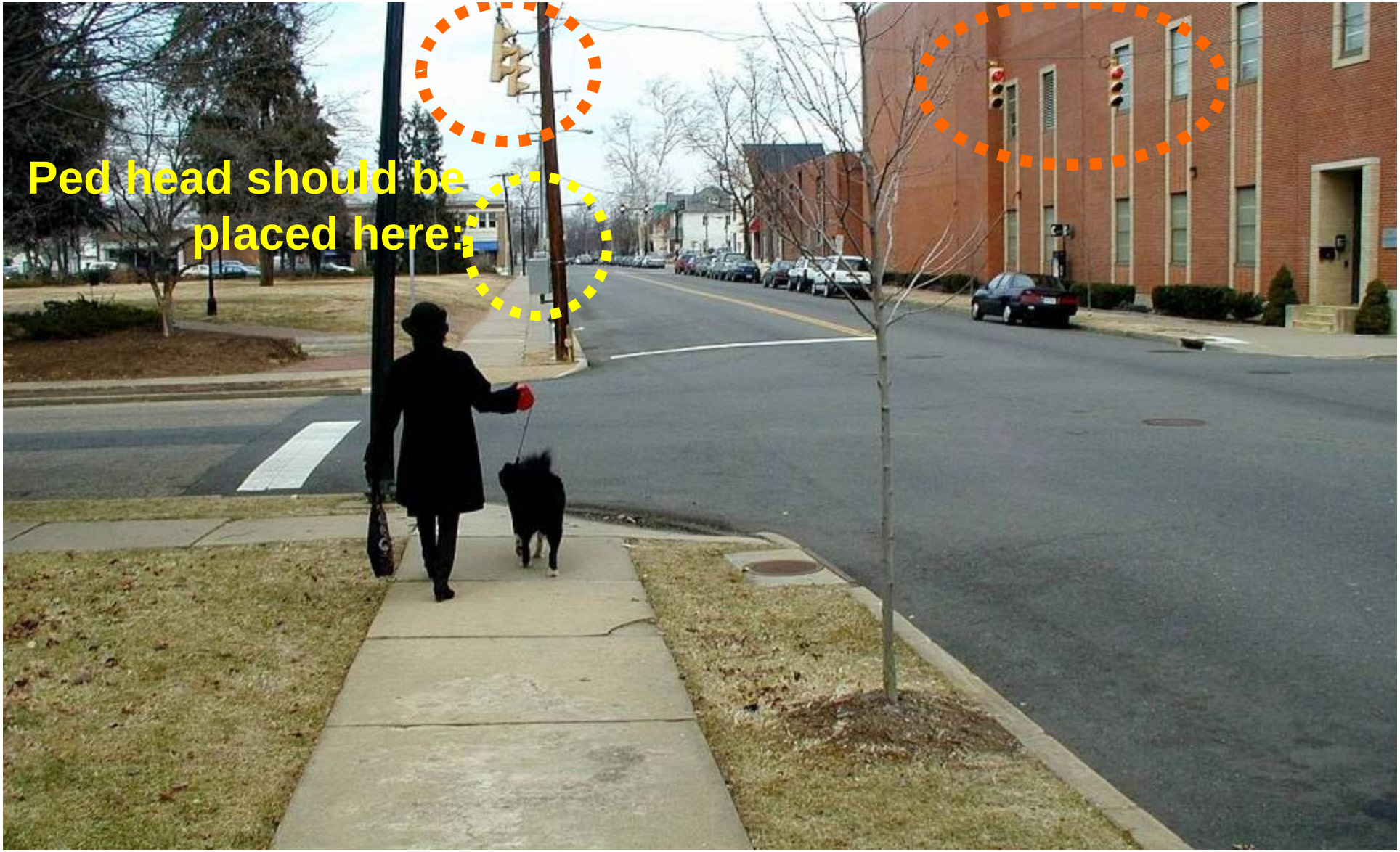


MUTCD Sec. 2B.52 and Section 4E.08

Pedestrian Signals
(AKA Ped Heads/Pedestrian Indicators)

Need and Placement at Signalized Intersections

- In general, use signals wherever pedestrians may be present (if in doubt, install them)



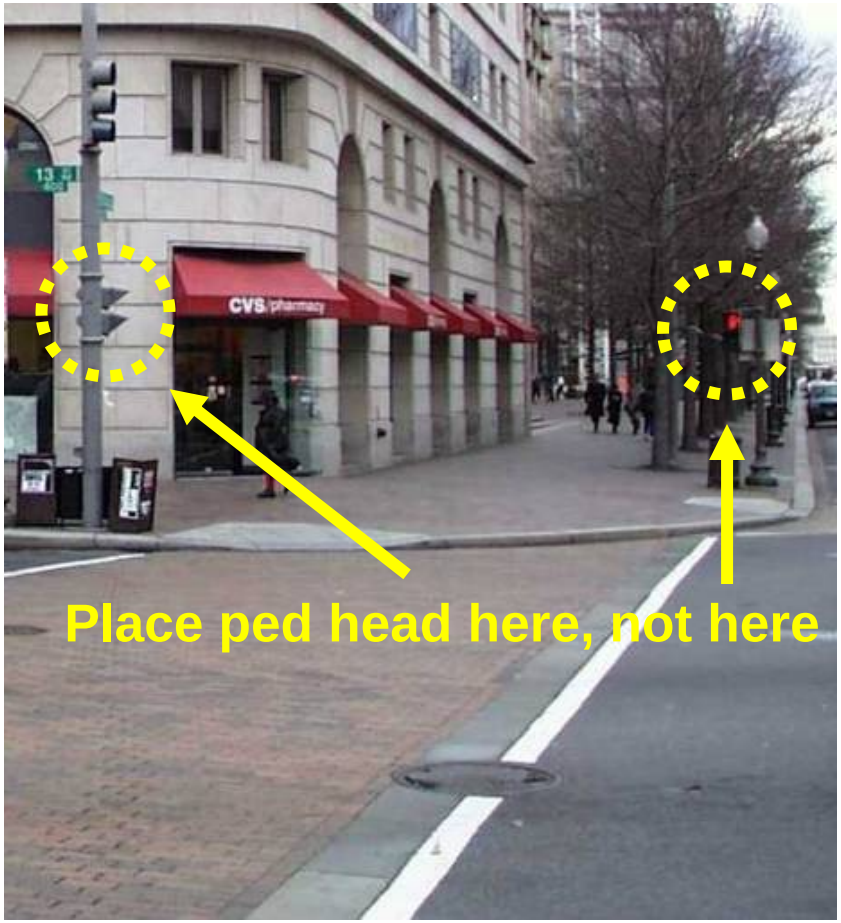
6-21 Fredericksburg VA

Pedestrian signals should be provided, Otherwise pedestrians don't know when to cross

6-22 Raleigh NC

- Lack of pedestrian signals on one way street:
  - The pedestrian may not notice the signal

Ped head placement: close to crosswalk, visible to pedestrians, especially with long crosswalk

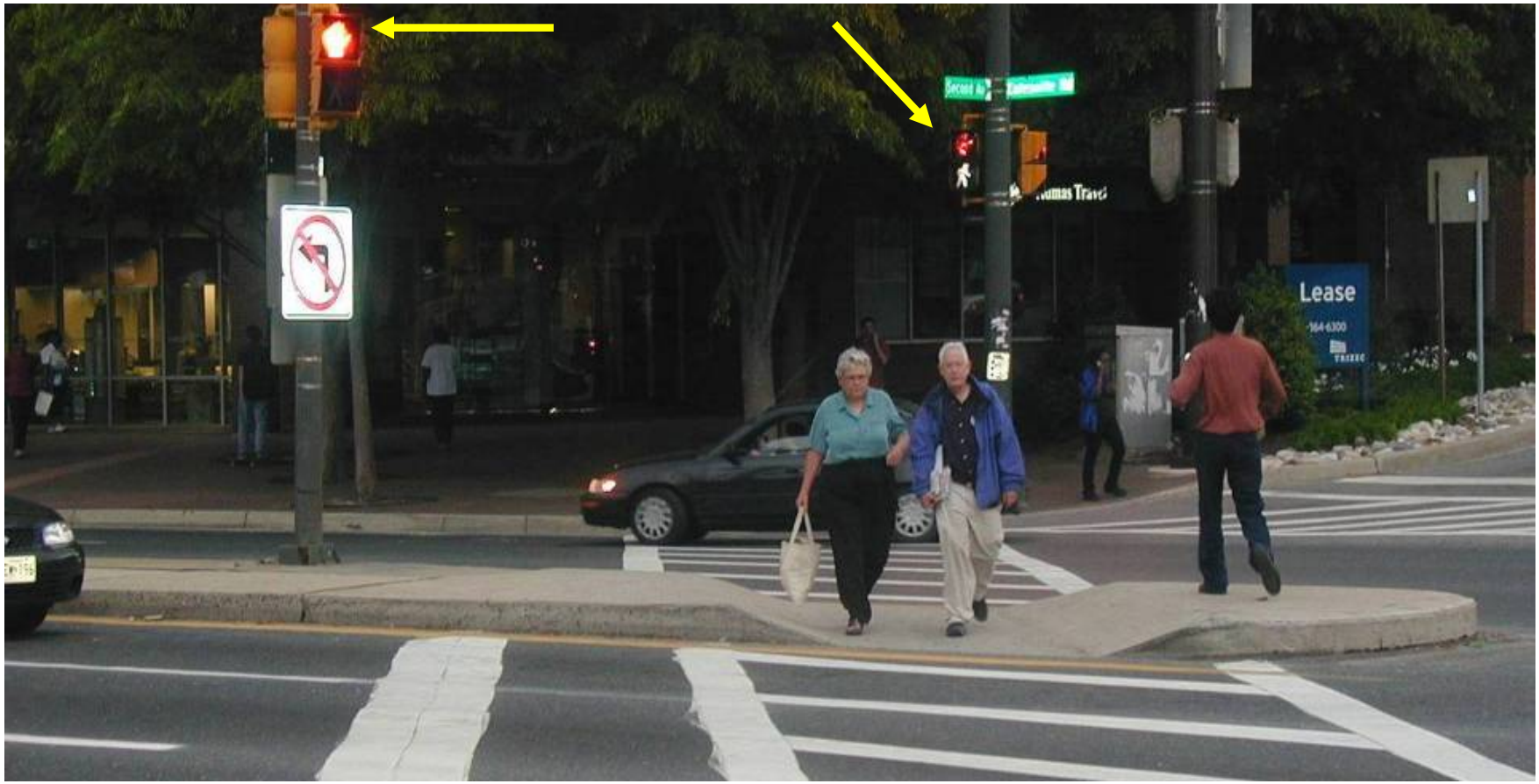


Poor example

Good example

2009 MUTCD Section 4E.05

Two-step signals: ensure pedestrians don't see conflicting signals



These pedestrians kept walking, not noticing the separate signal for the 2nd half of the roadway

6-25

Accessible Pedestrian Signals (APS)

Accessible Pedestrian Signals (APS)

- Provide ped signal information in audible and vibrotactile format
- Benefit all pedestrians by providing redundancy
- The 2009 MUTCD describes the features of APS, but does not require them
- Future accessibility standards and future MUTCD editions will likely require APS for all ped signals

MUTCD Specifies Pushbutton-integrated APS

- Not the loud Cuckoo/Chirps used in the past
- Key Features:
  - Speakers at the pushbutton
  - Pushbutton locator tone  **(Click to play sample locator tone)**
  - Tactile arrow (described earlier)
  - Automatic volume adjustment (so tones are audible within 6 to 12 feet of the button)
  - APS location is critical to proper functioning (see standards described earlier)

APS WALK indications

- APS should have both audible and vibrotactile WALK indications
  - Audible WALK indication: tone or speech message during WALK
  - Vibrotactile WALK indication: tactile arrow (or other surface on button) vibrates during WALK

Video, click play button to start

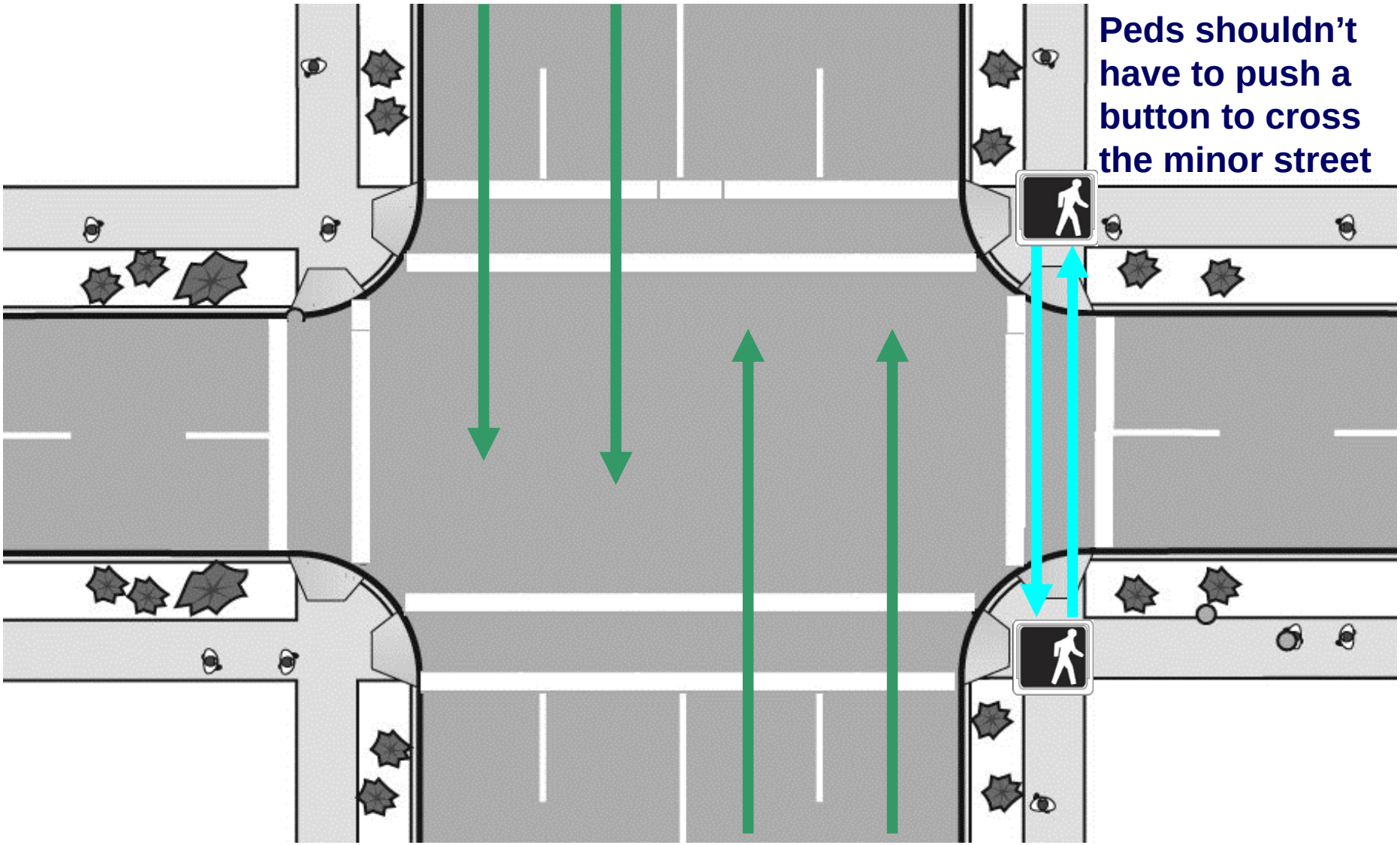
6-29

“Recall to Walk”

(Walk Signal Comes Up Automatically)

At high-use crosswalks, pedestrians should get a signal at every cycle

Set pedestrian signals to recall to WALK when major street is set to recall to green



Signal Timing & Walking Speeds

Use Short Signal Cycle Length

Long wait causes stacking: pedestrians wait in street, or don't wait and cross against the signal

Pedestrian Walking Speeds

6-34 **Portland OR**

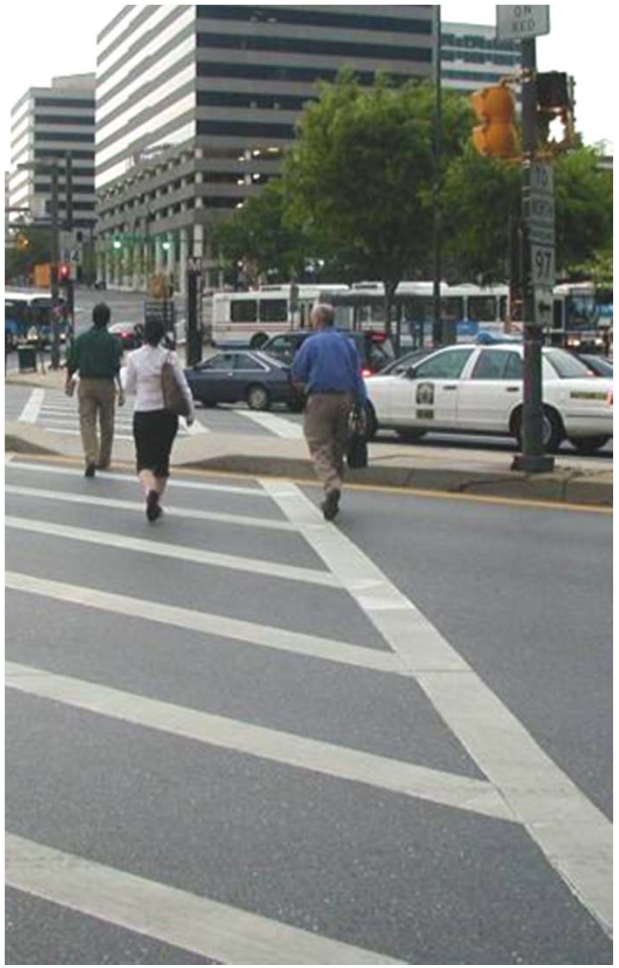
2003 (old) MUTCD requirements:

- 7 sec steady walk (peds may enter crosswalk); 4 sec "option"
- Pedestrian clearance time (flashing orange hand) calculated at 4'/sec curb-to-curb
- Example: 60' crosswalk requires 15 sec
- Example: 15 + 7 = 22 sec absolute minimum walk plus clearance

Pedestrian Walking Speeds

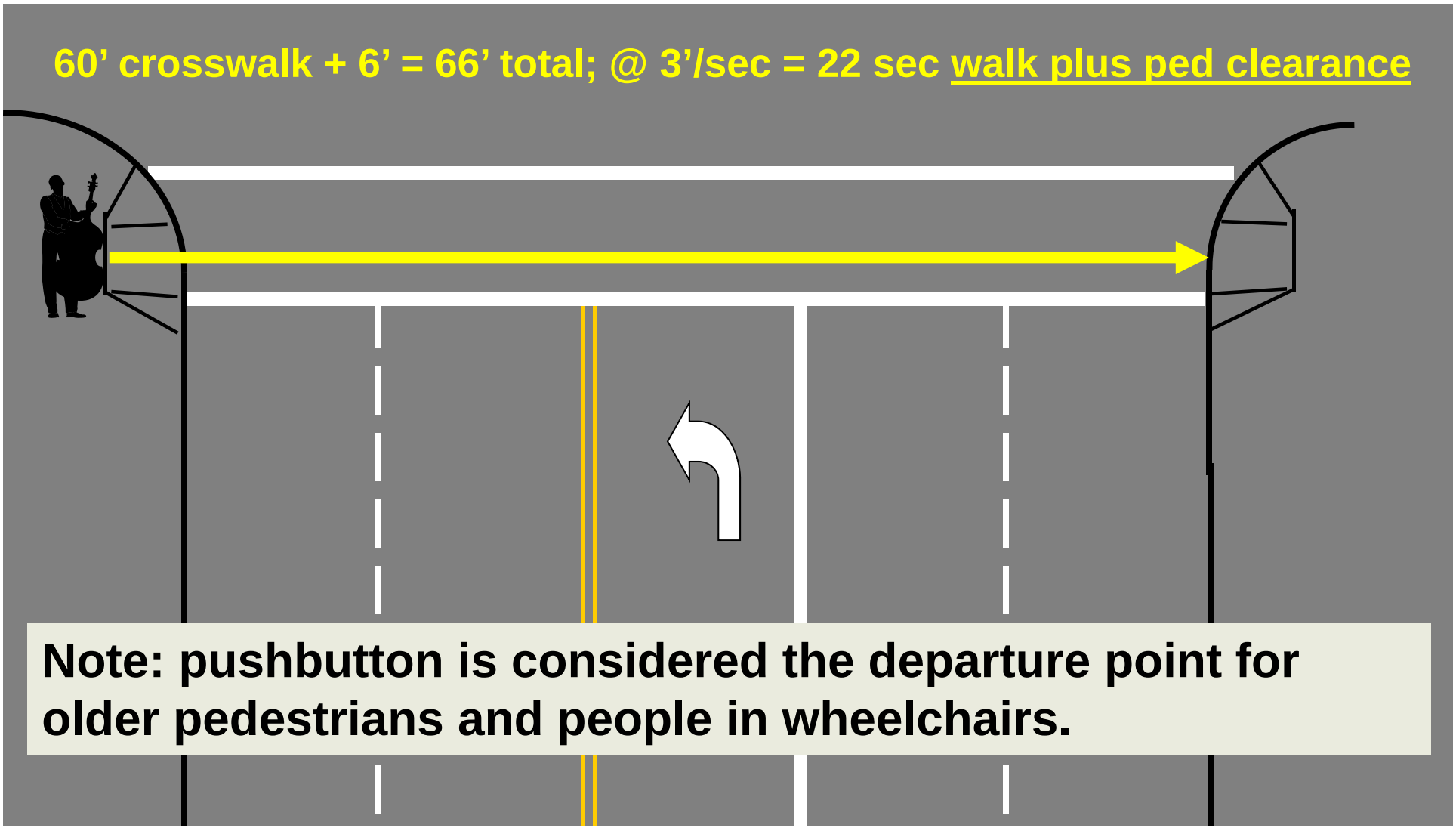
2009 MUTCD:

- 7 sec walk, 4 sec option (no change)
- Ped clearance time (flashing hand) calculated at 3.5'/sec curb-to-curb.
- Example: 60' crosswalk requires 17 sec
  - 7 + 17 = 24 sec total
- Additional test for walk plus clearance time: Calculate travel time from push button (or 6' feet from curb if no button) to curb on other side at 3'/sec
  - Example: 6' + 60' crosswalk = 66
    - 66' requires 22 sec
    - 24 sec > 22 sec; passes test.



MUTCD Sec. 4E.06

Guidance for walk plus clearance: Calculate time from pushbutton (or 6’ from curb) to curb on other side at 3’/sec



Old System

1. Ped symbol or WALK
2. Flashing Hand or DON'T WALK
3. Steady Hand or DON'T WALK

1/2 of Americans don't understand it;

- Is there a better system?

*** Flashing orange hand/DON'T WALK is ped clearance interval: very counterintuitive**

MUTCD Sec. 2B.51 and Section 4E.06

Problem with old system: People not sure if they can start during flashing hand / DON'T WALK

New system: countdown pedestrian signal tells pedestrians how much time remains for crossing

Streetfilms: Guadalajara Countdownn

Countdown pedestrian signal research results:

1. Pedestrians understand how it works
2. More people start crossing during clearance phase, but…
3. Fewer people initiate walk late in clearance phase
4. Very few pedestrians in crosswalk in steady don't walk
5. Drivers don't take a cue and accelerate to beat the light

What about crash reduction?

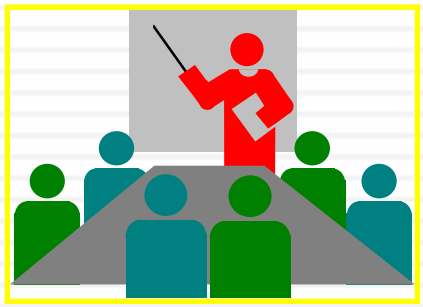
Results from San Francisco study are promising:

CMF = 0.75 (CRF = 25%)

2009 MUTCD requirement

- Countdown displays required for new pedestrian signals (except the rare situation where the change interval is 7 seconds or less)
- Why? Significant reductions in pedestrian-vehicle crashes

MUTCD Sec. 4E.07



Discussion:

What are your policies & practices regarding the provision of pedestrian indicators and countdown signals?

ITS

Using ITS to Adjust Pedestrian Signal Timing

6-46 **Portland OR**

- In this example a high-tech signal was used to help slower pedestrians cross the street with minimal delay to traffic.
- A slower crossing speed would delay traffic significantly

Portland OR

Microwave sensors are aimed at the crosswalks to track peds

Portland OR

Pedestrian clearance is timed @ 3.5 ft/sec

The sensor tracks peds as they cross the street

MUTCD Sec. 4E.06, Paragraph 08

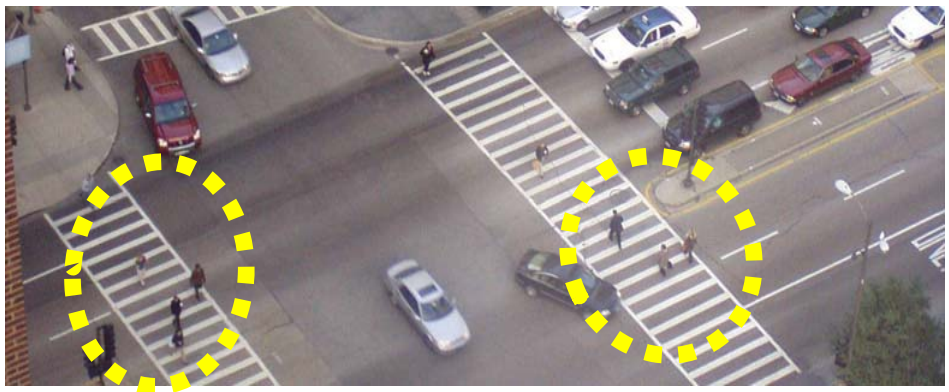
ITS Pedestrian Signal

6-49 Portland OR

- The controller adds 4 seconds crossing time if pedestrian hasn't finished crossing (8 seconds maximum)
- In this case, the walk phase was prolonged in 20% of crossings, reducing unnecessary traffic delay the other 80% of crossings.

Reducing Conflicts between Pedestrians and Turning Vehicles

- At signals, turning movements account for most ped crashes
- Left/right turn ratio is roughly 2:1
- Countermeasures
  - Protected vs. permissive turns
  - No turn on Red
  - Exclusive Pedestrian Phase
  - Leading Pedestrian Interval



Signs: Remind Turning Drivers to Yield to Peds

R10-15 in 2009 MUTCD

Older local variations, using MUTCD-approved lettering and symbols:

Leesburg, FL

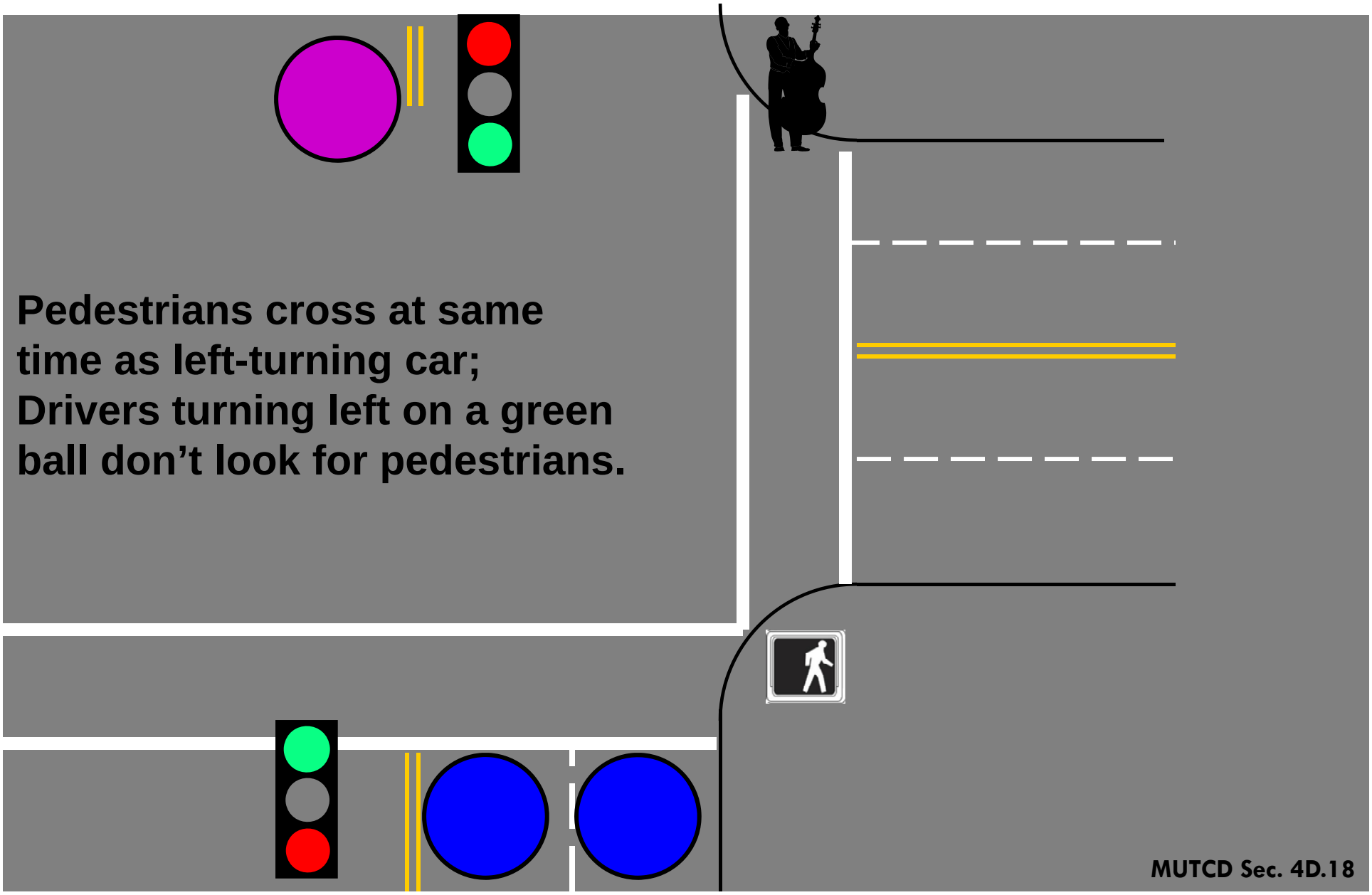
Juneau, AK
Orlando, FL

MUTCD Sec. 2B.53, Paragraph 09

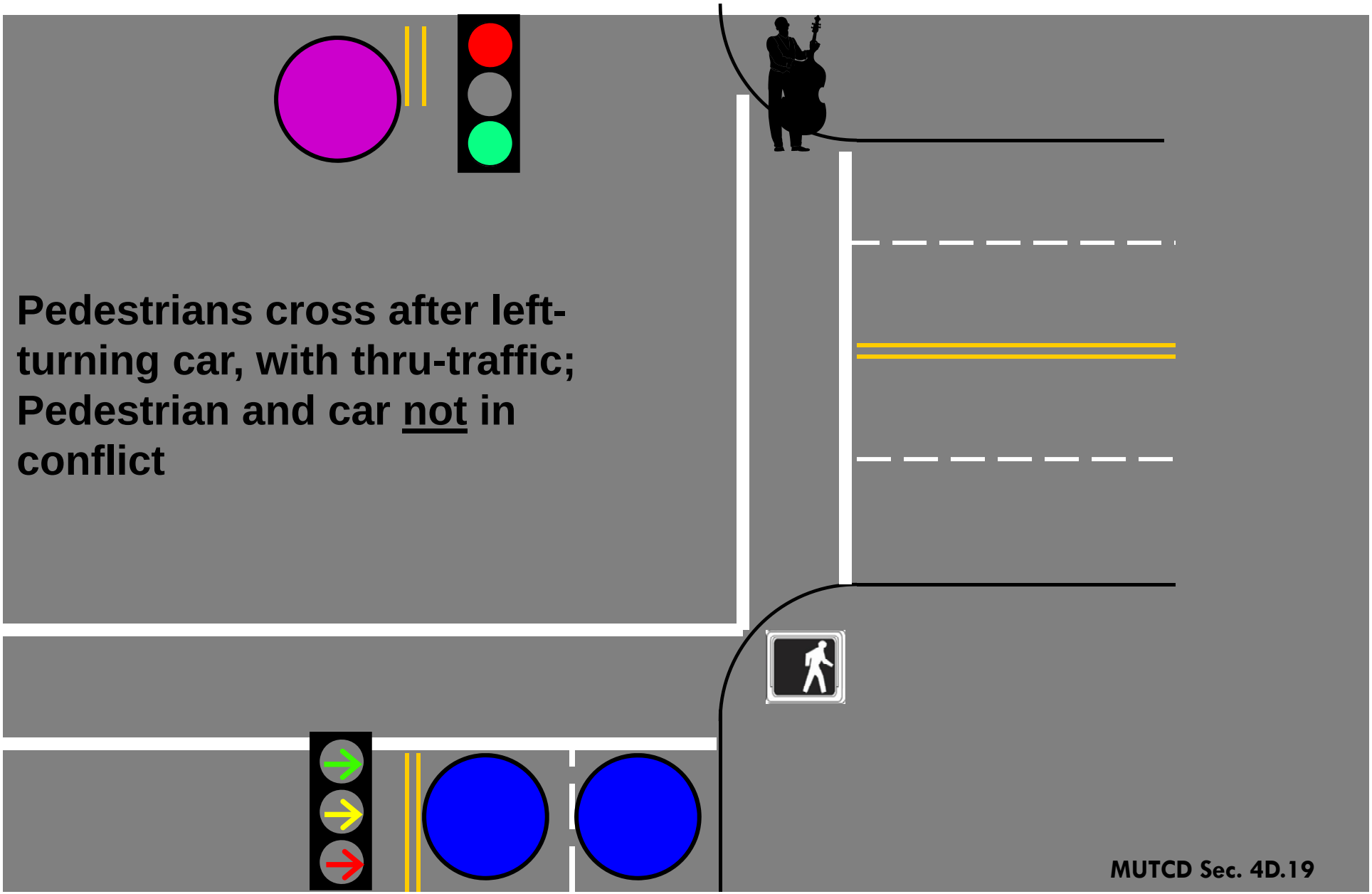
Protected Vs. Permissive Left Turns

* CMF = 0.3 (CRF 70%) (all crashes) converting permissive left turns to protected only left turns

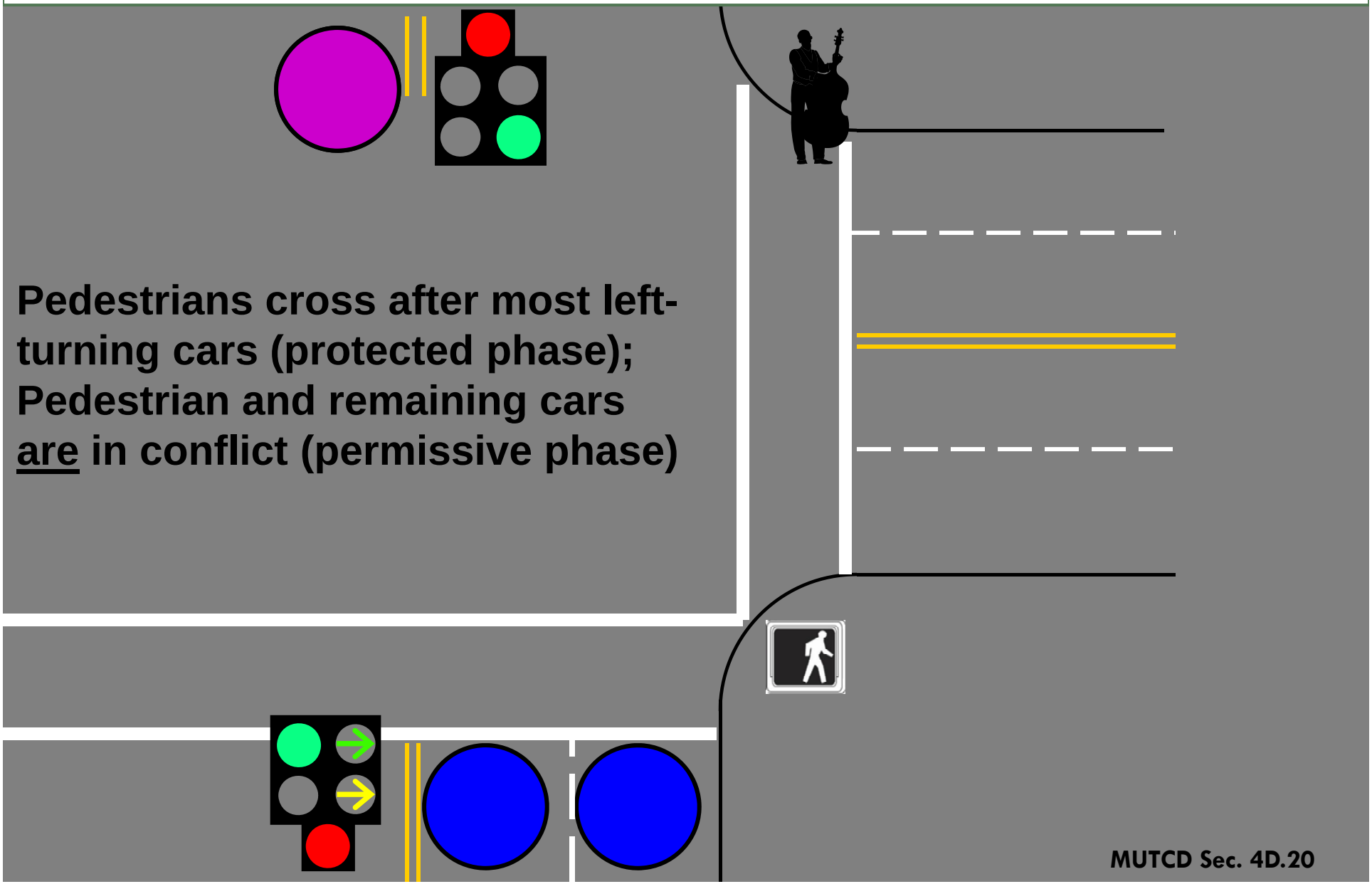
Permissive Left Turns



Protected Left Turns

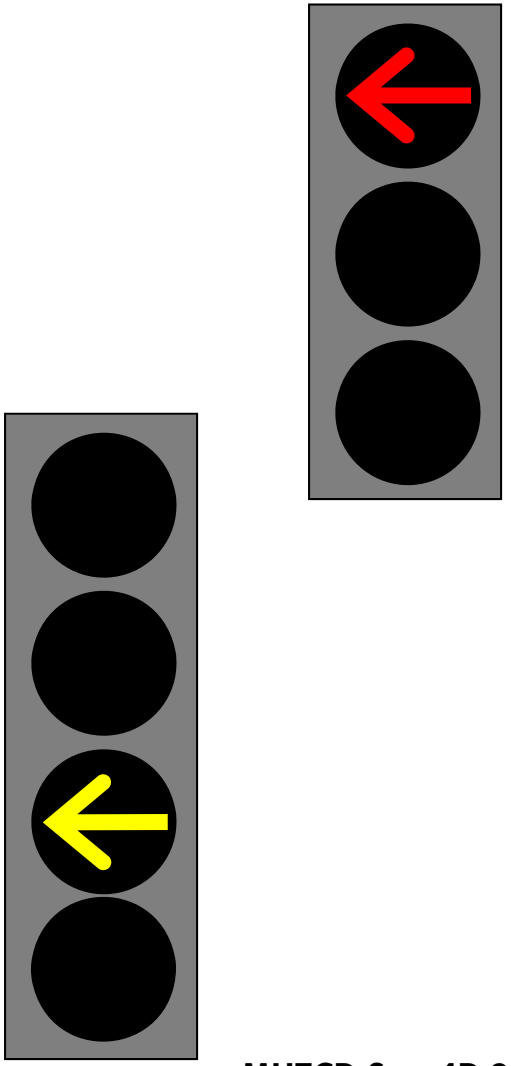


Protected/permissive Left Turns



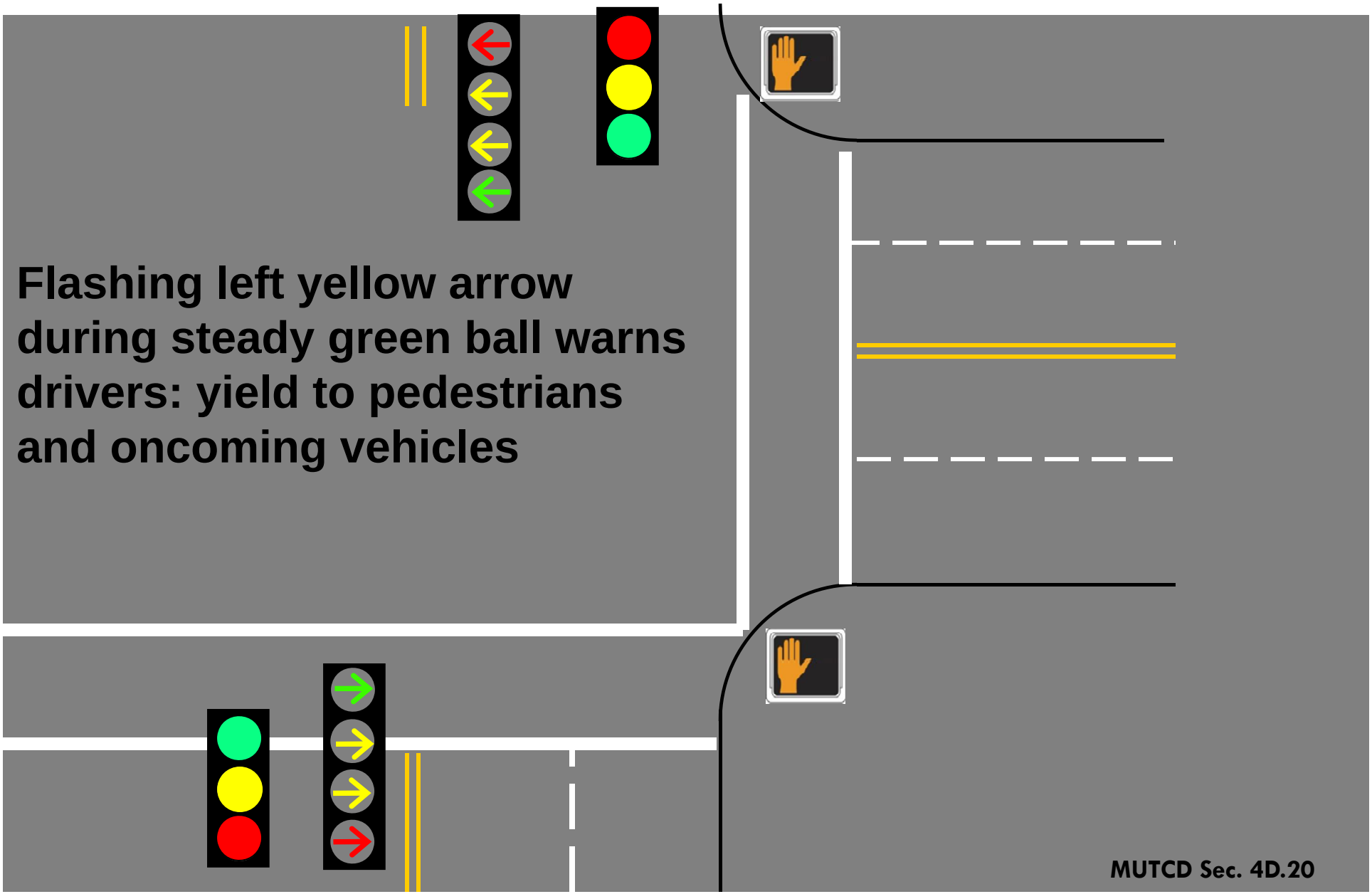
Protected/permissive Left Turns: Solutions

1. Provide protected-permissive phasing by default, but revert to protected-only when pedestrian button is pushed or based on time of day
2. Flashing Yellow Arrow (details on the next slide)

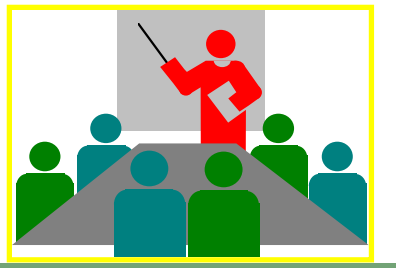


MUTCD Sec. 4D.20

Flashing Yellow Arrow



Discussion



- Do you use protected left turns to protect pedestrians from turning vehicles?
- Do you use protected/permissive phasing?
- If so, have you considered flashing yellow arrow during the steady green ball?

Restricting Turns on Red

Consider No Turn on Red signs where there is:

- Poor sight distance between vehicles and peds;
- An unusual number of ped conflicts with turns on red (compared to turns on green);
- An exclusive pedestrian phase; or
- A leading pedestrian interval

MUTCD Section 2B.54

Restricting Turns on Red:

1. At all times

Restricting Turns on Red

2. When pedestrians are present

Difficult to enforce

Restricting Turns on Red:

3. By time of day

Limits most turns on red

Restricting Turns on Red:

4. Changeable message sign – can be activated when ped pushes button or as set by controller

Note: An on-demand NTOR sign can be used to improve the effectiveness of a Lead Pedestrian Interval

Exclusive Pedestrian Phase (Barnes Dance)

6-64 **Pasadena CA**

- Popular because all traffic stops and pedestrians can cross in any direction (must ban turns on red)

MUTCD Figure 3B-20 (Markings)

6-65 **Pasadena CA**

- Pedestrians pay a price in delay:
- Pedestrians wait for traffic in one direction

Pedestrians wait for traffic in other direction

Reward: pedestrians can cross in any direction

6-68

LPI = Lead Pedestrian Interval

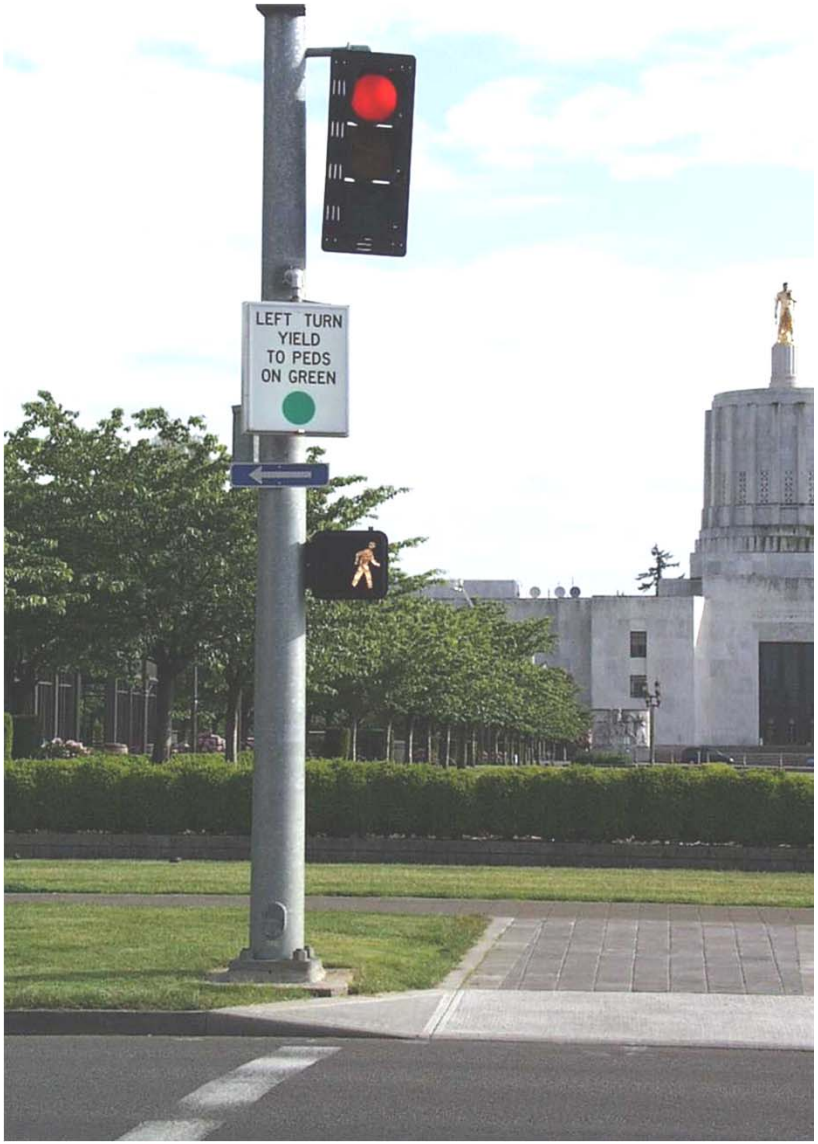
LPI gives pedestrians a head start

It's like a "mini" exclusive phase

MUTCD Sec. 4E.06, paragraphs 19-23

Leading Pedestrian Interval

STREETFILMS

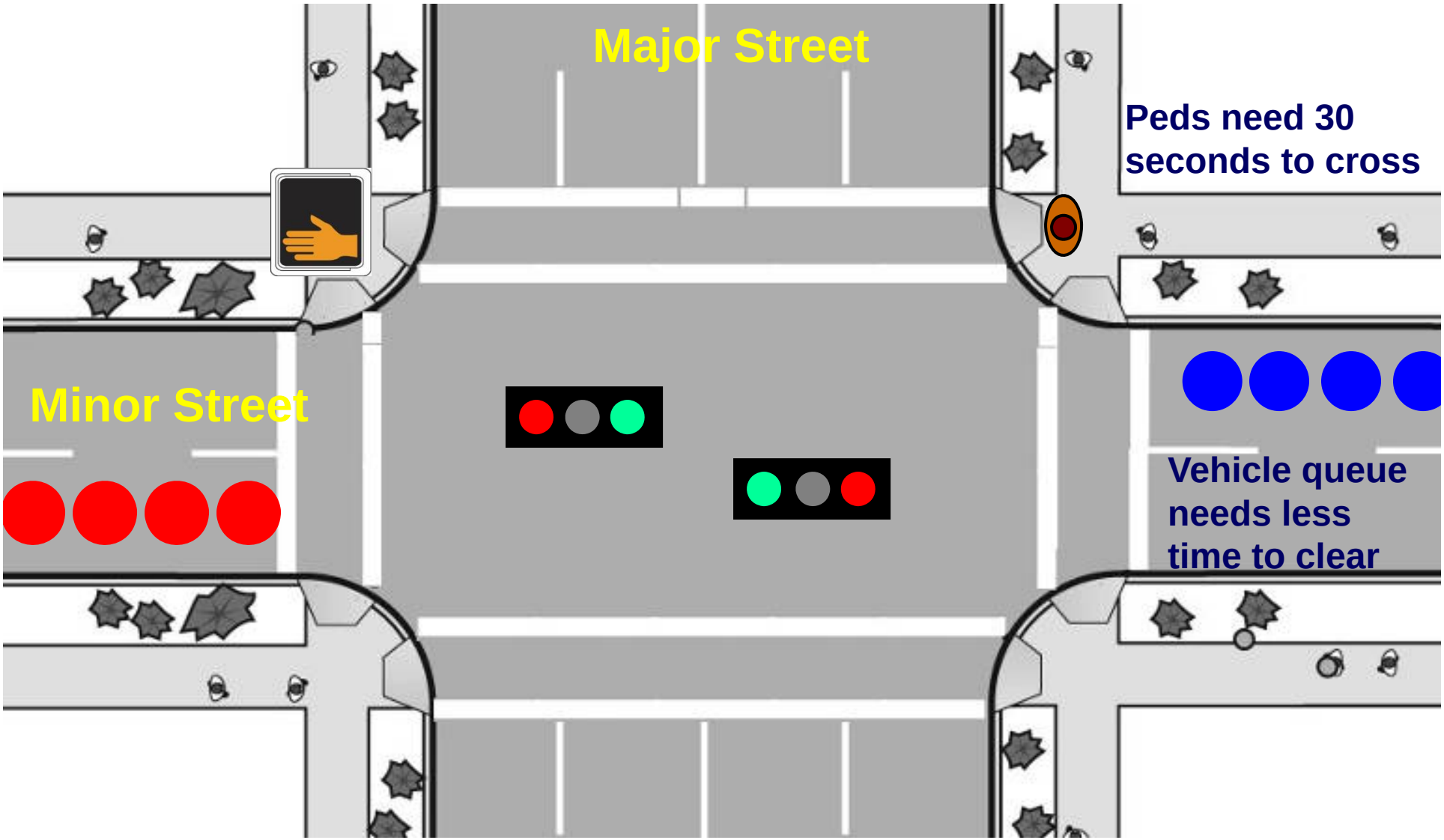


6-70

Salem OR

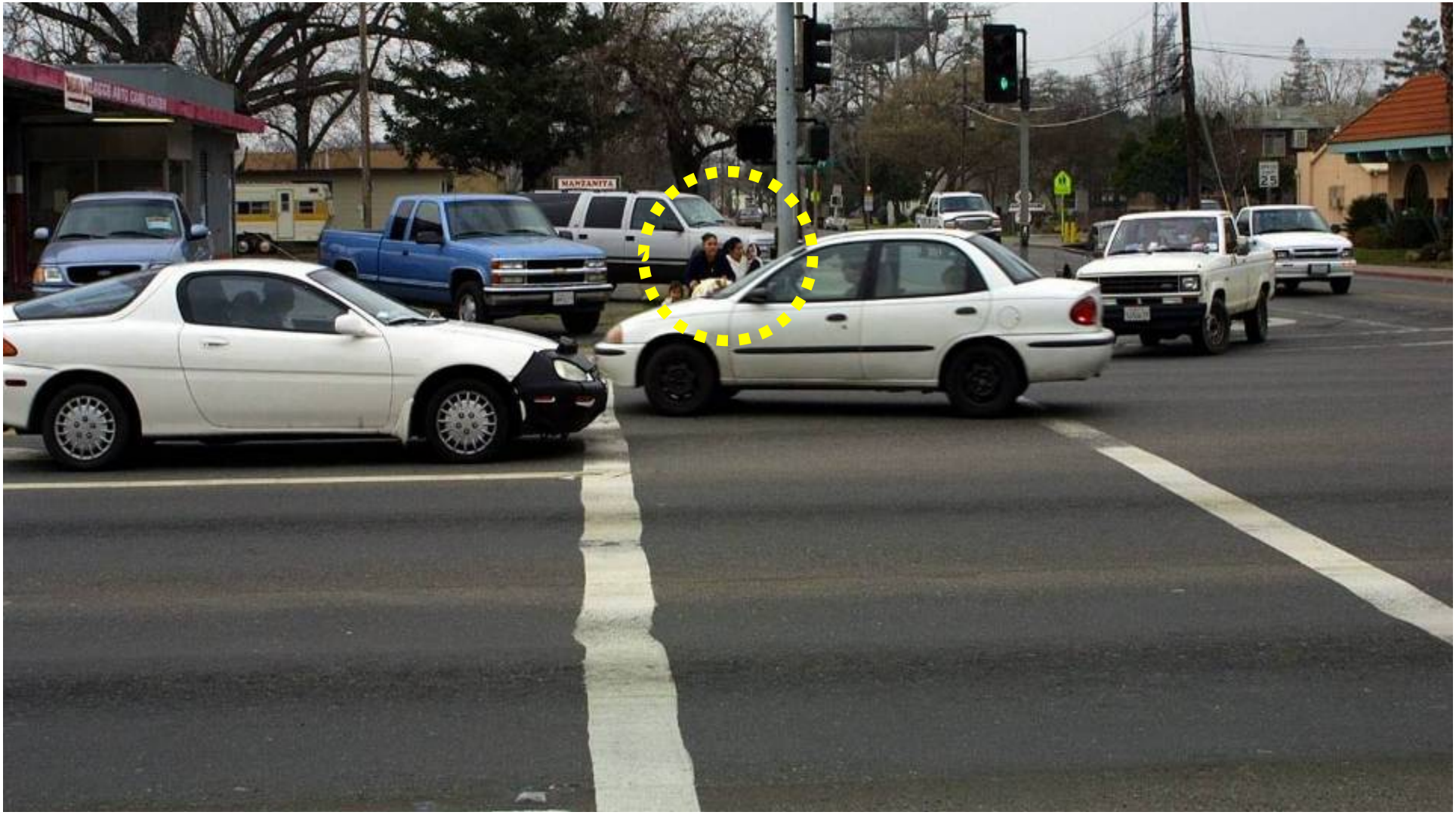
LPI : WALK comes on at least 3 seconds prior to the green signal; pedestrians enter crosswalk before turning vehicles arrive there.

Where do the extra 3-5 seconds come from?



Exclusive Ped Phases or LPI and Accessible Ped Signals

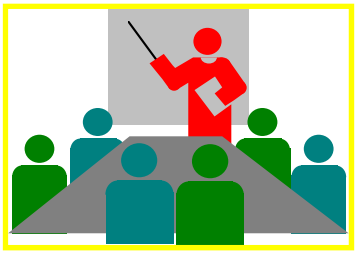
- Without APS, pedestrians with vision impairments cross by listening to vehicle movement
- With an exclusive ped phase or LPI, the walk signal does not coincide with vehicle movement
- Use APS with LPI or exclusive ped phases



6-73 **Gridley CA**

- These peds waited 3 cycles before turning drivers let them cross as legally required. LPI would give them a head start.
- CMF = 0.95 (CRF: 5%)

Discussion



- Do you restrict right turns on red where appropriate?
- Do you use Exclusive Pedestrian Phases or LPIs?

Learning Outcomes

You should now be able to:

1. Explain why traffic signals don't "guarantee" safety; they assign the right of way
2. Identify signal timing techniques that favor pedestrian crossing
3. Identify major conflicts: concurrent turn movements
4. Select protected turns to improve ped safety

Questions?