



National Committee on Uniform Traffic Control Devices

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NOTE: This is a recommendation to FHWA on changes to the MUTCD by the National Committee on Uniform Traffic Control Devices (NCUTCD). This recommendation is not a revision to the MUTCD and does not constitute official standards, guidance, or options. No proposed revision to the MUTCD is effective unless and until approved by FHWA through an Interim Approval or through the Federal rulemaking process.

TECHNICAL COMMITTEE:	Signals Technical Committee
TOPIC:	Recommendation – Reorganization and Revisions to Part 4
STATUS/DATE OF ACTION:	<ul style="list-style-type: none"> -Sent to sponsors following the January 2014 meeting - Sponsor comments reviewed at Summer 2014 meeting - Approved by NCUTCD Council at Summer 2014 meeting
Technical Committee Vote:	Jan 2014 meeting - STC – Unanimous
Transmitted to Sponsors:	March 2014
Council Approval:	June 28, 2014
ORIGIN OF REQUEST:	FHWA & STC
AFFECTED SECTIONS OF MUTCD:	All of Part 4

SUMMARY:

Prior to the January 2014 National Committee meeting, FHWA provided a Fall 2013 Compilation of Draft Technical Updates/Considerations file (Compilation file) for Part 4 of the MUTCD. The file included a reorganization and renumbering Part 4, the reduction of various Standard statements to other categories, deletion of some items, relocation of some items to other Parts, addition of some new text, and modifications to some existing text. The STC reviewed this document at the January meeting. This recommendation has been prepared for review and comment by the NCUTCD Sponsoring organizations.

Due to the size of the document and the number of changes included, it was not possible for the STC to review each and every change. Therefore, the STC discussion was limited to those items which were raised for discussion by various STC members. . For items where the STC feels that the changes included in the document received from FHWA should either not be made or should be modified, the recommendation from the STC was listed and sent to Sponsors for review and comment. The comments were reviewed at the June 2014 meeting, revisions were made, and the item was presented to and approved by the NCUTCD Council.

DISCUSSION:

After the 2009 MUTCD was issued, FHWA expressed an interest in reviewing Standard statements in the MUTCD to see which, if any, could either be reduced to Guidance or be eliminated. Although the STC has spent time on this review effort, we have not prepared a Technical Committee Recommendation on the issue. The Compilation file received from FHWA includes many revisions to Standard statements.

The STC feels that many of the reductions from Standard to Guidance are appropriate and supports the changes. However, there are some that the STC feels should remain a Standard for various reasons. One of the primary concerns is that the reduction to Guidance would eliminate the requirements established by the Standard thus opening the door to perhaps unexpected and undesired results. As an example, the 2009 MUTCD requires that the inside of signal visors (hoods), the surface of louvers and fins, and the front surface of backplates have a dull black finish. This Standard was proposed to be reduced to Guidance in the FHWA document. The STC is concerned that, if reduced to Guidance, then any color could be used for these items. Do we want purple, pink, blue, and/or any number of other colors to be used for these items? The flat black color currently required intends to minimize light reflection and to increase contrast between the signal indication and its background. The STC did not feel that the MUTCD should allow these items to be various (an unspecified) colors with no listed limitations. However, that is the result if a Guidance statement is used rather than a Standard statement. Many of the items that the STC is recommending to remain as a Standard rather than be reduced to Guidance are due to concerns of what unexpected results may occur if no requirement exists.

In addition to changes to Part 4 included in the Compilation file received from FHWA, the STC and the NCUTCD for Part 4 of the MUTCD also recommends some additional changes to the MUTCD which are included in this recommendation. Some of the more significant ones include revisions to the signal faces and displays used for flashing yellow arrow applications, the crash warrant, and to extended pushbutton press features. There is also a separate NCUTCD recommendation concerning the bicycle signal faces.

The proposed changes to Part 4 of the MUTCD are in a later Recommended Changes to the MUTCD section of this recommendation. These recommended changes include the items in the Compilation file received from FHWA that the NCUTCD concur with as well as items that the NCUTCD recommends vary from what was included in the Compilation file received from FHWA. The following items are a discussion of items included in Compilation file for which the NCUTCD does not concur, is proposing alternative language, or is proposing a change to the MUTCD not included in the Compilation file. The reference numbers listed in parenthesis have been inserted and highlighted in the Recommended Changes to the MUTCD section for ease of reference.

(1) Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Keep the following as a Standard rather than reducing it to Guidance in order to maintain a requirement for analysis of operations which would not be required as Guidance.

Standard:

The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic 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

(2) Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Keep the following as a Standard. Reducing this to Guidance implies that the satisfaction of a warrant could require signal installation. This statement is not intended to limit the installation of a signal. If a warrant is satisfied (or even if it is not for that matter) a signal is allowed to be installed based on an engineering study. There may be factors other than the warrant that are determined to justify signal installation. However, the MUTCD should not leave it for interpretation that the satisfaction of a warrant in and of itself could require signal installation.

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

(3) Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Make an editorial change by adding “as” as shown in yellow highlighting:

Option:

For signal warrant analysis, a location with a wide median, even if the median width is greater than 30 feet, ~~should~~ may be considered analyzed as one intersection or as two intersections based on engineering judgment.

(4) Section 4C.08 Warrant 7, Crash Experience

Revise the crash warrant based on research documented in the Final Report for NCHRP Project No. 07-18, CRASH EXPERIENCE WARRANT FOR TRAFFIC SIGNALS. This was performed by Kittelson & Associates, Inc., Portland, Oregon.

(Revisions shown in the Recommended Changes to the MUTCD section of this recommendation.)

(5) Section 4D.01 General

Keep the first sentence of the paragraph as a Standard rather than reducing it to Guidance. Reducing to a Standard eliminates any requirement for covering the signal faces or removing them from the view of approaching drivers when signals are not in operation. If not covered or removed from view, the signal faces could appear dark to approaching drivers. In at least some states, a dark traffic control signal must be treated as a STOP sign. In addition to unnecessary delay, this increases the risk of collisions due to unexpected stops. Concur with adding the new paragraph to Guidance.

Standard:

When a traffic control signal is not in operation, such as before it is placed in service, during seasonal shutdowns, or when it is not desirable to operate the traffic control signal, the signal faces shall be covered, turned, or taken down to clearly indicate that the traffic control signal is not in operation.

Guidance:

If a cover is placed over a traffic control signal face that is not in operation and that has a yellow retroreflective strip along the perimeter of its signal backplate (see Paragraph 21 in Section 4D.12), the entire signal face, including the backplate, should be covered. If a traffic control signal face that is not in operation and that has a yellow retroreflective strip along the perimeter of its signal backplate is turned, the turned signal face should be oriented such that the yellow backplate border will not reflect light back to road users on any of the approaches to the intersection.

(6) Section 4D.01 General

Keep this sentence as a Standard rather than reducing it to Guidance. This sentence has been in the MUTCD for quite some time. Reducing it to a Standard could result in placement of signal faces at locations where the area they are intended to control is unclear or confusing. Concur with reducing the second sentence to Guidance.

1 **Standard:**

2 **A traffic control signal shall control traffic only at the intersection or midblock location where**
3 **the signal faces are placed.**

4 ~~Standard~~ Guidance:

5 Midblock crosswalks ~~shall~~ should not be signalized if they are located within 300 feet from the
6 nearest traffic control signal, unless the proposed traffic control signal will not restrict the progressive
7 movement of traffic.

9 (7) Section ~~4D.03~~ 4D.02 Provisions for Pedestrians

10 Keep this as a Standard rather than reducing it to Guidance. Pedestrian signal heads or vehicular
11 signal heads visible to pedestrians are the only likely ways to provide information to pedestrians when
12 engineering judgment has determined that provisions for pedestrians are needed. Therefore their use
13 should be required.

15 **Standard:**

16 **If engineering judgment indicates the need for provisions for a given pedestrian movement,**
17 **signal faces conveniently visible to pedestrians shall be provided by pedestrian signal heads (see**
18 **Chapter 4E) or a vehicular signal face(s) for a concurrent vehicular movement.**

20 (8) Section ~~4D.12~~ 4D.05 Visibility, Aiming, and Shielding of Signal Faces

21 Keep this as a Standard rather than reducing it to Guidance. A reduction to Guidance removes all
22 requirements for the color of backplates, the inside of visors, etc. and could result in multiple colors
23 used for any number of reasons that are unrelated to traffic control. For example, different colored
24 backplates could be used to identity (brand) one suburb versus another in a metropolitan area or one
25 neighborhood versus another within a city. The dull back finish if specified to reduce/minimize
26 reflected light that could wash out active signal indications. Therefore, that requirement should be
27 retained.

29 **Standard:**

30 **The inside of signal visors (hoods), the entire surface of louvers and fins, and the front surface**
31 **of backplates shall have a dull black finish to minimize light reflection and to increase contrast**
32 **between the signal indication and its background.**

34 (9) Section ~~4D.15~~ 4D.08 Mounting Height of Signal Faces

35 Make editorial corrections to change “shall” to “should” in sentences listed as being changed from
36 Standard to Guidance.

38 *The bottom of the signal housing (including brackets) of a vehicular signal face that is vertically*
39 *arranged and not located over a roadway:*

40 A. ~~Shall~~ Should be a maximum of 19 feet above the sidewalk or, if there is no sidewalk, above the
41 pavement grade at the center of the roadway.

42 B. ~~Shall~~ Should be a maximum of 19 feet above the median island grade of a center median island if
43 located on the near side of the intersection.

44 *The bottom of the signal housing (including brackets) of a vehicular signal face that is horizontally*
45 *arranged and not located over a roadway:*

46 A. ~~Shall~~ Should be a maximum of 22 feet above the sidewalk or, if there is no sidewalk, above the
47 pavement grade at the center of the roadway.

48 B. ~~Shall~~ Should be a maximum of 22 feet above the median island grade of a center median island if
49 located on the near side of the intersection.

(10) Section ~~4D.32~~4D.10 Temporary and Portable Traffic Control Signals

Although the title of the section lists both temporary and portable traffic control signals, portable signals were not mentioned in the section. Add a Support statement noting that a portable signal is a temporary signal as shown in the Recommended Changes to the MUTCD section of this recommendation.

(11) Section ~~4D.06~~4E.01 Signal Indications – Design, Illumination, Color, and Shape

Make editorial change from “alternate” to “alternating” when referring to the different displays from a dual-arrow signal section.

(12) Section ~~4D.17~~4F.02 Signal Indications for Left-Turn Movements – General

Concur with keeping as a Standard rather than reducing it to Guidance but recommend the following alternate language:

Standard:

If a combined left-turn/through lane exists on an approach, a protected only mode left-turn movement that does not begin and terminate at the same time as the adjacent through movement shall not be provided on ~~the~~an approach ~~unless an exclusive left turn lane exists.~~

(13) Section 4F.08 Signal Indications for Protected/Permissive Mode Left-Turn Movements in a Separate Signal Face

Concur with keeping the existing sentence as a Standard but recommend that the proposed new sentence be added as an Option rather than a Standard and added without a reference to providing a red clearance interval.

Standard:

C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication. ~~It shall be permitted to display a steady left-turn RED ARROW signal indication immediately following the steady left turn YELLOW ARROW signal indication to provide a red clearance interval.~~

Option:

A steady left-turn RED ARROW signal indication may be displayed immediately following the steady left-turn YELLOW ARROW signal indication.

(14) Section 4F.15 Signal Indications for Protected/Permissive Mode Right-Turn Movements in a Separate Signal Face

Concur with keeping the existing sentence as a Standard but recommend that the proposed new sentence be added as an Option rather than a Standard and added without a reference to providing a red clearance interval.

Standard:

C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-turn GREEN ARROW signal indication. ~~It shall be permitted to display a steady right turn RED ARROW signal indication immediately following the steady right turn YELLOW ARROW signal indication to provide a red clearance interval.~~

Option:

A steady right-turn RED ARROW signal indication may be displayed immediately following the steady right-turn YELLOW ARROW signal indication.

(15) Section ~~4D.26~~4F.17 Yellow Change and Red Clearance Intervals

Recommend against adding the proposed new language in the MUTCD. This level of specificity in determining the duration of a yellow change is felt appropriate for inclusion in an engineering practices publication rather than in the MUTCD.

Support:

~~Because research has shown that the 85th percentile speed for free-flowing vehicles in the through lanes on an approach to a signalized location is typically about 7 mph higher than the posted or statutory speed limit on the approach, both the requirement provided in Paragraph 5 and the recommendation provided in Paragraph 6 are applicable to the minimum duration of a yellow change interval.~~

Standard:

~~The duration of the yellow change interval for a through movement shall not be lower than the value determined by the following formula:~~

$$Y = 1 + (1.47V)/(20 + 64.4g)$$

~~where Y equals the duration of the yellow change interval in seconds; V equals the posted or statutory speed limit in mph on the approach; and g equals the approach grade in percent divided by 100, with negative numbers for downgrades.~~

Guidance:

~~The duration of the yellow change interval for a through movement should not be lower than the value determined by the following formula:~~

$$Y = 1 + (1.47(V + 7))/(20 + 64.4g)$$

~~where Y equals the duration of the yellow change interval in seconds; V equals the posted or statutory speed limit in mph on the approach; and g equals the approach grade in percent divided by 100, with negative numbers for downgrades. If the 85th percentile speed on an approach has been documented by an engineering study to be less than 7 mph higher than the posted or statutory speed limit, the 85th percentile speed in mph should be substituted for the "V + 7" value in the formula.~~

(16) Section 4F.19 Preemption Control of Traffic Control Signals

Recommend that hybrid beacons be added to this Guidance since hybrid beacons display red indications and therefore, if installed near a grade crossing, the need for preemption should be considered.

Guidance:

*If a traffic control signal **or hybrid beacon** is installed near or within a grade crossing or if a grade crossing with active traffic control devices is within or near a signalized highway intersection, Chapter 8C should be consulted.*

(17) Section ~~4E.07~~4I.05 Countdown Pedestrian Signals

Recommend that the following sentence be retained as a Standard rather than reducing it to Guidance. Most countdown displays are now integral with the UPRAISED HAND (symbolizing DON'T WALK) indication. In cases where the countdown display is a separate unit, it needs to be near the UPRAISED HAND indication since each of these provides complimentary information about pedestrian crossings. While "immediately adjacent" may not be a specified dimension, it is felt to be a better description than the term "near the UPRAISED HAND".

Standard:

The countdown pedestrian signal shall be located immediately adjacent to the associated UPRAISED HAND (symbolizing DONT WALK) pedestrian signal head indication (see Figure 4E-1).

(18) Section ~~4E.08~~4I.06 Pedestrian Detectors

Concur with the changes in the FHWA document but recommend that this be combined into a single continuous paragraph as follows rather than list A and B sentences:

Option:

Where there are physical constraints on a particular corner that make it impractical to provide the 10-foot separation between the two pedestrian pushbuttons, or when an exclusive pedestrian phase is used at an intersection and the pedestrian signals controlling the crosswalks on a given corner of the intersection both operate together such that the "Walk" indication is always simultaneous for both crosswalks, the pushbuttons may be placed closer together or on the same pole.

(19) Section ~~4E.08~~4I.06 Pedestrian Detectors

Recommend keeping this as a Standard rather than reducing it to Guidance. These signs provide valuable information concerning the purpose of the pushbutton as well as the operation of the pedestrian signal heads. Therefore, their use is important and the requirement ought to be continued.

Standard:

Signs (see Section 2B.52) shall be mounted adjacent to or integral with pedestrian pushbuttons, explaining their purpose and use.

(20) Section ~~4E.08~~4I.06 Pedestrian Detectors

Recommend keeping this as a Standard rather than reducing it to Guidance. Since many pushbuttons and pushbutton signs contain an arrow indicating the direction of the crossing, it is important that they indicate which crosswalk is controlled by which pushbutton therefore this should remain a Standard. However, it was felt that the term "clearly" did not provide specific value or clarity to the sentence and it is therefore recommended for deletion.

Standard:

The positioning of pedestrian pushbuttons and the legends on the pedestrian pushbutton signs shall ~~clearly~~ indicate which crosswalk signal is actuated by each pedestrian pushbutton.

(21) Section ~~4E.06~~4I.07 Pedestrian Intervals and Signal Phases

Recommend changing the listed duration of the buffer interval from 3 seconds to 2 seconds based on FHWA approved experimentation that was conducted in Delaware.

Standard:

A pedestrian change interval consisting of a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication shall begin immediately following the WALKING PERSON (symbolizing WALK) signal indication. Following the pedestrian change interval, a buffer interval consisting of a steady UPRAISED HAND (symbolizing DONT WALK) signal indication shall be displayed for at least 32 seconds prior to the release of any conflicting vehicular movement. The sum of the time of the pedestrian change interval and the buffer interval shall not be less than the calculated pedestrian clearance time (see Paragraphs 7 through 16). The buffer interval shall not begin later than the beginning of the red clearance interval, if used.

(22) Section ~~4E.09~~4J.01 ~~Accessible Pedestrian Signals and Detectors~~ — General

Concur with keeping the first sentence of existing MUTCD 4E.09, P6 paragraph as a Standard but also recommend that the second sentence be retained as a Standard rather than reducing it to Guidance. However, it was felt that the term "clearly" in this sentence did not provide specific value or clarity it is therefore recommended for deletion. Also recommend that existing MUTCD Section 4E.09, P7 be retained as a Standard. This group of Standard statements is recommended as follows:

Standard:

When used, accessible pedestrian signals shall be used in combination with pedestrian signal timing. The information provided by an accessible pedestrian signal shall ~~clearly~~ indicate which pedestrian crossing is served by each device.

Under stop-and-go operation, accessible pedestrian signals shall not be limited in operation by the time of day or day of week.

(23) Section ~~4E.09~~4J.01 ~~Accessible Pedestrian Signals and Detectors~~ — General

Recommend that this be retained as a Standard rather than reducing it to Guidance. This sentence is located in a section addressing accessible pedestrian signals. Therefore, it is assumed that the items within this section are being applied where accessible pedestrian signals exist. Since a pushbutton is often incorporated into an accessible pedestrian signal, it is important that a pushbutton actuation activate the WALK indications provided by the pedestrian signal heads and by the accessible pedestrian signal. This also applies in the event both a “standard” pushbutton and an accessible pedestrian signal with an integral pushbutton exist for a given crosswalk since a person with a visually disability might find and activate the “standard” pushbutton rather than the pushbutton in the accessible pedestrian signal.

Standard:

At accessible pedestrian signal locations where pedestrian pushbuttons are used, each pushbutton shall activate both the walk interval and the accessible pedestrian signals.

(24) Section ~~4E.11~~4J.03 ~~Accessible Pedestrian Signals and Detectors~~ — Walk Indications

Concur with keeping the first sentence of existing MUTCD 4E.11, P4 paragraph as a Standard but also recommend that the second sentence be retained as a Standard rather than reducing it to Guidance. Also recommend a minor text change to clarify the point where the audible WALK indication is required to be audible.

Standard:

The audible walk indication shall be audible ~~at~~from the beginning of the associated crosswalk.

(25) Section ~~4E.11~~4J.03 ~~Accessible Pedestrian Signals and Detectors~~ — Walk Indications

Recommends that this be retained as a Standard rather than reducing it to Guidance in order to establish requirements for automatic volume adjustment as well as a maximum volume. Neither would exist if this were a Guidance statement. An editorial change in the sentence wording is also recommended and shown as follows:

Standard:

Automatic volume adjustment up to a maximum volume of 100 dBA in response to ambient traffic sound level shall be provided ~~up to a maximum volume of 100 dBA~~.

(26) Section ~~4E.11~~4J.03 ~~Accessible Pedestrian Signals and Detectors~~ — Walk Indications

Recommend that this be retained as a Standard rather than reducing it to Guidance. Whether or not a pilot light is used, it is good to sound a “wait” message any time an accessible pedestrian signal button is actuated. Doing so provides positive feedback that it is not the proper time to begin a crossing. Since there is a chance that someone might incorrectly misinterpret an illuminated pilot light as meaning a WALK is active, sounding a “WAIT” message when the accessible pedestrian signal is actuated and a pilot light is illuminated is even more important.

Standard:

If a pilot light (see Section 4E.08) is used at an accessible pedestrian signal location, each actuation shall be accompanied by the speech message “wait.”

(27) Section ~~4E.12~~4J.04 ~~Accessible Pedestrian Signals and Detectors~~ — Vibrotactile Arrows and Locator Tones

Recommend that the existing paragraph be retained as a Standard and that the new text shown as Guidance also be included as a Standard. It is important that accessible pedestrian signals be locatable and provide unambiguous information to persons with visual disabilities. It is also recommended that the vibrotactile arrow be on the button, not adjacent to it. This edit is shown below. It is recommended that the word “plunger” be deleted where it is used (in two places) as it is an undefined term and is somewhat ambiguous as used.

Standard:

To enable pedestrians who have visual disabilities to distinguish and locate the appropriate pushbutton at an accessible pedestrian signal location, pushbuttons shall ~~clearly~~ indicate by means of vibrotactile arrows which crosswalk signal is actuated by each pushbutton. Vibrotactile arrows shall be located on the ~~button (plunger) of the pushbutton assembly or immediately adjacent to the button (plunger) on the same surface of the pushbutton assembly housing,~~ shall ~~should~~ have high visual contrast (light on dark or dark on light), and shall be aligned parallel to the direction of travel on the associated crosswalk.

- (28) Section ~~4E.124J.04 Accessible Pedestrian Signals and Detectors~~ Vibrotactile Arrows and Locator Tones

Recommend that the existing language be retained as a Standard rather than reducing it to Guidance and that the additional language be added as a Standard as shown below. If this is reduced to Guidance, there will no longer be a requirement establishing the duration of the locator tone or its rate of repetition.

Standard:

Pushbutton locator tones shall have a duration of 0.15 seconds or less, and, except as provided in Paragraph 6, pushbutton locator tones shall repeat at 1-second intervals at all times that the audible walk indication is not active, including during the pedestrian change interval and during the time that the pedestrian signal is resting in walk (see Paragraph 6 in Section 4E.11).

- (29) Section ~~4E.124J.04 Accessible Pedestrian Signals and Detectors~~ Vibrotactile Arrows and Locator Tones

Recommend that the first part of this be retained as a Standard rather than being reduced to Guidance. If changed to Guidance, there would be no requirement that accessible pedestrian signals be intensity responsive to ambient sound. Concur that the second portion of the sentence is appropriate as Guidance.

Standard:

Pushbutton locator tones shall be intensity responsive to ambient sound.⁵

Guidance:

Pushbutton locator tones should ~~and~~ be audible 6 to 12 feet from the pushbutton, or to the building line, whichever is less.

- (30) Section ~~4E.134J.05 Accessible Pedestrian Signals and Detectors~~ Extended Pushbutton Press Features

Recommends that this be retained as a Standard rather than reducing it to Guidance in order to require consistency in the operation. If reduced to a Guidance statement, any duration could be used.

Standard:

If an extended pushbutton press is used to provide any additional feature(s), a pushbutton press of less than one second shall actuate only the pedestrian timing and any associated accessible walk indication, and a pushbutton press of one second or more shall actuate the pedestrian timing, any associated accessible walk indication, and any additional feature(s).

- (31) Modification to Extended Pushbutton Press Features

Research has been conducted for approximately 10 years to find ways that an APS could provide an audible beacon that would reliably help blind pedestrians cross within the crosswalk and not veer into moving traffic on the street beside them. The only reliable beaconing system was one in which the beacon comes from the opposite end of the crosswalk, i.e. the end toward which the pedestrian is headed. This was initially technically difficult and expensive and there were concerns that blind pedestrians would make mistakes in recognizing which walk indication was for the crosswalk they wanted to use. However, about 5 years ago, technology had developed to the point where having an audible beacon that came from the far side of the crosswalk only was feasible and not exorbitant in cost.

Research was conducted in three cities that showed consistent benefits of pedestrians staying within the crosswalk when a far side beacon was used. The far side beacon was activated by a long button press and the volume from a far side speaker was elevated only for the pushbutton locator tone during the pedestrian change interval following the walk indication. The volume of the walk indication was not elevated.

A final experiment with this type of beaconing was conducted to determine whether there was any reasonable likelihood that pedestrians would mistake the walk indication for a crosswalk other than the crosswalk they intended to use. The experiment was conducted at a relatively small, skewed intersection, with buildings on all corners that might reflect the sound and confuse blind pedestrians. On one third of the trials, an experimenter pushed a button to actuate a beacon for a crosswalk other than the one that participants intended to cross, and for which the participant had pushed the button themselves. No participants began to cross with the wrong signal. Therefore the concerns about where beaconing should be used are not relevant for this type of beaconing. This was the only beaconing that worked for its intended purpose of helping blind pedestrians go straight across the street.

None of the options provided as Standard in the 2009 MUTCD (Pg. 70, Lines 7-11) succeeded in improving pedestrians staying within the crosswalk. Therefore, they are recommended for deletion. .

Elevating the volume of both the walk indication and pushbutton locator tone during the subsequent pedestrian change interval is helpful in enabling blind pedestrians who have concomitant hearing loss to simply hear the signal above ambient sound. We now require that the volume of both the walk indication and the pushbutton locator tone adjust to ambient sound, and we limit the upper level of that volume to 100 dBA. Yet visually impaired travelers, most of whom are older than 65, typically have some degree of age-related hearing loss, and they may find it hard to hear the APS tones. Given a way to elevate the volume, just for the phase in which they want to cross typically enables them to hear the APS tones. This elevated volume of both the walk indication and the subsequent pushbutton locator tone does not function as a beacon, but it makes it more likely that the pedestrian who is visually impaired who also has some degree of hearing loss will actually be able to benefit from the standard APS features. Therefore this is included as an Option. All APS devices currently marketed in the US have this capability.

Proposed changes are included in the Recommended Changes to the MUTCD section of this recommendation.

(32) Section ~~4F.02~~4K.02 Design of Pedestrian Hybrid Beacons

Pedestrian hybrid beacons are installed specifically to assist pedestrians crossing a roadway. In order to accommodate pedestrians with visual disabilities, it is recommended to add a new Guidance statement as follows:

Accessible pedestrian signals should be installed in conjunction with a pedestrian hybrid beacon.

(33) Section ~~4F.02~~4K.02 Design of Pedestrian Hybrid Beacons

An R-10-23 sign is currently required at a pedestrian hybrid beacon. While this sign addresses appropriate driver action on a red indication, it does not address the appropriate driver actions during the flashing red indications. Many drivers remain stopped during the flashing red period when they are allowed to proceed and they could do so without conflict with any pedestrian movements. Therefore, some cities have used other signs to indicate that drivers are allowed to proceed after stopping when the flashing red indications are active. Some cities have also felt that pedestrian crossing signs were needed at a pedestrian crosswalk controlled by a hybrid beacon. While there was discussion on adding a new sign to address the driver actions during the flashing red indications, no determination was made on the appropriate sign and conditions.

It is recommended to change the use of the existing R10-23 sign from a Standard to an Option. Additionally, concur with the FHWA proposal to change the requirement for a sign adjacent to an overhead signal face from Standard to Guidance. It is also recommended to modify this sentence to note that it is applicable “when an associated sign is used”.

Proposed changes are included in the Recommended Changes to the MUTCD section of this recommendation.

(34) ~~Section 4E-03~~ 4K.03 Operation of Pedestrian Hybrid Beacons

Recommend an editorial change to the Standard as follows to clarify that the activation of the pedestrian hybrid beacon may not be immediate (as could be incorrectly inferred from “upon”), but that the pedestrian hybrid beacon sequence will begin “following” the actuation. This allows for a minimum time setting between successive activations or use in a coordinated system with predetermined yield points to serve the pedestrian crossing.

~~Upon~~ **Following an** actuation by a pedestrian, a pedestrian hybrid beacon face shall display a flashing CIRCULAR YELLOW signal indication, followed by a steady CIRCULAR YELLOW signal indication, followed by both steady CIRCULAR RED signal indications during the pedestrian walk interval, followed by alternating flashing CIRCULAR RED signal indications during the pedestrian change interval (see Figure 4F-3). Upon termination of the pedestrian change interval, the pedestrian hybrid beacon faces shall revert to a dark (not illuminated) condition.

(35) CHAPTER 4L. RECTANGULAR RAPID FLASHING BEACONS

It is recommended that, assuming RRFBs are included in the next MUTCD, that language addressing the use of audible information device be included. See #41 for more explanation and the Recommended Changes to the MUTCD section of this recommendation for the recommend language.

(36) ~~Section 4G-01~~ 4M.01 Application of Emergency-Vehicle Traffic Control Signals and Hybrid Beacons

Recommend that “safely” be deleted from the Support statement since safety cannot be guaranteed or necessarily provided by the traffic control device. Rather, it is dependent on proper road user actions in conjunction with well-designed and operated traffic control devices.

(37) ~~Section 4L-02~~ 4S.02 Intersection Control Beacon

Standards in this section indicate one of the applications of an intersection control beacon is red indications for all approaches. However, it notes parenthetically “if the warrant described in Section 2B.07 for a multi-way stop is satisfied” thus implying that red indications for all approaches would not be allowed if an all-way stop existed but the warrant was not satisfied. The presence of the all-way stop control should be the determining factor rather than the satisfaction, or lack thereof, of the warrant. If an all-way stop exists, the only practical and logical application of an intersection control beacon is red indications for all approaches. An exception would be the unlikely case where the all-way stop was being converted to stop control on only one of the roadways in conjunction with the installation of the

intersection control beacon. Therefore, it is recommended that the condition for using red indications for all approaches be modified as follows:

Application of Intersection Control Beacon signal indications shall be limited to the following:

- A. Yellow on one route (normally the major street) and red for the remaining approaches, and**
- B. Red for all approaches (if ~~the warrant described in Section 2B.07 for~~ a multi-way stop ~~exists~~is satisfied).**

Flashing yellow signal indications shall not face conflicting vehicular approaches.

(38) Section ~~4L.03~~4S.03 Warning Beacon

It is recommended that language addressing the use of audible information device be included in this section. See #41 for more explanation and the Recommended Changes to the MUTCD section of this recommendation for the recommend language.

(39) CHAPTER ~~4M~~4T. LANE-USE CONTROL SIGNALS

The FHWA document noted that this chapter is being considered for relocation to Part 2. It is recommended that this chapter remain in Part 4 as lane use control signals are typically installed, operated, and maintained by traffic signal personnel and use traffic signal components. They may also be coordinated with traffic signal equipment such that signal phases and lane control signals operational plans change at the same time.

(40) CHAPTER ~~4N~~4U. IN-ROADWAY WARNING LIGHTS

The FHWA document noted that this chapter is being considered for relocation to Part 3. It is recommended that this chapter remain in Part 4. Although these lights physically look like illuminated pavement markers, their function is like a warning beacon.

(41) CHAPTER ~~4N~~4U. IN-ROADWAY WARNING LIGHTS

Recommend that these lines be modified to eliminate the reference to accessible pedestrian signal (APS) features since, by definition (see Section 1A.13 paragraph 3, definition #1), an APS is “a device that communicates information about pedestrian signal timing”. No pedestrian signals are in place in conjunction with In-Roadway Warning Lights and therefore the use of an APS is inappropriate. However, an “audible information device” (referenced several times in Part 6) can be used in conjunction with In-Roadway Warning Lightsto provide an audible indication of when the In-Roadway Warning Lights are active. Similar situations may also exist at other traffic control devices where a pushbutton may be used to activate a feature but there is no pedestrian signal present. Recommended changes to the MUTCD have also been as separate items for those cases.

The following Standard and Guidance language is recommended as an alternative to that included in the document from FHWA for In-Roadway Warning Lights:

~~Guidance:~~

~~If accessible pedestrian signal features (see Section 4E.09) are used in conjunction with In-Roadway Warning Lights, the audible message during the time that the lights are flashing should be a speech message that says, “Flashing yellow lights are on.”~~

~~Standard:~~

~~If accessible pedestrian signal features are used in conjunction with In-Roadway Warning Lights, the vibrotactile indications that are required for walk indications (see Paragraph 2 in Section 4E.11) shall not be used.~~

STANDARD

An audible information device used in conjunction with In-Roadway Warning Lights shall not use vibrotactile indications or percussive indications.

Guidance:

If an audible information device is used in conjunction with In-Roadway Warning Lights, the audible message should be a speech message that says, "Yellow lights are flashing". The audible message should be spoken twice.

(42) Flashing Yellow Arrow for permissive turns issue

The NCUTCD is recommending changes concerning the display for flashing yellow arrows for permissive turning movements. When the use of a flashing YELLOW ARROW for permissive movements was added to the MUTCD, the signal face that contains a flashing YELLOW ARROW indication was required to be a four-section signal face with separate sections for the steady YELLOW ARROW and the flashing YELLOW ARROW. However, a three-section signal face containing a dual-arrow signal section was allowed in cases where signal head height limitations (or lateral positioning limitations for a horizontally-mounted signal face) do not permit the use of a four-section signal face. When a three-section signal face was used, the dual-arrow signal section was required to display a GREEN ARROW for the protected turn movement and a flashing YELLOW ARROW for the permissive turn movement.

Some agencies expressed interest in being allowed to use a three-section signal face with a dual-arrow section whether or not physical limitations existed at the location. Additionally, some agencies were interested in using a steady YELLOW ARROW/flashing YELLOW ARROW dual-arrow section rather than the using the steady GREEN ARROW/flashing YELLOW ARROW dual-arrow section listed in the MUTCD. Experimentation and research has since been performed.

The flashing YELLOW ARROW and steady YELLOW arrow were initially required to be in different sections as it was felt there was a greater likelihood of drivers observing the change in the display from flashing to steady. However, the research has since indicated that there is not a significant difference in driver comprehension when the flashing YELLOW ARROW was displayed bi-modally in the bottom section (with the GREEN ARROW) or bi-modally in the middle section (with the steady YELLOW ARROW).

Therefore, the NCUTCD is recommending:

1. In addition to a four-section signal face with separate sections for each indication, that a three-section signal face be permitted without restrictions relating to mounting height or lateral positioning limitations but that the 3-section signal face shall contain a single signal section to display the steady yellow arrow and the flashing yellow arrow, and
2. When two indications are provided from a single signal section in conjunction with a flashing yellow arrow application, that signal section shall display the steady YELLOW ARROW and the flashing YELLOW ARROW.

A dual-arrow section used to display a steady green arrow and a steady yellow arrow is permitted by the MUTCD. Nothing in this recommendation or is intended to eliminate or prohibit the use of such dual-arrow signal sections.

The implementation of this recommendation includes changes to several sections of Part 4. The MUTCD changes are marked with a reference to the following discussion items:

- 42.01 Section ~~4D.06~~4E.01 Signal Indications – Design, Illumination, Color, and Shape
Insert “steady” before “YELLOW ARROW” in order to continue to allow a dual-arrow section that is capable of independently displaying a steady GREEN ARROW or a steady YELLOW arrow. Such a dual arrow section may be used to provide 5 separate indications from a 4-section signal face and would typically be used in place of a 5-section shared signal face. “Steady” does not need to be added before “GREEN ARROW” as flashing green indications are not allowed.
- 42.02 Section ~~4D.09~~4E.04 Positions of Signal Indications Within a Vertical Signal Face

Insert “steady” before “YELLOW ARROW” in order to continue to allow a dual-arrow section that is capable of independently displaying a steady GREEN ARROW or a steady YELLOW arrow. “Steady” does not need to be added before “GREEN ARROW” as flashing green indications are not allowed.

42.03 Section ~~4D.09~~[4E.04](#) Positions of Signal Indications Within a Vertical Signal Face

Currently a four-section signal face with a RED ARROW, YELLOW ARROW, FLASHING YELLOW ARROW, and GREEN ARROW is typically used for a separate signal face controlling a protected/permissive left-turn or right-turn movement. (A CIRCULAR RED section can be used in place of the RED ARROW section for a separate right-turn signal face.) At locations where there are signal head height limitations, or lateral positioning limitations for a horizontally-mounted signal face, that do not permit the use of a four-section signal face, a three-section signal face containing a dual-arrow section capable of displaying a GREEN ARROW and a flashing YELLOW ARROW can be used. It is proposed that the existing dual-arrow section be deleted and a signal section capable of displaying a steady YELLOW ARROW and a flashing YELLOW ARROW be used instead. Therefore the two lines listed as “A” can be deleted. However, the line listed as “B” needs to be retained and modified to have the relative location of the flashing YELLOW ARROW to the steady YELLOW ARROW when they are in separate sections.

42.04 Section ~~4D.10~~[4E.05](#) Positions of Signal Indications Within a Horizontal Signal Face

Currently a four-section signal face with a RED ARROW, YELLOW ARROW, FLASHING YELLOW ARROW, and GREEN ARROW is typically used for a separate signal face controlling a protected/permissive left-turn or right-turn movement. (A CIRCULAR RED section can be used in place of the RED ARROW section for a separate right-turn signal face.) At locations where there are signal head height limitations, or lateral positioning limitations for a horizontally-mounted signal face, that do not permit the use of a four-section signal face, a three-section signal face containing a dual-arrow section capable of displaying a GREEN ARROW and a flashing YELLOW ARROW can be used. It is proposed that the existing dual-arrow section be deleted and a signal section capable of displaying a steady YELLOW ARROW and a flashing YELLOW ARROW be used instead. Therefore the lines listed as “A” can be deleted. However, the lines listed as “B” need to be retained and modified to have the relative location of the flashing YELLOW ARROW to the steady YELLOW ARROW when they are in separate sections.

42.05 Section ~~4D.05~~[4F.01](#) Application of Steady and Flashing Signal Indications during Steady (Stop-and-Go) Operation

The first sentence of this paragraph can be deleted since the proposed change is to use the same signal section to display both a flashing yellow and a steady yellow indication during steady mode operation.

42.06 Section ~~4D.17~~[4F.02](#) Signal Indications for Left-Turn Movements – General

Modify to reflect that a single section will display both the steady and flashing YELLOW ARROW indications rather than the GREEN ARROW and flashing YELLOW ARROW indications.

42.07 [Section 4F.04 Signal Indications for Permissive Only Mode Left-Turn Movements in a Separate Signal Face](#)

Modify “E” to reflect if a single section is used to display two indications, it will display both the steady and flashing YELLOW ARROW indications rather than the GREEN ARROW and flashing YELLOW ARROW indications. No change is needed to “F” as that operation is unchanged from the current MUTCD.

42.08 [Section 4F.08 Signal Indications for Protected/Permissive Mode Left-Turn Movements in a Separate Signal Face](#)

Modify to reflect indicate that either a four-section signal face can be used (as is listed in the current MUTCD), or than a three-section signal face can be used. If a three-section signal face is

used, it shall include a section that displays both the steady and the flashing YELLOW ARROW indications.

42.09 Section ~~4D.21~~ 4F.09 Signal Indications for Right-Turn Movements – General

Modify to reflect that the dual-arrow signal section will display both the steady and flashing YELLOW ARROW indications rather than the GREEN ARROW and flashing YELLOW ARROW indications.

42.10 Section 4F.11 Signal Indications for Permissive Only Mode Right-Turn Movements in a Separate Signal Face

Modify “F” to reflect if a single section is used to display two indications, it will display both the steady and flashing YELLOW ARROW indications rather than the GREEN ARROW and flashing YELLOW ARROW indications. No change is needed to “G” as that operation is unchanged from the current MUTCD.

42.11 Section 4F.15 Signal Indications for Protected/Permissive Mode Right-Turn Movements in a Separate Signal Face

Modify to reflect indicate that a three-section signal face with a section that displays two different indications can be used. If a three-section signal face is used, it shall include a dual-arrow section to display both the steady and the flashing YELLOW ARROW indications.

42.12 4F.16 Signal Indications for Approaches with ~~Shared Left-Turn/Right-Turn Lanes and~~ No Through Movement

Modify to reflect that both the steady and flashing YELLOW ARROW indications will be displayed from a single section rather than the GREEN ARROW and flashing YELLOW ARROW indications.

EXPLANATION OF RECOMMENDATION FORMAT:

Typically, the NCUTCD technical committees initiate a recommended change to the MUTCD which is then presented to and approved by the NCUTCD Council before being forwarded to FHWA. Therefore, the typical recommendation includes text in black font to indicate existing MUTCD text with underline red used to show added text and ~~strikethrough red~~ used to show deleted text. However, this recommendation “began” with color coded text showing additions and deletions. The document received from FHWA included underlined light blue for additions and ~~strikethrough red~~ for deletions. The FHWA document also contained some informational text with white text in a green highlight. This is not part of the MUTCD changes but provides information about a proposed change. Finally, the FHWA document included some text that was proposed to be relocated to another MUTCD Part. This text was identified by a light green background.

The color coding from the original FHWA document has been maintained to the degree practical.

In order to identify changes proposed by the NCUTCD, the following additional color coding has been used:

Additions – dark blue underline with light gray highlight

Deletions to previous MUTCD text – ~~strikethrough black text with light gray highlight~~

Deletions to FHWA proposed new MUTCD text – ~~strikethrough light blue text with light gray highlight~~

There are also reference numbers embedded in the following recommendation section that refer to explanation information numbers in the previous section. These numbers are in parenthesis and are coded with red text in yellow highlight.

RECOMMENDED CHANGES TO THE MUTCD:

1 Following are the NCUTCD recommended changes to Part 4.
2

CHAPTER 4A. GENERAL

Section 4A.01 Types

Support:

The following types and uses of highway traffic signals are discussed in Part 4: traffic control signals; pedestrian signals; hybrid beacons; emergency-vehicle signals; traffic control signals for one-lane, two-way facilities; traffic control signals for freeway entrance ramps; traffic control signals for movable bridges; toll plaza traffic signals; flashing beacons; lane-use control signals; and in-roadway [warning](#)lights.

Section 4A.02 Definitions and AcronymsRelating to Highway Traffic Signals

Support:

Definitions and acronyms pertaining to Part 4 are provided in Sections 1A.13 and 1A.14.

Section ~~4D.04~~4A.03 Meanings of Vehicular Signal Indications This section contains Paragraphs 1 and 2 of existing Section 4D.04

Support:

The “Uniform Vehicle Code” (see Section 1A.11) is the primary source for the standards for the meanings of vehicular signal indications to both vehicle operators and pedestrians as provided in ~~this~~ Sections [4A.04](#) and [4A.05](#), and the standards for the meanings of separate pedestrian signal head indications as provided in Section ~~4E.02~~[4A.06](#).

The physical area that is defined as being “within the intersection” is dependent upon the conditions that are described in the definition of intersection in Section 1A.13.

Section [4A.04](#) Meanings of Steady Vehicular Signal Indications This section contains Items A, B, and C in Paragraph 3 of existing Section 4D.04

Standard:

The following meanings shall be given to [steady](#) highway traffic signal indications for vehicles and pedestrians:

A. Steady green signal indications shall have the following meanings:

1. Vehicular traffic facing a CIRCULAR GREEN signal indication is permitted to proceed straight through or turn right or left or make a U-turn movement except as such movement is modified by lane-use signs, turn prohibition signs, lane markings, roadway design, separate turn signal indications, or other traffic control devices.

Such vehicular traffic, including vehicles turning right or left or making a U-turn movement, shall yield the right-of-way to:

- (a) Pedestrians lawfully within an associated crosswalk, and
- (b) Other vehicles lawfully within the intersection.

In addition, vehicular traffic turning left or making a U-turn movement to the left shall yield the right-of-way to other vehicles approaching from the opposite direction so closely as to constitute an immediate hazard during the time when such turning vehicle is moving across or within the intersection.

2. Vehicular traffic facing a GREEN ARROW signal indication, displayed alone or in combination with another signal indication, is permitted to cautiously enter the intersection only to make the movement indicated by such arrow, or such other movement as is permitted by other signal indications displayed at the same time.

Such vehicular traffic, including vehicles turning right or left or making a U-turn movement, shall yield the right-of-way to:

- (a) Pedestrians lawfully within an associated crosswalk, and
- (b) Other vehicles lawfully within the intersection.

3. Pedestrians facing a CIRCULAR GREEN signal indication, unless otherwise directed by a pedestrian signal indication or other traffic control device, are permitted to proceed across the roadway within any marked or unmarked associated crosswalk. The pedestrian shall

- yield the right-of-way to vehicles lawfully within the intersection or so close as to create an immediate hazard at the time that the green signal indication is first displayed.
4. Pedestrians facing a GREEN ARROW signal indication, unless otherwise directed by a pedestrian signal indication or other traffic control device, shall not cross the roadway.

B. Steady yellow signal indications shall have the following meanings:

1. Vehicular traffic facing a steady CIRCULAR YELLOW signal indication is thereby warned that the related green movement or the related flashing arrow movement is being terminated or that a steady red signal indication will be displayed immediately thereafter when vehicular traffic shall not enter the intersection. The rules set forth concerning vehicular operation under the movement(s) being terminated shall continue to apply while the steady CIRCULAR YELLOW signal indication is displayed.
2. Vehicular traffic facing a steady YELLOW ARROW signal indication is thereby warned that the related GREEN ARROW movement or the related flashing arrow movement is being terminated. The rules set forth concerning vehicular operation under the movement(s) being terminated shall continue to apply while the steady YELLOW ARROW signal indication is displayed.
3. Pedestrians facing a steady CIRCULAR YELLOW or YELLOW ARROW signal indication, unless otherwise directed by a pedestrian signal indication or other traffic control device shall not start to cross the roadway.

C. Steady red signal indications shall have the following meanings:

1. Vehicular traffic facing a steady CIRCULAR RED signal indication, unless entering the intersection to make another movement permitted by another signal indication, shall stop at a clearly marked stop line; but if there is no stop line, traffic shall stop before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, then before entering the intersection; and shall remain stopped until a signal indication to proceed is displayed, or as provided below.

Except when a traffic control device is in place prohibiting a turn on red or a steady RED ARROW signal indication is displayed, vehicular traffic facing a steady CIRCULAR RED signal indication is permitted to enter the intersection to turn right, or to turn left from a one-way street into a one-way street, after stopping. The right to proceed with the turn shall be subject to the rules applicable after making a stop at a STOP sign.

2. Vehicular traffic facing a steady RED ARROW signal indication shall not enter the intersection to make the movement indicated by the arrow and, unless entering the intersection to make another movement permitted by another signal indication, shall stop at a clearly marked stop line; but if there is no stop line, before entering the crosswalk on the near side of the intersection; or if there is no crosswalk, then before entering the intersection; and shall remain stopped until a signal indication or other traffic control device permitting the movement indicated by such RED ARROW is displayed.

When a traffic control device is in place permitting a turn on a steady RED ARROW signal indication, vehicular traffic facing a steady RED ARROW signal indication is permitted to enter the intersection to make the movement indicated by the arrow signal indication, after stopping. The right to proceed with the turn shall be limited to the direction indicated by the arrow and shall be subject to the rules applicable after making a stop at a STOP sign.

3. Unless otherwise directed by a pedestrian signal indication or other traffic control device, pedestrians facing a steady CIRCULAR RED or steady RED ARROW signal indication shall not enter the roadway.

Section 4A.05 Meanings of Flashing Vehicular Signal Indications This section contains Items D, E, and F in Paragraph 3 of existing Section 4D.04

Standard:

The following meanings shall be given to flashing highway traffic signal indications for vehicles and pedestrians:

- 1 A. A flashing green signal indication has no meaning and shall not be used.
- 2 B. Flashing yellow signal indications shall have the following meanings:
- 3 1. Vehicular traffic, on an approach to an intersection, facing a flashing CIRCULAR
- 4 YELLOW signal indication is permitted to cautiously enter the intersection to proceed
- 5 straight through or turn right or left or make a U-turn except as such movement is modified
- 6 by lane-use signs, turn prohibition signs, lane markings, roadway design, separate turn
- 7 signal indications, or other traffic control devices.
- 8 Such vehicular traffic, including vehicles turning right or left or making a U-turn, shall
- 9 yield the right-of-way to:
- 10 (a) Pedestrians lawfully within an associated crosswalk, and
- 11 (b) Other vehicles lawfully within the intersection.
- 12 In addition, vehicular traffic turning left or making a U-turn to the left shall yield the
- 13 right-of-way to other vehicles approaching from the opposite direction so closely as to
- 14 constitute an immediate hazard during the time when such turning vehicle is moving across
- 15 or within the intersection.
- 16 2. Vehicular traffic, on an approach to an intersection, facing a flashing YELLOW ARROW
- 17 signal indication, displayed alone or in combination with another signal indication, is
- 18 permitted to cautiously enter the intersection only to make the movement indicated by such
- 19 arrow, or other such movement as is permitted by other signal indications displayed at the
- 20 same time.
- 21 Such vehicular traffic, including vehicles turning right or left or making a U-turn, shall
- 22 yield the right-of-way to:
- 23 (a) Pedestrians lawfully within an associated crosswalk, and
- 24 (b) Other vehicles lawfully within the intersection.
- 25 In addition, vehicular traffic turning left or making a U-turn to the left shall yield the
- 26 right-of-way to other vehicles approaching from the opposite direction so closely as to
- 27 constitute an immediate hazard during the time when such turning vehicle is moving across
- 28 or within the intersection.
- 29 3. Pedestrians facing any flashing yellow signal indication at an intersection, unless otherwise
- 30 directed by a pedestrian signal indication or other traffic control device, are permitted to
- 31 proceed across the roadway within any marked or unmarked associated crosswalk.
- 32 Pedestrians shall yield the right-of-way to vehicles lawfully within the intersection at the
- 33 time that the flashing yellow signal indication is first displayed.
- 34 4. When a flashing CIRCULAR YELLOW signal indication(s) is displayed as a beacon (see
- 35 Chapter 4L) to supplement another traffic control device, road users are notified that there
- 36 is a need to pay extra attention to the message contained thereon or that the regulatory or
- 37 warning requirements of the other traffic control device, which might not be applicable at
- 38 all times, are currently applicable.
- 39 C. Flashing red signal indications shall have the following meanings:
- 40 1. Vehicular traffic, on an approach to an intersection, facing a flashing CIRCULAR RED
- 41 signal indication shall stop at a clearly marked stop line; but if there is no stop line, before
- 42 entering the crosswalk on the near side of the intersection; or if there is no crosswalk, at the
- 43 point nearest the intersecting roadway where the driver has a view of approaching traffic on
- 44 the intersecting roadway before entering the intersection. The right to proceed shall be
- 45 subject to the rules applicable after making a stop at a STOP sign.
- 46 2. Vehicular traffic, on an approach to an intersection, facing a flashing RED ARROW signal
- 47 indication if intending to turn in the direction indicated by the arrow shall stop at a clearly
- 48 marked stop line; but if there is no stop line, before entering the crosswalk on the near side
- 49 of the intersection; or if there is no crosswalk, at the point nearest the intersecting roadway
- 50 where the driver has a view of approaching traffic on the intersecting roadway before
- 51 entering the intersection. The right to proceed with the turn shall be limited to the direction
- 52 indicated by the arrow and shall be subject to the rules applicable after making a stop at a
- 53 STOP sign.

3. Pedestrians facing any flashing red signal indication at an intersection, unless otherwise directed by a pedestrian signal indication or other traffic control device, are permitted to proceed across the roadway within any marked or unmarked associated crosswalk. Pedestrians shall yield the right-of-way to vehicles lawfully within the intersection at the time that the flashing red signal indication is first displayed.
4. When a flashing CIRCULAR RED signal indication(s) is displayed as a beacon (see Chapter 4L) to supplement another traffic control device, road users are notified that there is a need to pay extra attention to the message contained thereon or that the regulatory requirements of the other traffic control device, which might not be applicable at all times, are currently applicable. Use of this signal indication shall be limited to supplementing STOP (R1-1), DO NOT ENTER (R5-1), or WRONG WAY (R5-1a) signs, and to applications where compliance with the supplemented traffic control device requires a stop at a designated point.

Section ~~4E.02~~ 4A.06 Meanings of Pedestrian Signal ~~Head~~ Indications **This section was relocated from Section 4E.02**

Standard:

Pedestrian signal ~~head~~ indications shall have the following meanings:

- A. A steady WALKING PERSON (symbolizing WALK) signal indication means that a pedestrian facing the signal indication is permitted to start to cross the roadway in the direction of the signal indication, possibly in conflict with turning vehicles. The pedestrian shall yield the right-of-way to vehicles lawfully within the intersection at the time that the WALKING PERSON (symbolizing WALK) signal indication is first shown.
- B. A flashing UPRAISED HAND (symbolizing DONT WALK) signal indication means that a pedestrian shall not start to cross the roadway in the direction of the signal indication, but that any pedestrian who has already started to cross on a steady WALKING PERSON (symbolizing WALK) signal indication shall proceed to the far side of the traveled way of the street or highway, unless otherwise directed by a traffic control device to proceed only to the median of a divided highway or only to some other island or pedestrian refuge area.
- C. A steady UPRAISED HAND (symbolizing DONT WALK) signal indication means that a pedestrian shall not enter the roadway in the direction of the signal indication.
- D. A flashing WALKING PERSON (symbolizing WALK) signal indication has no meaning and shall not be used.

Section ~~4D.33~~ 4A.07 Lateral Offset of Signal Supports and Cabinets **This section was relocated from Section 4D.33**

Guidance:

The following items should be considered when placing signal supports and cabinets:

- A. Reference should be made to the American Association of State Highway and Transportation Officials (AASHTO) "Roadside Design Guide" (see Section 1A.11) and to the "Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)" (see Section 1A.11).
- B. Signal supports should be placed as far as practical from the edge of the traveled way without adversely affecting the visibility of the signal indications.
- C. Where supports cannot be located based on the recommended AASHTO clearances, consideration should be given to the use of appropriate safety devices.
- D. No part of a concrete base for a signal support should extend more than 4 inches above the ground level at any point. This limitation does not apply to the concrete base for a rigid support.
- E. In order to minimize hindrance to the passage of persons with physical disabilities, a signal support or controller cabinet should not obstruct the sidewalk, or access from the sidewalk to the crosswalk.
- F. Controller cabinets should be located as far as practical from the edge of the roadway.
- G. On medians, the minimum clearances provided in Items A through E for signal supports should be obtained if practical.

1 **Section ~~4D.34~~ 4A.08 Use of Signs at Signalized Locations** **This section was relocated from Section**

2 **4D.34**

3 Support:

4 Traffic signal signs are sometimes used at highway traffic signal locations to instruct or guide pedestrians,
5 bicyclists, or motorists. Among the signs typically used at or on the approaches to signalized locations are
6 movement prohibition signs (see Section 2B.18), lane control signs (see Sections 2B.19 to 2B.22), pedestrian
7 crossing signs (see Section 2B.51), pedestrian actuation signs (see Section 2B.52), traffic signal signs (see
8 Sections 2B.53 and 2C.48), Signal Ahead warning signs (see Section 2C.36), Street Name signs (see Section
9 2D.43), and Advance Street Name signs (see Section 2D.44).

10 *Guidance:*

11 *Regulatory, warning, and guide signs should be used at highway traffic ~~control~~ signal locations as*
12 *provided in Part 2 and as specifically provided elsewhere in Part 4.*

13 *Traffic signal signs should be located adjacent to the signal face to which they apply.*

14 Support:

15 Section 2B.19 contains information regarding the use of overhead lane control signs on signalized
16 approaches where lane drops, multiple-lane turns involving ~~shared~~ combined through-and-turn lanes, or other
17 lane-use regulations that would be unexpected by unfamiliar road users are present.

18 ~~Standard~~ Guidance:

19 *If used, illuminated traffic signal signs ~~shall~~ should be designed and mounted in such a manner as to avoid*
20 *glare and reflections that seriously detract from the signal indications. Highway traffic ~~control~~ signal faces*
21 *~~shall~~ should be given dominant position and brightness to maximize their priority in the overall display.*

22 Standard:

23 **The minimum vertical clearance and horizontal offset of the total assembly of traffic signal signs**
24 **(see Section 2B.53) shall comply with the provisions of Sections 4D.15 and 4D.16.**

25 **STOP signs shall not be used in conjunction with any highway traffic ~~control~~ signal operation,**
26 **except in either of the following cases:**

27 **A. If the signal indication for an approach is a flashing red at all times, or**

28 **B. If a minor street or driveway is located within or adjacent to ~~the~~ an area controlled by ~~the~~ a traffic**
29 **control signal, but does not require separate traffic signal control because an extremely low**
30 **potential for conflict exists.**

31 **Section ~~4D.35~~ 4A.09 Use of Pavement Markings at Signalized Locations** **This section was**
32 **relocated from Section 4D.35**

33 Support:

34 Pavement markings (~~see Part 3~~) that clearly communicate the operational plan of an intersection to road
35 users play an important role in the effective operation of highway traffic ~~control~~ signals. By designating the
36 number of lanes, the use of each lane, the length of additional lanes on the approach to an intersection, and the
37 proper stopping points, the engineer can design the signal phasing and timing to best match the goals of the
38 operational plan.

39 *Guidance:*

40 *Pavement markings should be used at highway traffic ~~control~~ signal locations as provided in Part 3. If the*
41 *road surface will not retain pavement markings, signs should be installed to provide the needed road user*
42 *information.*

43 **Section ~~4D.02~~ 4A.10 Responsibility for Operation and Maintenance** **This section was relocated**
44 **from Section 4D.02**

45 *Guidance:*

46 *Prior to installing any highway traffic ~~control~~ signal, the responsibility for the maintenance of the signal*
47 *and all of the appurtenances, hardware, software, and the timing plan(s) should be clearly established. The*
48 *responsible agency should provide for the maintenance of the highway traffic ~~control~~ signal and all of its*
49 *appurtenances in a competent manner.*

1 *To this end the agency should:*

- 2 *A. Keep every controller assembly in effective operation in accordance with its predetermined timing*
3 *schedule; check the operation of the controller assembly frequently enough to verify that it is*
4 *operating in accordance with the predetermined timing schedule; and establish a policy to maintain a*
5 *record of all timing changes and that only authorized persons are permitted to make timing changes;*
6 *B. Clean the optical system of the signal sections and replace the light sources as frequently as*
7 *experience proves necessary;*
8 *C. Clean and service equipment and other appurtenances as frequently as experience proves necessary;*
9 *D. Provide for alternate operation of the traffic control signal during a period of failure, using flashing*
10 *mode or manual control, or manual traffic direction by proper authorities as might be required by*
11 *traffic volumes or congestion, or by erecting other traffic control devices;*
12 *E. Have properly skilled maintenance personnel available without undue delay for all signal*
13 *malfunctions and signal indication failures;*
14 *F. Provide spare equipment to minimize the interruption of highwaytraffic ~~control~~ signal operation as a*
15 *result of equipment failure;*
16 *G. Provide for the availability of properly skilled maintenance personnel for the repair of all*
17 *components; and*
18 *H. Maintain the appearance of the signal displays and equipment.*
19

CHAPTER 4B. TRAFFIC CONTROL SIGNALS—GENERAL

Section 4B.01 General

Support:

Words such as pedestrians and bicyclists are used redundantly in selected Sections of Part 4 to encourage sensitivity to these elements of “traffic.”

Standards for traffic control signals are important because traffic control signals need to attract the attention of a variety of road users, including those who are older, those with impaired vision, as well as those who are fatigued or distracted, or who are not expecting to encounter a signal at a particular location.

Section 4B.02 Basis of Installation ~~or Removal~~ of Traffic Control Signals

Support:

A careful analysis of traffic operations, pedestrian and bicyclist needs, and other factors at a large number of signalized and unsignalized locations, coupled with engineering judgment, has provided a series of signal warrants, described in Chapter 4C, that define the minimum conditions under which installing traffic control signals might be justified. **The sequence of Paragraphs 1 and 2 has been reversed**

Guidance:

The ~~selection and use~~ *design (including the phasing, operation, and timing)* of new traffic control signals should be based on an engineering study of roadway, traffic, and other conditions.

Engineering judgment should be applied in the review of operating traffic control signals to determine whether the type of installation and the timing program meet the current requirements of all forms of traffic.

Section 4B.03 Basis of Removal of Traffic Control Signals

Guidance:

If changes in traffic patterns eliminate the need for a traffic control signal, consideration should be given to removing it and replacing it with appropriate alternative traffic control devices, if any are needed.

If the engineering study indicates that the traffic control signal is no longer justified, and a decision is made to remove the signal, removal should be accomplished using the following steps:

- A. Determine the appropriate traffic control to be used after removal of the signal.
- B. Remove any sight-distance restrictions as necessary.
- C. Inform the public of the removal study.
- D. Flash or cover the signal heads for a minimum of 90 days, and install the appropriate stop control or other traffic control devices.
- E. Remove the signal if the engineering data collected during the removal study period confirms that the signal is no longer needed.

Option:

Because Items C, D, and E in Paragraph 5 are not relevant when a temporary traffic control signal (see Section 4D.32) is removed, a temporary traffic control signal may be removed immediately after Items A and B are completed.

Instead of total removal of a traffic control signal, the poles, controller cabinet, and cables may remain in place after removal of the signal heads for continued analysis.

Section ~~4B.03~~ 4B.04 Advantages and Disadvantages of Traffic Control Signals

Support:

When properly used, traffic control signals are valuable devices for the control of vehicular and pedestrian traffic. They ~~assign the right-of-way to~~ control the various traffic movements by alternating between directing them to stop and permitting them to proceed and thereby profoundly influence traffic flow.

Traffic control signals that are properly designed, located, operated, and maintained will have one or more of the following advantages:

- A. They provide for the orderly movement of traffic.
- B. They increase the traffic-handling capacity of the intersection if:
 1. Proper physical layouts and control measures are used, and

2. The signal operational parameters are reviewed and updated (if needed) on a regular basis (as engineering judgment determines that significant traffic flow and/or land use changes have occurred) to maximize the ability of the traffic control signal to satisfy current traffic demands.
- C. They reduce the frequency and severity of certain types of crashes, especially right-angle collisions.
- D. They are coordinated to provide for continuous or nearly continuous movement of traffic at a definite speed along a given route under favorable conditions.
- E. They are used to interrupt heavy traffic at intervals to permit other traffic, vehicular or pedestrian, to cross.

Traffic control signals are often considered a panacea for all traffic problems at intersections. This belief has led to traffic control signals being installed at many locations where they are not needed, adversely affecting the safety and efficiency of vehicular, bicycle, and pedestrian traffic.

Traffic control signals, even when justified by traffic and roadway conditions, can be ill-designed, ineffectively placed, improperly operated, or poorly maintained. Improper or unjustified traffic control signals can result in one or more of the following disadvantages:

- A. Excessive delay,
- B. Excessive disobedience of the signal indications,
- C. Increased use of less adequate routes as road users attempt to avoid the traffic control signals, and
- D. Significant increases in the frequency of collisions (especially rear-end collisions).

Section ~~4B.04~~ 4B.05 Alternatives to Traffic Control Signals

Guidance:

Since vehicular delay and the frequency of some types of crashes are sometimes greater under traffic signal control than under STOP sign control, consideration should be given to providing alternatives to traffic control signals even if one or more of the signal warrants has been satisfied.

Option:

These alternatives may include, but are not limited to, the following:

- A. Installing signs along the major street to warn road users approaching the intersection;
- B. Relocating the stop line(s) and making other changes to improve the sight distance at the intersection;
- C. Installing measures designed to reduce speeds on the approaches;
- D. Installing a flashing beacon at the intersection to supplement STOP sign control;
- E. Installing flashing beacons on warning signs in advance of a STOP sign controlled intersection on major- and/or minor-street approaches;
- F. Adding one or more lanes on a minor-street approach to reduce the number of vehicles per lane on the approach;
- G. Revising the geometrics at the intersection to channelize vehicular movements and reduce the time required for a vehicle to complete a movement, which could also assist pedestrians;
- H. Revising the geometrics at the intersection to add pedestrian median refuge islands and/or curb extensions;
- I. Installing roadway lighting if a disproportionate number of crashes occur at night;
- J. Restricting one or more turning movements, perhaps on a time-of-day basis, if alternate routes are available;
- K. If the warrant is satisfied, installing multi-way STOP sign control;
- L. Installing a pedestrian hybrid beacon (see Chapter 4F) or In-Roadway Warning Lights (see Chapter 4N) if pedestrian safety is the major concern;
- M. Installing a roundabout; and
- N. Employing other alternatives, depending on conditions at the intersection.

Section ~~4B.05~~ 4B.06 Adequate Roadway Capacity

Consideration is being given to deleting this section, as it is not related to uniformity. Instead it primarily discusses roadway design philosophy.

Support:

The delays inherent in ~~the alternating assignment of right-of-way~~ the stop and proceed indications to the various traffic movements at intersections controlled by traffic control signals can frequently be reduced

1 bywidening the major roadway, the minor roadway, or both roadways. Widening the minor roadway often
2 benefits the operations on the major roadway, because it reduces the green time that must be assigned to
3 minor-roadway traffic. In urban areas, the effect of widening can be achieved by eliminating parking on
4 intersection approaches. It is desirable to have at least two lanes for moving traffic on each approach to a
5 signalized location. Additional width on the departure side of the intersection, as well as on the approach side,
6 will sometimes be needed to clear traffic through the intersection effectively.

7 *Guidance:*

8 *Adequate roadway capacity should be provided at a signalized location. Before an intersection is*
9 *widened, the additional green time pedestrians need to cross the widened roadways should be considered to*
10 *determine if it will exceed the green time saved through improved vehicular flow.*

11 *Other methods of increasing the roadway capacity at signalized locations that do not involve roadway*
12 *widening, such as revisions to the pavement markings and the careful evaluation of proper lane-use*
13 *assignments (including varying the lane use by time of day), should be considered where appropriate. Such*
14 *consideration should include evaluation of any impacts that changes to pavement markings and lane*
15 *assignments will have on bicycle travel.*

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

Except for temporary traffic control signals (see Section 4D.32), before a traffic control signal is installed at a particular location, an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed and placed in the agency's files. The engineering study shall clearly indicate the reason(s) that a traffic control signal was determined whether installation of a traffic control signal is to be justified at a particular the location.

Guidance: (1)

The investigation of the need for a traffic control signal ~~shall~~ should shall (1) include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic 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

The satisfaction of a traffic signal warrant or warrants ~~shall~~ should shall (2) not in itself require the installation of a traffic control signal.

Support:

Sections 8C.09 and 8C.10 contain information regarding the use of traffic control signals instead of gates and/or flashing-light signals at highway-railgrade crossings and highway-light rail transit grade crossings, respectively.

Guidance:

A traffic control signal should not be installed unless one or more of the factors described in this Chapter are met.

A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.

A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.

The study should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrants listed in Paragraph 2.

Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics should dictate whether an approach is considered as one lane or two lanes. For example, for an approach with one lane for through and right-turning traffic plus a left-turn lane, if engineering judgment indicates that it should be considered a one-lane approach because the traffic using the left-turn lane is minor, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.

Similar engineering judgment and rationale should be applied to a street approach with one through/left-turn lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turn traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.

At a location that is under development or construction and where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into stop-and-go operation to determine if the signal is justified. If not justified, the signal should be taken out of stop-and-go operation or removed.

Option:

For signal warrant analysis, a location with a wide median, even if the median width is greater than 30 feet, ~~should~~ may be ~~considered~~ analyzed as one intersection or as (3) two intersections based on engineering judgment.

~~Option:~~

At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the “minor-street” volume and the corresponding single direction of opposing traffic on the major street as the “major-street” volume.

For signal warrants requiring conditions to be present for a certain number of hours in order to be satisfied, any four ~~sequential~~ consecutive 15-minute periods may be considered as 1 hour if the separate 1-hour periods used in the warrant analysis do not overlap each other and both the major-street volume and the minor-street volume are for the same specific one-hour periods.

For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support:

When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option:

Engineering study data may include the following:

- A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
- B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.
- C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
- D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.
- E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.
- F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.
- G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.

The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods described in Item B of Paragraph 17:

- A. Vehicle-hours of stopped time delay determined separately for each approach.
- B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
- C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
- D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
- E. Queue length on stop-controlled approaches.

Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume

Support:

The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied and analyses of Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied and an analysis of the combination of Conditions A and B is not needed.

~~Standard~~ *Guidance:*

The need for a traffic control signal ~~shall~~ should be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:

- A. The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or*
- B. The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.*

In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100 percent columns.

Guidance:

The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

~~Standard~~

The need for a traffic control signal ~~shall~~ should be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:

- A. The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and*
- B. The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.*

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

1 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if
2 the intersection lies within the built-up area of an isolated community having a population of less than 10,000,
3 the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

4 **Section 4C.03 Warrant 2, Four-Hour Vehicular Volume**

5 Support:

6 The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume
7 of intersecting traffic is the principal reason to consider installing a traffic control signal.

8 ~~Standard~~ Guidance:

9 *The need for a traffic control signal ~~shall~~ should be considered if an engineering study finds that, for each*
10 *of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street*
11 *(total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street*
12 *approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination*
13 *of approach lanes.* **The second sentence was revised to Support and moved to the next paragraph**

14 Support:

15 On the minor street, the higher volume ~~shall~~ is not ~~be~~ required to be on the same approach during each of
16 these 4 hours.

17 Option:

18 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if
19 the intersection lies within the built-up area of an isolated community having a population of less than 10,000,
20 Figure 4C-2 may be used in place of Figure 4C-1.

21 **Section 4C.04 Warrant 3, Peak Hour**

22 Support:

23 The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a
24 minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing
25 the major street.

26 ~~Standard~~ Guidance:

27 *This signal warrant ~~shall~~ should be applied only in unusual cases, such as office complexes, manufacturing*
28 *plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of*
29 *vehicles over a short time.*

30 *The need for a traffic control signal ~~shall~~ should be considered if an engineering study finds that the*
31 *criteria in either of the following two categories are met:*

32 *A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute*
33 *periods) of an average day:*

- 34 *1. The total stopped time delay experienced by the traffic on one minor-street approach (one*
35 *direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane*
36 *approach or 5 vehicle-hours for a two-lane approach; and*
- 37 *2. The volume on the same minor-street approach (one direction only) equals or exceeds 100*
38 *vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes;*
39 *and*
- 40 *3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for*
41 *intersections with three approaches or 800 vehicles per hour for intersections with four or more*
42 *approaches.*

43 *B. The plotted point representing the vehicles per hour on the major street (total of both approaches)*
44 *and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction*
45 *only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the*
46 *applicable curve in Figure 4C-3 for the existing combination of approach lanes.*

47 Option:

48 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if
49 the intersection lies within the built-up area of an isolated community having a population of less than 10,000,

Figure 4C-4 may be used in place of Figure 4C-3 to evaluate the criteria in the second category of the Standard.

If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal may be operated in the flashing mode during the hours that the volume criteria of this warrant are not met.

Guidance:

If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal should be traffic-actuated.

Section 4C.05 Warrant 4, Pedestrian Volume

Support:

The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

~~Standard~~*Guidance:*

The need for a traffic control signal at an intersection or midblock crossing ~~shall~~should be considered if an engineering study finds that one of the following criteria is met:

- A. For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) all fall above the curve in Figure 4C-5; or*
- B. For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) falls above the curve in Figure 4C-7.*

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 35 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-6 may be used in place of Figure 4C-5 to evaluate Criterion A in Paragraph 2, and Figure 4C-8 may be used in place of Figure 4C-7 to evaluate Criterion B in Paragraph 2.

Where there is a divided street having a median of sufficient width for pedestrians to wait, the criteria in Items A and B of Paragraph 2 may be applied separately to each direction of vehicular traffic. **This is a variation of the second sentence of Item B in Paragraph 2 of Section 4C.05 in the 2003 MUTCD**

~~Standard~~*Guidance:*

The Pedestrian Volume signal warrant ~~shall~~should not be applied at locations where the distance to the nearest traffic control signal or STOP sign controlling the street that pedestrians desire to cross is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Standard:

If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads complying with the provisions set forth in Chapter 4E.

Guidance:

If this warrant is met and a traffic control signal is justified by an engineering study, then:

- A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.*
- B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to*

provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.

C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.

Option:

The criterion for the pedestrian volume crossing the major street may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.

A traffic control 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 street.

Section 4C.06 Warrant 5, School Crossing

Support:

The School Crossing signal warrant is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word “schoolchildren” includes elementary through high school students.

~~Standard~~ Guidance:

The need for a traffic control signal ~~shall~~ should be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of schoolchildren at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the schoolchildren are using the crossing is less than the number of minutes in the same period (see Section 7A.03) and there are a minimum of 20 schoolchildren during the highest crossing hour.

Before a decision is made to install a traffic control signal, consideration ~~shall~~ should be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

The School Crossing signal warrant ~~shall~~ should not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.

~~Guidance:~~

If this warrant is met and a traffic control signal is justified by an engineering study, then:

A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.

B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.

C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.

Section 4C.07 Warrant 6, Coordinated Signal System

Support:

Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

~~Standard~~ Guidance:

The need for a traffic control signal ~~shall~~ should be considered if an engineering study finds that one of the following criteria is met:

A. On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.

- B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

~~Guidance:~~

The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 1,000 feet.

Section 4C.08 Warrant 7, Crash Experience

Support:

The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

~~Standard~~ Guidance:

The need for a traffic control signal ~~shall~~ should be considered if an engineering study finds that all of the following criteria are met:

- A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and
- B. ~~Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and~~
One of the following conditions apply to the reported crash history (where each reported crash considered is related to the intersection and apparently exceeds the applicable requirements for a reportable crash):
 1. The number of reported angle crashes and pedestrian crashes within a one-year period equals or exceeds the threshold number in Table 4C-2 for total angle crashes and pedestrian crashes (all severities); or
 2. The number of reported fatal-and-injury angle crashes and pedestrian crashes within a one-year period equals or exceeds the threshold number in Table 4C-2 for total fatal-and-injury angle crashes and pedestrian crashes ; or
 3. The number of reported angle crashes and pedestrian crashes within a three-year period equals or exceeds the threshold number in Table 4C-3 for total angle crashes and pedestrian crashes (all severities); or
 4. The number of reported fatal-and-injury angle crashes and pedestrian crashes within a three-year period equals or exceeds the threshold number in Table 4C-3 for total fatal-and-injury angle crashes and pedestrian crashes; and (4)
- C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Note: Yellow highlight in the following two tables indicates they are new tables. (I could not format with gray highlight) (4)

Table 4C-2. Reported crash value for use with Criterion B of Warrant 7 based on one-year crash history.

Area Type	Number of Through Lanes on Each Approach		Minimum Number of Reported Crashes in <u>One-Year</u> Period			
			Total of Angle Crashes and Pedestrian Crashes (all severities) ^b		Total of Fatal-and-Injury Angle Crashes and Pedestrian Crashes ^b	
			Four Legs	Three Legs	Four Legs	Three Legs
Urban	1	1	5	4	3	3
	2+	1	5	4	3	3
	2+	2+	5	4	3	3
	1	2+	5	4	3	3
Rural ^a	1	1	4	3	3	3
	2+	1	10	9	6	6
	2+	2+	10	9	6	6
	1	2+	4	3	3	3

Notes:

a – “Rural” values apply to intersections where the major-road speed exceeds 40 mi/h or intersections located in an isolated community with a population of less than 10,000.

b – Angle crashes include all crashes that occur at an angle and involve one or more vehicles on the major road and one or more vehicles on the minor road.

Table 4C-3. Reported crash value for use with Criterion B of Warrant 7 based on three-year crash history.

Area Type	Number of Through Lanes on Each Approach		Minimum Number of Reported Crashes in <u>Three-Year</u> Period			
			Total of Angle Crashes and Pedestrian Crashes (all severities) ^b		Total of Fatal-and-Injury Angle Crashes and Pedestrian Crashes ^b	
			Four Legs	Three Legs	Four Legs	Three Legs
Urban	1	1	6	5	4	4
	2+	1	6	5	4	4
	2+	2+	6	5	4	4
	1	2+	6	5	4	4
Rural ^a	1	1	6	5	4	4
	2+	1	16	13	9	9
	2+	2+	16	13	9	9
	1	2+	6	5	4	4

Notes:

a – “Rural” values apply to intersections where the major-road speed exceeds 40 mi/h or intersections located in an isolated community with a population of less than 10,000.

b – Angle crashes include all crashes that occur at an angle and involve one or more vehicles on the major road and one or more vehicles on the minor road.

Section 4C.09 Warrant 8, Roadway Network

Support:

Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

~~Standard~~ Guidance:

The need for a traffic control signal ~~shall~~ should be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:

- A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or
 - B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).
- A major route as used in this signal warrant ~~shall~~ should have at least one of the following characteristics:
- A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow.
 - B. It includes rural or suburban highways outside, entering, or traversing a city.
 - C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

Section 4C.10 Warrant 9, Intersection Near a Grade Crossing

Support:

The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity ~~to the intersection~~ of a grade crossing on an ~~intersection~~ approach controlled by a STOP or YIELD sign at a highway-highway intersection is the principal reason to consider installing a traffic control signal.

Guidance:

This signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing. Among the alternatives that should be considered or tried are:

- A. Providing additional pavement that would enable vehicles to clear the track or that would provide space for an evasive maneuver, or
- B. Reassigning the stop controls at the highway-highway intersection to make the approach across the track a non-stopping approach.

~~Standard:~~

The need for a traffic control signal ~~shall~~ should be considered if an engineering study finds that both of the following criteria are met:

- A. A grade crossing exists on an approach controlled by a STOP or YIELD sign at a highway-highway intersection and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and
- B. During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) of the highway-highway intersection and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 4C-9 or 4C-10 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in Section 1A.13.

~~Guidance:~~

The following considerations apply when plotting the traffic volume data on Figure 4C-9 or 4C-10:

- A. Figure 4C-9 should be used if there is only one lane approaching the highway-highway intersection at the track crossing location and Figure 4C-10 should be used if there are two or more lanes approaching the highway-highway intersection at the track crossing location.
- B. After determining the actual distance D, the curve for the distance D that is nearest to the actual distance D should be used. For example, if the actual distance D is 95 feet, the plotted point should be compared to the curve for D = 90 feet.
- C. If the rail traffic arrival times are unknown, the highest traffic volume hour of the day should be used.

Option:

The traffic volume on the minor-street approach ~~volume to the highway-highway intersection~~ may be multiplied by up to three adjustment factors as provided in Paragraphs 6 through 8.

1 Because the curves are based on an average of four occurrences of rail traffic per day, the vehicles per hour
2 on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-2 for the
3 appropriate number of occurrences of rail traffic per day.

4 Because the curves are based on typical vehicle occupancy, if at least 2% of the vehicles crossing the track
5 are buses carrying at least 20 people, the vehicles per hour on the minor-street approach may be multiplied by
6 the adjustment factor shown in Table 4C-3 for the appropriate percentage of high-occupancy buses.

7 Because the curves are based on tractor-trailer trucks comprising 10% of the vehicles crossing the track,
8 the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table
9 4C-4 for the appropriate distance and percentage of tractor-trailer trucks.

10 **Standard:**

11 **If this warrant is met and a traffic control signal at the highway-highway intersection is justified by**
12 **an engineering study, then:**

13 **A. The traffic control signal shall have actuation on the minor street;**

14 **B. Preemption control shall be provided in accordance with Sections 4D.27, 8C.09, and 8C.10; and**

15 **C. The grade crossing shall have flashing-light signals (see Chapter 8C).**

16 *Guidance:*

17 *If this warrant is met and a traffic control signal at the highway-highway intersection is justified by an*
18 *engineering study, the grade crossing should have automatic gates (see Chapter 8C).*
19

CHAPTER 4D. DESIGN OF TRAFFIC CONTROL SIGNALS ~~FEATURES~~

Section 4D.01 General

Support:

The features of traffic control signals of interest to road users are the location, design, and meaning of the signal indications. Uniformity in the design features that affect the traffic to be controlled, as set forth in this Manual, is especially important for the safety and efficiency of operations.

Traffic control signals can be operated in pretimed, semi-actuated, or full-actuated modes. For isolated (non-interconnected) signalized locations on rural high-speed highways, full-actuated mode with advance vehicle detection on the high-speed approaches is typically used. These features are designed to reduce the frequency with which the onset of the yellow change interval is displayed when high-speed approaching vehicles are in the “dilemma zone” such that the drivers of these high-speed vehicles find it difficult to decide whether to stop or proceed.

~~Standard~~ ~~Guidance~~ **Standard: (5)**

When a traffic control signal is not in operation, such as before it is placed in service, during seasonal shutdowns, or when it is not desirable to operate the traffic control signal, the signal faces ~~shall~~ ~~should~~ **shall (5) be covered, turned, or taken down to clearly indicate that the traffic control signal is not in operation.**

Guidance: (5)

If a cover is placed over a traffic control signal face that is not in operation and that has a yellow retroreflective strip along the perimeter of its signal backplate (see Paragraph 21 in Section 4D.12), the entire signal face, including the backplate, should be covered. If a traffic control signal face that is not in operation and that has a yellow retroreflective strip along the perimeter of its signal backplate is turned, the turned signal face should be oriented such that the yellow backplate border will not reflect light back to road users on any of the approaches to the intersection.

Support:

Seasonal shutdown is a condition in which a permanent traffic signal is turned off or otherwise made non-operational during a particular season when its operation is not justified. This might be applied in a community where tourist traffic during most of the year justifies the permanent signalization, but a seasonal shutdown of the signal during an annual period of lower tourist traffic would reduce delays; or where a major traffic generator, such as a large factory, justifies the permanent signalization, but the large factory is shut down for an annual factory vacation for a few weeks in the summer.

~~Standard~~ ~~Guidance~~ **Standard: (6)**

A traffic control signal ~~shall~~ ~~should~~ **shall (6) control traffic only at the intersection or midblock location where the signal faces are placed.**

Guidance: (6)

Midblock crosswalks ~~shall~~ ~~should~~ not be signalized if they are located within 300 feet from the nearest traffic control signal, unless the proposed traffic control signal will not restrict the progressive movement of traffic.

~~Guidance:~~

A midblock crosswalk location should not be controlled by a traffic control signal if the crosswalk is located within 100 feet from side streets or driveways that are controlled by STOP signs or YIELD signs.

Engineering judgment should be used to determine the proper phasing and timing for a traffic control signal. Since traffic flows and patterns change, phasing and timing should be reevaluated regularly and updated if needed.

Traffic control signals within 1/2 mile of one another along a major route or in a network of intersecting major routes should be coordinated, preferably with interconnected controller units. Where traffic control signals that are within 1/2 mile of one another along a major route have a jurisdictional boundary or a boundary between different signal systems between them, coordination across the boundary should be considered.

Support:

Signal coordination need not be maintained between control sections that operate on different cycle lengths.

For coordination with grade crossing signals and movable bridge signals, see Sections 4D.27, 4J.03, 8C.09, and 8C.10.

~~Section 4D.02 Responsibility for Operation and Maintenance~~ This section has been relocated to Section 4A.10 and the text has been revised to apply to all types of highway traffic signals, not just to traffic control signals

Section ~~4D.03~~ 4D.02 Provisions for Pedestrians

Support:

Chapter 4E contains additional information regarding pedestrian signals and Chapter 4F contains additional information regarding pedestrian hybrid beacons.

~~Standard~~ Guidance:

The design and operation of traffic control signals ~~shall~~ should take into consideration the needs of pedestrian as well as vehicular traffic.

Standard: (7)

If engineering judgment indicates the need for provisions for a given pedestrian movement, signal faces conveniently visible to pedestrians ~~shall~~ should ~~shall~~ (7) be provided by pedestrian signal heads (see Chapter 4E) or a vehicular signal face(s) for a concurrent vehicular movement.

~~Guidance:~~ Guidance: (7)

Accessible pedestrian signals (see Sections 4E.09 through 4E.13) that provide information in non-visual formats (such as audible tones, speech messages, and/or vibrating surfaces) should be provided where determined appropriate by engineering judgment.

Where pedestrian movements regularly occur, pedestrians should be provided with sufficient time to cross the roadway by adjusting the traffic control signal operation and timing to provide sufficient crossing time every cycle or by providing pedestrian detectors.

If it is necessary or desirable to prohibit certain pedestrian movements at a traffic control signal location, No Pedestrian Crossing (R9-3) signs (see Section 2B.51) should be used if it is not practical to provide a barrier or other physical feature to physically prevent the pedestrian movements.

Section 4D.03 Provisions for Bicyclists

~~Text needed~~ See separate NCUTCD Recommendation on Bicycle Signal Faces

~~Section 4D.04 Meaning of Vehicular Signal Indications~~ This section has been relocated to Sections 4A.03 through 4A.05 because this text applies to all types of highway traffic signals, not just to traffic control signals

~~Section 4D.05 Application of Steady Signal Indications~~ This section has been relocated to Section 4F.01

~~Section 4D.06 Signal Indications—Design, Illumination, Color, and Shape~~ This section has been relocated to Section 4E.01

~~Section 4D.07 Size of Vehicular Signal Indications~~ This section has been relocated to Section 4E.02

~~Section 4D.08 Positions of Signal Indications Within a Signal Face—General~~ This section has been relocated to Section 4E.03

~~Section 4D.09 Positions of Signal Indications Within a Vertical Signal Face~~ This section has been relocated to Section 4E.04

~~Section 4D.10 Positions of Signal Indications Within a Horizontal Signal Face~~ This section has been relocated to Section 4E.05

Section ~~4D.11~~4D.04 Number of Signal Faces on an Approach

Standard:

The signal faces for each approach to an intersection or a midblock location shall be provided as follows:

- A. If a signalized through movement exists on an approach, a minimum of two primary signal faces shall be provided for the through movement. If a signalized through movement does not exist on an approach, a minimum of two primary signal faces shall be provided for the signalized turning movement that is considered to be the major movement from the approach (also see Section 4D.25).
- B. See Sections 4D.17 through 4D.20 for left-turn (and U-turn to the left) signal faces.
- C. See Sections 4D.21 through 4D.24 for right-turn (and U-turn to the right) signal faces.

Option:

Where a movement (or a certain lane or lanes) at the intersection never conflicts with any other signalized vehicular or pedestrian movement, a continuously-displayed single-section GREEN ARROW signal indication may be used to inform road users that the movement is free-flow and does not need to stop.

Support:

In some circumstances where the through movement never conflicts with any other signalized vehicular or pedestrian movement at the intersection, such as at T-intersections with appropriate geometrics and/or pavement markings and signing, an engineering study might determine that the through movement (or certain lanes of the through movement) can be free-flow and not signalized.

Guidance:

If two or more left-turn lanes are provided for a separately controlled protected only mode left-turn movement, or if a left-turn movement represents the major movement from an approach, two or more primary left-turn signal faces should be provided.

If two or more right-turn lanes are provided for a separately controlled right-turn movement, or if a right-turn movement represents the major movement from an approach, two or more primary right-turn signal faces should be provided.

Support:

Locating primary signal faces overhead on the far side of the intersection has been shown to provide safer operation by reducing intersection entries late in the yellow interval and by reducing red signal violations, as compared to post-mounting signal faces at the roadside or locating signal faces overhead within the intersection on a diagonally-oriented mast arm or span wire. On approaches with two or more lanes for the through movement, one signal face per through lane, centered over each through lane, has also been shown to provide safer operation.

Guidance:

If the posted or statutory speed limit or the 85th-percentile speed on an approach to a signalized location is 45 mph or higher, signal faces should be provided as follows for all new or reconstructed signal installations (see Figure 4D-3):

- A. *The minimum number and location of primary (non-supplemental) signal faces for through traffic should be provided in accordance with Table 4D-1.*
- B. *If the number of overhead primary signal faces for through traffic is equal to the number of through lanes on an approach, one overhead signal face should be located approximately over the center of each through lane.*
- C. *Except for shared left-turn and right-turn signal faces, any primary signal face required by Sections 4D.17 through 4D.25 for an exclusive turn lane should be located overhead approximately over the center of each exclusive turn lane.*
- D. *All primary signal faces should be located on the far side of the intersection.*

E. In addition to the primary signal faces, one or more supplemental pole-mounted or overhead signal faces should be considered to provide added visibility for approaching traffic that is traveling behind large vehicles.

F. All signal faces should have backplates.

This layout of signal faces should also be considered for any major urban or suburban arterial street with four or more lanes and for other approaches with speeds of less than 45 mph.

Section ~~4D.12~~ 4D.05 Visibility, Aiming, and Shielding of Signal Faces

~~Standard~~ *Guidance:*

The ~~primary~~ *most important* consideration in signal face placement, aiming, and adjustment ~~shall~~ *should* be to optimize the visibility of signal indications to approaching traffic.

Road users approaching a signalized intersection or other signalized area, such as a midblock crosswalk, ~~shall~~ *should* be given a clear and unmistakable indication of ~~their right-of-way assignment~~ *whether they are being directed to stop or permitted to proceed*.

The geometry of each intersection to be signalized, including vertical grades, horizontal curves, and obstructions as well as the lateral and vertical angles of sight toward a signal face, as determined by typical driver-eye position, ~~shall~~ *should* be considered in determining the vertical, longitudinal, and lateral position of the signal face.

~~Guidance:~~

The two primary signal faces required as a minimum for each approach should be continuously visible to traffic approaching the traffic control signal, from a point at least the minimum sight distance provided in Table 4D-2 in advance of and measured to the stop line. This range of continuous visibility should be provided unless precluded by a physical obstruction or unless another signalized location is within this range.

There should be legal authority to prohibit the display of any unauthorized sign, signal, marking, or device that interferes with the effectiveness of any official traffic control device (see Section 11-205 of the "Uniform Vehicle Code").

At signalized midblock crosswalks, at least one of the signal faces should be over the traveled way for each approach.

~~Standard:~~

If approaching traffic does not have a continuous view of at least two signal faces for at least the minimum sight distance shown in Table 4D-2, a sign (see Section 2C.36) ~~shall~~ *should* be installed to warn approaching traffic of the traffic control signal.

Option:

If a sign is installed to warn approaching road users of the traffic control signal, the sign may be supplemented by a Warning Beacon (see Section 4L.03).

A Warning Beacon used in this manner may be interconnected with the traffic signal controller assembly in such a manner as to flash yellow during the period when road users passing this beacon at the legal speed for the roadway might encounter a red signal indication (or a queue resulting from the display of the red signal indication) upon arrival at the signalized location.

If the sight distance to the signal faces for an approach is limited by horizontal or vertical alignment, supplemental signal faces aimed at a point on the approach at which the signal indications first become visible may be used.

Guidance:

Supplemental signal faces should be used if engineering judgment has shown that they are needed to achieve intersection visibility both in advance and immediately before the signalized location.

If supplemental signal faces are used, they should be located to provide optimum visibility for the movement to be controlled.

~~Standard:~~

In cases where irregular street design necessitates placing signal faces for different street approaches with a comparatively small angle between their respective signal indications, each signal indication

~~shall~~*should*, to the extent practical, be visibility-limited by signal visors, signal louvers, or other means so that an approaching road user's view of the signal indication(s) controlling movements on other approaches is minimized.

Signal visors exceeding 12 inches in length ~~shall~~*should* not be used on free-swinging signal faces.

~~Guidance:~~

Signal visors should be used on signal faces to aid in directing the signal indication specifically to approaching traffic, as well as to reduce "sun phantom," which can result when external light enters the lens.

The use of signal visors, or the use of signal faces or devices that direct the light without a reduction in intensity, should be considered as an alternative to signal louvers because of the reduction in light output caused by signal louvers.

Option:

Special signal faces, such as visibility-limited signal faces, may be used such that the road user does not see signal indications intended for other approaches before seeing the signal indications for their own approach, if simultaneous viewing of both signal indications could cause the road user to be misdirected.

Guidance:

If the posted or statutory speed limit or the 85th-percentile speed on an approach to a signalized location is 45 mph or higher, signal backplates should be used on all of the signal faces that face the approach. Signal backplates should also be considered for use on signal faces on approaches with posted or statutory speed limits or 85th-percentile speeds of less than 45 mph where sun glare, bright sky, and/or complex or confusing backgrounds indicate a need for enhanced signal face target value.

Support:

The use of backplates enhances the contrast between the traffic signal indications and their surroundings for both day and night conditions, which is also helpful to older drivers.

~~Standard~~*Guidance***Standard: (8)**

The inside of signal visors (hoods), the entire surface of louvers and fins, and the front surface of backplates ~~shall~~*should***shall (8)** have a dull black finish to minimize light reflection and to increase contrast between the signal indication and its background.

Option:

A yellow retroreflective strip with a minimum width of 1 inch and a maximum width of 3 inches may be placed along the perimeter of the face of a signal backplate to project a rectangular appearance at night.

~~Section 4D.13~~**Section 4D.06 Lateral Positioning of Signal Faces**

Standard:

At least one and preferably both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach shall be located between two lines intersecting with the center of the approach at a point 10 feet behind the stop line, one making an angle of approximately 20 degrees to the right of the center of the approach extended, and the other making an angle of approximately 20 degrees to the left of the center of the approach extended. The signal face that satisfies this requirement shall simultaneously satisfy the longitudinal placement requirement described in Section 4D.14 (see Figure 4D-4).

If both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach are post-mounted, they shall both be on the far side of the intersection, one on the right and one on the left of the approach lane(s).

The required signal faces for through traffic on an approach shall be located not less than 8 feet apart measured horizontally perpendicular to the approach between the centers of the signal faces.

If more than one separate turn signal face is provided for a turning movement and if one or both of the separate turn signal faces are located over the roadway, the signal faces shall be located not less than 8 feet apart measured horizontally perpendicular to the approach between the centers of the signal faces.

Guidance:

If a signal face controls a specific lane or lanes of an approach, its position should make it readily visible to road users making that movement.

Support:

Section 4D.11 contains additional provisions regarding lateral positioning of signal faces for approaches having a posted or statutory speed limit or an 85th-percentile speed of 45 mph or higher.

~~Standard~~ Guidance:

If an exclusive left-turn, right-turn, or U-turn lane is present on an approach and if a primary separate turn signal face controlling that lane is mounted over the roadway, the primary separate turn signal face ~~shall~~ should not be positioned any further to the right than the extension of the right-hand edge of the exclusive turn lane or any further to the left than the extension of the left-hand edge of the exclusive turn lane.

Support:

Supplemental turn signal faces mounted over the roadway ~~shall~~ are not ~~be~~ subject to the positioning ~~requirements~~ recommendations in the previous paragraph.

Guidance:

For new or reconstructed signal installations, on an approach with an exclusive turn lane(s) for a permissive left-turn (or U-turn to the left) movement ~~and with opposing vehicular traffic~~, signal faces that display a CIRCULAR GREEN signal indication should not be post-mounted on the far-side median or mounted overhead above the exclusive turn lane(s) or the extension of the lane(s).

Standard:

If supplemental post-mounted signal faces are used, the following limitations shall apply:

- A. Left-turn arrows and U-turn arrows to the left shall not be used in near-right signal faces that are located to the right of the through and/or right-turn lanes.
- B. Right-turn arrows and U-turn arrows to the right shall not be used in far-left signal faces that are located to the left of the through and/or left-turn lanes. A far-side median-mounted signal face shall be considered a far-left signal face for this application.

Section ~~4D.14~~ 4D.07 Longitudinal Positioning of Signal Faces

Standard:

Except where the width of an intersecting roadway or other conditions make it physically impractical, the signal faces for each approach to an intersection or a midblock location shall be provided as follows:

- A. A signal face installed to satisfy the requirements for primary left-turn signal faces (see Sections 4D.17 through 4D.20) and primary right-turn signal faces (see Sections 4D.21 through 4D.24), and at least one and preferably both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach shall be located:
 - 1. No less than 40 feet beyond the stop line, and
 - 2. No more than 180 feet beyond the stop line unless a supplemental near-side signal face is provided, ~~and~~
 - ~~3. As near as practical to the line of the driver's normal view, if mounted over the roadway.~~
- B. The primary signal faces that are used to ~~satisfies~~ satisfy ~~this~~ the requirements ~~of Item A~~ shall simultaneously satisfy the lateral placement requirement described in Section 4D.13 (see Figure 4D-4).

Guidance:

~~B.~~ Where the nearest signal face is located between 150 and 180 feet beyond the stop line, engineering judgment of the conditions, including the worst-case visibility conditions, ~~shall~~ should be used to determine if the provision of a supplemental near-side signal face would be beneficial. **This paragraph was formerly Item B of the previous paragraph**

Supplemental near-side signal faces should be located as near as practical to the stop line.

Support:

Section 4D.11 contains additional provisions regarding longitudinal positioning of signal faces for approaches having a posted or 85th-percentile speed of 45 mph or higher. **This paragraph was relocated to the end of the section**

Section ~~4D.15~~ **4D.08** Mounting Height of Signal Faces

Standard:

The first two paragraphs were relocated to Guidance

The bottom of the signal housing and any related attachments to a vehicular signal face located over any portion of a highway that can be used by motor vehicles shall be at least 15 feet above the pavement.

The bottom of the signal housing (including brackets) of a vehicular signal face that is vertically arranged and not located over a roadway:

- A. Shall be a minimum of 8 feet ~~and a maximum of 19 feet~~ above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.
- B. Shall be a minimum of 4.5 feet ~~and a maximum of 19 feet~~ above the median island grade of a center median island if located on the near side of the intersection. **The maximum heights were relocated to Guidance**

The bottom of the signal housing (including brackets) of a vehicular signal face that is horizontally arranged and not located over a roadway:

- A. Shall be a minimum of 8 feet ~~and a maximum of 22 feet~~ above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.
- B. Shall be a minimum of 4.5 feet ~~and a maximum of 22 feet~~ above the median island grade of a center median island if located on the near side of the intersection. **The maximum heights were relocated to Guidance**

Guidance:

The top of the signal housing of a vehicular signal face located over any portion of a highway that can be used by motor vehicles ~~shall~~ should not be more than 25.6 feet above the pavement.

For viewing distances between 40 and 53 feet from the stop line, the maximum mounting height to the top of the signal housing of a vehicular signal face located over any portion of a highway that can be used by motor vehicles ~~shall~~ should be as shown in Figure 4D-5.

The bottom of the signal housing (including brackets) of a vehicular signal face that is vertically arranged and not located over a roadway:

- A. ~~Shall~~ **Should** **(9)** be a maximum of 19 feet above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.*
- B. ~~Shall~~ **Should** **(9)** be a maximum of 19 feet above the median island grade of a center median island if located on the near side of the intersection.*

The bottom of the signal housing (including brackets) of a vehicular signal face that is horizontally arranged and not located over a roadway:

- A. ~~Shall~~ **Should** **(9)** be a maximum of 22 feet above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.*
- B. ~~Shall~~ **Should** **(9)** be a maximum of 22 feet above the median island grade of a center median island if located on the near side of the intersection.*

Section ~~4D.16~~ **4D.09** Lateral Offset (Clearance) of Signal Faces

~~Standard~~ Guidance:

Signal faces mounted at the side of a roadway with curbs at less than 15 feet from the bottom of the housing and any related attachments ~~shall~~ should have a horizontal offset of not less than 2 feet from the face of a vertical curb, or if there is no curb, not less than 2 feet from the edge of a shoulder.

Section ~~4D.32~~ **4D.10** Temporary and Portable Traffic Control Signals

Support:

1 A temporary traffic control signal is generally installed using methods that minimize the costs of
2 installation, relocation, and/or removal. Typical temporary traffic control signals are for specific purposes,
3 such as for one-lane, two-way facilities in temporary traffic control zones (see Chapter 4H), for a haul-road
4 intersection, or for access to a site that will have a permanent access point developed at another location in the
5 near future. Portable traffic signals are temporary traffic signals. (10)

6 **Standard:**

7 **Advance signing shall be used when employing a temporary traffic control signal.**

8 **A temporary traffic control signal shall:**

- 9 **A. Meet the physical display and operational requirements of a conventional traffic control signal.**
10 **B. Be removed when no longer needed.**
11 **C. Be placed in the flashing mode (or in a semi-actuated mode with green signal indications being**
12 **shown to major-street traffic except when a vehicle call is received on a minor-street**
13 **approach when not being used if it will be operated in the steady mode within 5 working days;**
14 **otherwise, it shall be removed.**
15 **D. Be placed in the flashing mode (or in a semi-actuated mode with green signal indications being**
16 **shown to major-street traffic except when a vehicle call is received on a minor-street**
17 **approach during periods when it is not desirable to operate the signal, or the signal heads shall**
18 **be covered, turned, or taken down to indicate that the signal is not in operation.**

19 *Guidance:*

20 *A temporary traffic control signal should be used only if engineering judgment indicates that installing*
21 *the signal will improve the overall safety and/or operation of the location.*

22 *The use of temporary traffic control signals by a work crew on a regular basis in their work area should*
23 *be subject to the approval of the jurisdiction having authority over the roadway.*

24 *A temporary traffic control signal should not operate longer than 30 days unless associated with a longer-*
25 *term temporary traffic control zone project.*

26 *For use of temporary traffic control signals in temporary traffic control zones, reference should be made*
27 *to Section 6F.84.*

CHAPTER 4E. TRAFFIC CONTROL SIGNAL INDICATIONS

Section ~~4D.06~~4E.01 Signal Indications – Design, Illumination, Color, and Shape

Standard:

The illuminated part of each signal indication, except those used for pedestrian signal heads and lane-use control signals, shall be circular or arrow.

Letters or numbers (including those associated with countdown displays) shall not be displayed as part of a vehicular signal indication.

Strobes shall not be used within or adjacent to any signal indication.

Except for the flashing signal indications and the preemption confirmation lights that are expressly allowed by the provisions of this Chapter, flashing displays shall not be used within or adjacent to any signal indications.

Each circular signal indication shall emit a single color: red, yellow, or green.

Each arrow signal indication shall emit a single color: red, yellow, or green except that the ~~alternate~~alternating (11) display (dual-arrow signal section) of a GREEN ARROW and a ~~steady~~ (42.01) YELLOW ARROW signal indication, both pointing in the same direction, shall be permitted, provided that they are not displayed simultaneously.

The arrow, which shall show only one direction, shall be the only illuminated part of an arrow signal indication.

Arrows shall be pointed:

- A. Vertically upward to indicate a straight-through movement, or
- B. Horizontally in the direction of the turn to indicate a turn at approximately or greater than a right angle, or
- C. Upward with a slope at an angle approximately equal to that of the turn if the angle of the turn is substantially less than a right angle, or
- D. In a manner that directs the driver through the turn if a U-turn arrow is used (see Figure 4D-1).

Except as provided in Paragraph 10, the requirements of the publication entitled “Vehicle Traffic Control Signal Heads” (see Section 1A.11) that pertain to the aspects of the signal head design that affect the display of the signal indications shall be met.

Guidance:

The intensity and distribution of light from each illuminated signal lens should comply with the publications entitled “Vehicle Traffic Control Signal Heads” and “Traffic Signal Lamps” (see Section 1A.11).

~~Standard:~~

Paragraph 11 was changed to a Support statement and incorporated into Paragraph 12 as a new first sentence

Support:

References to signal lenses in this section ~~shall are not be used~~ intended to limit signal optical units to incandescent lamps within optical assemblies that include lenses. Research has resulted in signal optical units that are not lenses, such as, but not limited to, light emitting diode (LED) traffic signal modules. Some units are practical for all signal indications, and some are practical for specific types such as visibility-limited signal indications.

Guidance:

If a signal indication is so bright that it causes excessive glare during nighttime conditions, some form of automatic dimming should be used to reduce the brilliance of the signal indication.

Section ~~4D.07~~4E.02 Size of Vehicular Signal Indications

Standard:

There shall be two nominal diameter sizes for vehicular signal indications: 8 inches and 12 inches.

Twelve-inch signal indications shall be used for all arrow signal indications.

1 Except as provided in Paragraph 4 below, 12-inch signal indications shall be used for all
2 circular ~~signal sections~~ indications in all new signal faces.

3 Option:

4 Eight-inch circular signal indications may be used in new signal faces only for:

- 5 A. The green or flashing yellow signal indications in an emergency-vehicle traffic control signal (see
- 6 Section 4G.02);
- 7 B. The circular indications in signal faces controlling the approach to the downstream location where
- 8 two adjacent signalized locations are close to each other and it is not practical because of factors such
- 9 as high approach speeds, horizontal or vertical curves, or other geometric factors to install visibility-
- 10 limited signal faces for the downstream approach;
- 11 C. The circular indications in a signal face that is located less than 120 feet from the stop line on a
- 12 roadway with a posted or statutory speed limit of 30 mph or less;
- 13 D. The circular indications in a supplemental near-side signal face;
- 14 E. The circular indications in a supplemental signal face installed for the sole purpose of controlling
- 15 pedestrian movements (see Section 4D.03) rather than vehicular movements; ~~and~~
- 16 F. The circular indications in a signal face installed for the sole purpose of controlling a bikeway or a
- 17 bicycle movement; and
- 18 G. The circular indications in a flashing beacon (see Section 4L.02).

19 Existing 8-inch circular signal indications that are not included in Items A through F in Paragraph 3 may
20 be retained for the remainder of their useful service life.

21 Different sizes of signal indications may be used in the same signal face or signal head, provided that the
22 signal face or signal head complies with the requirements contained in Paragraphs 2 and 3 above. **This is a**
23 **variation of Paragraph 5 of Section 4D.15 in the 2003 MUTCD**

24 **Section ~~4D.08~~ 4E.03 Positions of Signal Indications Within a Signal Face – General**

25 Support:

26 Standardization of the number and arrangements of signal sections in vehicular traffic control signal faces
27 enables road users who are color vision deficient to identify the illuminated color by its position relative to
28 other signal sections.

29 **Standard:**

30 Unless otherwise provided in this Manual for a particular application, each signal face at a
31 signalized location shall have three, four, or five signal sections. Unless otherwise provided in this
32 Manual for a particular application, if a vertical signal face includes a cluster (see Section 4D.09), the
33 signal face shall have at least three vertical positions.

34 A single-section signal face shall be permitted at a traffic control signal if it consists of a
35 continuously-displayed GREEN ARROW signal indication that is being used to indicate a continuous
36 movement.

37 The signal sections in a signal face shall be arranged in a vertical or horizontal straight line, except
38 as otherwise provided in Section 4D.09.

39 The arrangement of adjacent signal sections in a signal face shall follow the relative positions listed
40 in Sections 4D.09 or 4D.10, as applicable.

41 If a signal section that displays a CIRCULAR YELLOW signal indication is used, it shall be located
42 between the signal section that displays the red signal indication and all other signal sections.

43 If a U-turn arrow signal section is used in a signal face for a U-turn to the left, its position in the
44 signal face shall be the same as stated in Sections 4D.09 and 4D.10 for a left-turn arrow signal section of
45 the same color. If a U-turn arrow signal section is used in a signal face for a U-turn to the right, its
46 position in the signal face shall be the same as stated in Sections 4D.09 and 4D.10 for a right-turn arrow
47 signal section of the same color.

48 A U-turn arrow signal indication pointing to the left shall not be used in a signal face that also
49 contains a left-turn arrow signal indication. A U-turn arrow signal indication pointing to the right shall
50 not be used in a signal face that also contains a right-turn arrow signal indication.

Option:

Within a signal face, two identical CIRCULAR RED or RED ARROW signal indications may be displayed immediately horizontally adjacent to each other in a vertical or horizontal signal face (see Figure 4D-2) for emphasis.

Horizontally-arranged and vertically-arranged signal faces may be used on the same approach provided they are separated to meet the lateral separation spacing required in Section 4D.13.

Support:

Figure 4D-2 illustrates some of the typical arrangements of signal sections in signal faces that do not control separate turning movements. Figures 4D-6 through 4D-12 illustrate the typical arrangements of signal sections in left-turn signal faces. Figures 4D-13 through 4D-19 illustrate the typical arrangements of signal sections in right-turn signal faces.

Section ~~4D.09~~4E.04 Positions of Signal Indications Within a Vertical Signal Face

Standard:

In each vertically-arranged signal face, all signal sections that display red signal indications shall be located above all signal sections that display yellow and green signal indications.

In vertically-arranged signal faces, each signal section that displays a YELLOW ARROW signal indication shall be located above the signal section that displays the GREEN ARROW signal indication to which it applies.

The relative positions of signal sections in a vertically-arranged signal face, from top to bottom, shall be as follows:

CIRCULAR RED
Steady and/or flashing left-turn RED ARROW
Steady and/or flashing right-turn RED ARROW
CIRCULAR YELLOW
CIRCULAR GREEN
Straight-through GREEN ARROW
Steady left-turn YELLOW ARROW
Flashing left-turn YELLOW ARROW
Left-turn GREEN ARROW
Steady right-turn YELLOW ARROW
Flashing right-turn YELLOW ARROW
Right-turn GREEN ARROW

If a dual-arrow signal section (capable of alternating between the display of a GREEN ARROW and a ~~steady~~(42.02) YELLOW ARROW signal indication) is used in a vertically-arranged signal face, the dual-arrow signal section shall occupy the same position relative to the other sections as the signal section that displays the GREEN ARROW signal indication in a vertically-arranged signal face would occupy.

Option:

In a vertically-arranged signal face, signal sections that display signal indications of the same color may be arranged horizontally adjacent to each other at right angles to the basic straight line arrangement to form a clustered signal face (see Figures 4D-2, 4D-9, 4D-11, 4D-16, and 4D-18).

Standard:

Such clusters shall be limited to the following:

- A. Two identical signal sections,**
- B. Two or three different signal sections that display signal indications of the same color, or**
- C. For only the specific case described in Section 4D.25 (see Drawing B of Figure 4D-20), two signal sections, one of which displays a GREEN ARROW signal indication and the other of which displays a flashing YELLOW ARROW signal indication.**

The signal section that displays a flashing yellow signal indication during steady mode operation

~~A. Shall not be placed in the same vertical position as the signal section that displays a steady yellow signal indication, and (42.03)~~

~~B. Shall be placed below the signal section that displays a steady yellow signal indication unless included in a signal section capable of alternating between the display of a steady YELLOW ARROW and a flashing YELLOW ARROW signal indication. (42.03)~~

Support:

Sections 4F.02 and 4G.04 contain exceptions to the provisions of this Section that are applicable to hybrid beacons.

Section ~~4D.40~~ 4E.05 Positions of Signal Indications Within a Horizontal Signal Face

Standard:

In each horizontally-arranged signal face, all signal sections that display red signal indications shall be located to the left of all signal sections that display yellow and green signal indications.

In horizontally-arranged signal faces, each signal section that displays a YELLOW ARROW signal indication shall be located to the left of the signal section that displays the GREEN ARROW signal indication to which it applies.

The relative positions of signal sections in a horizontally-arranged signal face, from left to right, shall be as follows:

CIRCULAR RED

Steady and/or flashing left-turn RED ARROW

Steady and/or flashing right-turn RED ARROW

CIRCULAR YELLOW

Steady left-turn YELLOW ARROW

Flashing left-turn YELLOW ARROW

Left-turn GREEN ARROW

CIRCULAR GREEN

Straight-through GREEN ARROW

Steady right-turn YELLOW ARROW

Flashing right-turn YELLOW ARROW

Right-turn GREEN ARROW

If a dual-arrow signal section (capable of alternating between the display of a GREEN ARROW and a steady YELLOW ARROW signal indication) is used in a horizontally-arranged signal face, the signal section that displays the dual left-turn arrow signal indication shall be located immediately to the right of the signal section that displays the CIRCULAR YELLOW signal indication, the signal section that displays the straight-through GREEN ARROW signal indication shall be located immediately to the right of the signal section that displays the CIRCULAR GREEN signal indication, and the signal section that displays the dual right-turn arrow signal indication shall be located to the right of all other signal sections.

The signal section that displays a flashing yellow signal indication during steady mode operation:

~~A. Shall not be placed in the same horizontal position as the signal section that displays a steady yellow signal indication, and (42.04)~~

~~B. Shall be placed to the right of the signal section that displays a steady yellow signal indication unless included in a signal section capable of alternating between the display of a steady YELLOW ARROW and a flashing YELLOW ARROW signal indication. (42.04)~~

CHAPTER 4F. STEADY (STOP-AND-GO) OPERATION OF TRAFFIC CONTROL SIGNALS

Section ~~4D.05~~ 4F.01 Application of Steady and Flashing Signal Indications during Steady (Stop-and-Go) Operation

Standard:

When a traffic control signal is being operated in a steady (stop-and-go) mode, at least one indication in each signal face shall be displayed at any given time.

A signal face(s) that controls a particular vehicular movement during any interval of a cycle shall control that same movement during all intervals of the cycle.

Steady **and flashing** signal indications shall be applied as follows:

A. A steady CIRCULAR RED signal indication:

1. Shall be displayed when it is intended to prohibit traffic, except pedestrians directed by a pedestrian signal head, from entering the intersection or other controlled area. Turning after stopping is permitted as stated in Item C.1 in Paragraph 3 of Section 4D.04.
2. Shall be displayed with the appropriate GREEN ARROW signal indications when it is intended to permit traffic to make a specified turn or turns, and to prohibit traffic from proceeding straight ahead through the intersection or other controlled area, except in protected only mode operation (see Sections 4D.19 and 4D.23), or in protected/permissive mode operation with separate turn signal faces (see Sections 4D.20 and 4D.24).

B. A steady CIRCULAR YELLOW signal indication:

1. Shall be displayed following a CIRCULAR GREEN or straight-through GREEN ARROW signal indication in the same signal face.
2. Shall not be displayed in conjunction with the change from the CIRCULAR RED signal indication to the CIRCULAR GREEN signal indication.
3. Shall be followed by a CIRCULAR RED signal indication except that, when entering preemption operation, the return to the previous CIRCULAR GREEN signal indication shall be permitted following a steady CIRCULAR YELLOW signal indication (see Section 4D.27).
4. Shall not be displayed to an approach from which drivers are turning left permissively or making a U-turn to the left permissively unless one of the following conditions exists:
 - (a) A steady CIRCULAR YELLOW signal indication is also simultaneously being displayed to the opposing approach;
 - (b) An engineering study has determined that, because of unique intersection conditions, the condition described in Item (a) cannot reasonably be implemented without causing significant operational or safety problems and that the volume of impacted left-turning or U-turning traffic is relatively low, and those left-turning or U-turning drivers are advised that a steady CIRCULAR YELLOW signal indication is not simultaneously being displayed to the opposing traffic if this operation occurs continuously by the installation near the left-most signal head of a W25-1 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC HAS EXTENDED GREEN; or
 - (c) Drivers are advised of the operation if it occurs only occasionally, such as during a preemption sequence, by the installation near the left-most signal head of a W25-2 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN.

C. A steady CIRCULAR GREEN signal indication shall be displayed only when it is intended to permit traffic to proceed in any direction that is lawful and practical.

D. A flashing YELLOW ARROW signal indication shall be displayed as part of a steady (stop-and-go) mode of operation only when it is intended to permit traffic to cautiously enter the intersection to make a turn in the direction indicated by the arrow after yielding to pedestrians, if any, and/or to opposing traffic, if any.

E. A flashing RED ARROW signal indication shall be displayed as part of a steady (stop-and-go) mode of operation only when it is intended to permit traffic, after coming to a full stop, to

cautiously enter the intersection to make a turn in the direction indicated by the arrow after yielding to pedestrians, if any, and/or to opposing traffic, if any.

- F. A steady RED ARROW signal indication shall be displayed when it is intended to prohibit traffic, except pedestrians directed by a pedestrian signal head, from entering the intersection or other controlled area to make the indicated turn. Except as described in Item C.2 in Paragraph 3 of Section 4D.04, turning on a steady RED ARROW signal indication shall not be permitted.
- G. A steady YELLOW ARROW signal indication:
1. Shall be displayed in the same direction as a GREEN ARROW signal indication following a GREEN ARROW signal indication in the same signal face, unless:
 - (a) The GREEN ARROW signal indication and a CIRCULAR GREEN (or straight-through GREEN ARROW) signal indication terminate simultaneously in the same signal face, or
 - (b) The green arrow is a straight-through GREEN ARROW (see Item B.1).
 2. Shall be displayed in the same direction as a flashing YELLOW ARROW signal indication or flashing RED ARROW signal indication following a flashing YELLOW ARROW signal indication or flashing RED ARROW signal indication in the same signal face, when the flashing arrow indication is displayed as part of a steady mode operation, if the signal face will subsequently display a steady red signal indication.
 3. Shall not be displayed in conjunction with the change from a steady RED ARROW, flashing RED ARROW, or flashing YELLOW ARROW signal indication to a GREEN ARROW signal indication, except when entering preemption operation as provided in Item 5(a).
 4. Shall not be displayed when any conflicting vehicular movement has a green or yellow signal indication (except for the situation regarding U-turns to the left provided in Paragraph 4) or any conflicting pedestrian movement has a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication, except that a steady left-turn (or U-turn to the left) YELLOW ARROW signal indication used to terminate a flashing left-turn (or U-turn to the left) YELLOW ARROW or a flashing left-turn (or U-turn to the left) RED ARROW signal indication in a signal face controlling a permissive left-turn (or U-turn to the left) movement as described in Sections 4D.18 and 4D.20 shall be permitted to be displayed when a CIRCULAR YELLOW signal indication is displayed for the opposing through movement. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate ~~departing~~ departure lane, and pavement markings or raised channelization clearly indicate which departure lane to use.
 5. Shall not be displayed to terminate a flashing arrow signal indication on an approach from which drivers are turning left permissively or making a U-turn to the left permissively unless one of the following conditions exists:
 - (a) A steady CIRCULAR YELLOW signal indication is also simultaneously being displayed to the opposing approach;
 - (b) An engineering study has determined that, because of unique intersection conditions, the condition described in Item (a) cannot reasonably be implemented without causing significant operational or safety problems and that the volume of impacted left-turning or U-turning traffic is relatively low, and those left-turning or U-turning drivers are advised that a steady CIRCULAR YELLOW signal indication is not simultaneously being displayed to the opposing traffic if this operation occurs continuously by the installation near the left-most signal head of a W25-1 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC HAS EXTENDED GREEN; or
 - (c) Drivers are advised of the operation if it occurs only occasionally, such as during a preemption sequence, by the installation near the left-most signal head of a W25-2 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN.
 6. Shall be terminated by a RED ARROW signal indication for the same direction or a CIRCULAR RED signal indication except:

- (a) When entering preemption operation, the display of a GREEN ARROW signal indication or a flashing arrow signal indication shall be permitted following a steady YELLOW ARROW signal indication.
- (b) When the movement controlled by the arrow is to continue on a permissive mode basis during an immediately following signal phase, the display of a CIRCULAR GREEN signal indication or flashing YELLOW ARROW signal indication shall be permitted following a steady YELLOW ARROW signal indication.

H. A steady GREEN ARROW signal indication:

1. Shall be displayed only to allow vehicular movements, in the direction indicated, that are not in conflict with other vehicles moving on a green or yellow signal indication (except for the situation regarding U-turns provided in Paragraph 4), even if the other vehicles are required to yield the right-of-way to the traffic moving on the GREEN ARROW signal indication, and are not in conflict with pedestrians crossing in compliance with a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate ~~departing~~ departure lane, and pavement markings or raised channelization clearly indicate which departure lane to use.
2. Shall be displayed on a signal face that controls a left-turn movement when said movement is not in conflict with other vehicles moving on a green or yellow signal indication (except for the situation regarding U-turns provided in Paragraph 4) and is not in conflict with pedestrians crossing in compliance with a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate ~~departing~~ departure lane, and pavement markings or raised channelization clearly indicate which departure lane to use.
3. Shall not be required on the stem of a T-intersection or for turns from a one-way street.

Option:

If U-turns are permitted from the approach and a right-turn GREEN ARROW signal indication is simultaneously being displayed to road users making a right turn from the conflicting approach to the left, road users making a U-turn may be advised of the operation by the installation near the left-turn signal face of a U-TURN YIELD TO RIGHT TURN (R10-16) sign (see Section 2B.53).

If not otherwise prohibited, a steady straight-through GREEN ARROW signal indication may be used instead of a CIRCULAR GREEN signal indication in a signal face on an approach intersecting a one-way street to discourage wrong-way turns.

If not otherwise prohibited, steady red, yellow, and green turn arrow signal indications may be used instead of steady circular red, yellow, and green signal indications in a signal face on an approach where all traffic is required to turn or where the straight-through movement is not physically possible.

Support:

Section 4D.25 contains information regarding the signalization of approaches that have a ~~shared~~ combined left-turn/right-turn lane and no through movement.

Standard:

If supplemental signal faces are used, the following limitations shall apply:

- A. Left-turn arrows and U-turn arrows to the left shall not be used in near-right signal faces.
- B. Right-turn arrows and U-turn arrows to the right shall not be used in far-left signal faces. A far-side median-mounted signal face shall be considered a far-left signal for this application.

A straight-through RED ARROW signal indication or a straight-through YELLOW ARROW signal indication shall not be displayed on any signal face, either alone or in combination with any other signal indication.

The following combinations of signal indications shall not be simultaneously displayed on any one signal face:

- 1 A. CIRCULAR RED with CIRCULAR YELLOW;
- 2 B. CIRCULAR GREEN with CIRCULAR RED; or
- 3 C. Straight-through GREEN ARROW with CIRCULAR RED;

4 Additionally, the above combinations shall not be simultaneously displayed on an approach as a
5 result of the combination of displays from multiple signal faces unless the display is created by a signal
6 face(s) devoted exclusively to the control of a right-turning movement and:

- 7 A. The signal face(s) controlling the right-turning movement is visibility-limited from the adjacent
8 through movement or positioned to minimize potential confusion to approaching road users, or
- 9 B. A RIGHT TURN SIGNAL (R10-10) sign (see Sections 4D.21 through 4D.24) is mounted
10 adjacent to the signal face(s) controlling the right-turning movement.

11 The following combinations of signal indications shall not be simultaneously displayed on any one
12 signal face or as a result of the combination of displays from multiple signal faces on an approach:

- 13 A. CIRCULAR GREEN with CIRCULAR YELLOW;
- 14 B. Straight-through GREEN ARROW with CIRCULAR YELLOW;
- 15 C. GREEN ARROW with YELLOW ARROW pointing in the same direction;
- 16 D. RED ARROW with YELLOW ARROW pointing in the same direction; or
- 17 E. GREEN ARROW with RED ARROW pointing in the same direction.

18 ~~Except as otherwise provided in Sections 4F.03 and 4G.04, the same signal section shall not be used~~
19 ~~to display both a flashing yellow and a steady yellow indication during steady mode~~
20 ~~operation.~~ (42.05) Except as otherwise provided in Sections 4D.18, 4D.20, 4D.22, and 4D.24, the same
21 signal section shall not be used to display both a flashing red and a steady red indication during steady
22 mode operation.

23 *Guidance:*

24 *No movement that creates an unexpected crossing of pathways of moving vehicles or pedestrians should*
25 *be allowed during any green or yellow interval, except when all three of the following conditions are met:*

- 26 A. *The movement involves only slight conflict, and*
- 27 B. *Serious traffic delays are substantially reduced by permitting the conflicting movement, and*
- 28 C. *Drivers and pedestrians subjected to the unexpected conflict are effectively warned thereof by a sign.*

29 **Section ~~4D.17~~ 4F.02 Signal Indications for Left-Turn Movements – General**

30 ~~Standard~~ **Support:**

31 In Sections 4D.17 through 4D.20, provisions applicable to left-turn movements and left-turn lanes
32 ~~shall~~ also ~~apply~~ **applicable** to signal indications for U-turns to the left that are provided at locations where left
33 turns are prohibited or not geometrically possible.

34 ~~Support:~~

35 Left-turning traffic is controlled by one of four modes as follows:

- 36 A. Permissive Only Mode—turns made on a CIRCULAR GREEN signal indication, a flashing left-turn
37 YELLOW ARROW signal indication, or a flashing left-turn RED ARROW signal indication after
38 yielding to pedestrians, if any, and/or opposing traffic, if any.
- 39 B. Protected Only Mode—turns made only when a left-turn GREEN ARROW signal indication is
40 displayed.
- 41 C. Protected/Permissive Mode—both modes can occur on an approach during the same cycle.
- 42 D. Variable Left-Turn Mode—the operating mode changes among the protected only mode and/or the
43 protected/permissive mode and/or the permissive only mode during different periods of the day or as
44 traffic conditions change.

45 **Option:**

46 In areas having a high percentage of older drivers, special consideration may be given to the use of
47 protected only mode left-turn phasing, when appropriate.

48 **Standard:**

49 During a permissive left-turn movement, the signal faces for through **and right-turning** traffic on the
50 opposing approach shall simultaneously display green or steady yellow signal indications. If

1 pedestrians crossing the lane or lanes used by the permissive left-turn movement to depart the
2 intersection are controlled by pedestrian signal heads, the signal indications displayed by those
3 pedestrian signal heads shall not be limited to any particular display during the permissive left-turn
4 movement.

5 During a protected left-turn movement, the signal faces for through traffic on the opposing
6 approach shall simultaneously display steady CIRCULAR RED signal indications. During a protected
7 left-turn movement, a GREEN ARROW or a YELLOW ARROW signal indication shall not
8 simultaneously be displayed to right-turn traffic on the opposing approach, except where a separate
9 departure lane is available for each left-turn and right-turn lane with moving traffic and pavement
10 markings or raised channelization clearly indicate which departure lane to use (see Item F.1 in
11 Paragraph 3 in Section 4D.05). If pedestrians crossing the lane or lanes used by the protected left-turn
12 movement to depart the intersection are controlled by pedestrian signal heads, the pedestrian signal
13 heads shall display a steady UPRAISED HAND (symbolizing DONT WALK) signal indication during
14 the protected left-turn movement.

15 If a combined left-turn/through lane exists on an approach, a protected only mode left-turn
16 movement that does not begin and terminate at the same time as the adjacent through movement shall
17 not be provided on the approach. ~~a protected only mode left-turn movement that does not begin and~~
18 ~~terminate at the same time as the adjacent through movement.~~ a left turn GREEN ARROW or left turn
19 YELLOW ARROW signal indication or a flashing left turn RED ARROW signal indication shall not
20 ~~be provided on~~ displayed to an the approach simultaneously with a CIRCULAR RED signal indication for
21 the through movement unless an exclusive left turn lane exists, and a left turn RED ARROW signal
22 indication shall not be displayed to the approach simultaneously with a CIRCULAR GREEN or
23 CIRCULAR YELLOW signal indication for the through movement. (12)

24 A yellow change interval for the left-turn movement shall not be displayed when the status of the
25 left-turn operation is changing from permissive to protected within any given signal sequence.

26 If the operating mode changes among the protected only mode and/or the protected/permissive
27 mode and/or the permissive only mode during different periods of the day or as traffic conditions
28 change, the requirements in Sections 4D.18 through 4D.20 that are appropriate to that mode of
29 operation shall be met, subject to the following:

- 30 A. The CIRCULAR GREEN and CIRCULAR YELLOW signal indications shall not be displayed
31 when operating in the protected only mode.
32 B. The left-turn GREEN ARROW and left-turn YELLOW ARROW signal indications shall not be
33 displayed when operating in the permissive only mode.

34 Option:

35 When variable-mode left-turn phasing is used for an approach with a combined left-and-through lane and
36 a flashing yellow arrow is used as the permissive turn display, a five-section shared left-turn signal face
37 containing both circular and arrow indications may be used in combination with one or more separate left-turn
38 signal faces for the exclusive left-turn lane(s) on the same approach. The shared signal face may be comprised
39 of five sections and be capable of displaying a total of six indications via a single dual arrow (42.06) signal
40 section that can alternate between a steady left-turn GREEN (42.06) ARROW signal indication and a
41 flashing left-turn YELLOW ARROW signal indication.

42 Additional static signs or changeable message signs may be used to meet the requirements for the variable
43 left-turn mode or to inform drivers that left-turn green arrows will not be available during certain times of the
44 day.

45 Support:

46 Sections 4D.17 through 4D.20 describe the use of the following two types of signal faces for controlling
47 left-turn movements:

- 48 A. Shared signal face – This type of signal face controls both the left-turn movement and the adjacent
49 movement (usually the through movement) and can serve as one of the two required primary signal
50 faces for the adjacent movement. A shared signal face always displays the same color of circular
51 indication that is displayed by the signal face or faces for the adjacent movement. If a shared signal
52 face that provides protected/permissive mode left turns is mounted overhead at the intersection, it is

usually positioned over or slightly to the right of the extension of the lane line separating the left-turn lane from the adjacent lane.

- B. Separate left-turn signal face – This type of signal face controls only the left-turn movement and cannot serve as one of the two required primary signal faces for the adjacent movement (usually the through movement) because it displays signal indications that are applicable only to the left-turn movement. If a separate left-turn signal face is mounted overhead at the intersection, it is positioned over the extension of the left-turn lane. In a separate left-turn signal face, a flashing left-turn YELLOW ARROW signal indication or a flashing left-turn RED ARROW signal indication is used to control permissive left-turning movements.

Section 4D.13 contains provisions regarding the lateral positioning of signal faces that control left-turn movements.

It is not necessary that the same mode of left-turn operation or same type of left-turn signal face be used on every approach to a signalized location. Selecting different modes and types of left-turn signal faces for the various approaches to the same signalized location is acceptable.

Option:

A signal face that is shared by left-turning and right-turning traffic may be provided for a ~~shared~~ combined left-turn/right-turn lane on an approach that has no through traffic (see Section 4D.25).

Section 4D.18 4F.03 Signal Indications for Permissive Only Mode Left-Turn Movements in a Shared Signal Face Paragraphs from existing Section 4D.18 have been placed in new Sections 4F.03 and 4F.04

Standard:

If a shared signal face is provided for a permissive only mode left turn, it shall meet the following requirements (see Figure 4D-6):

- A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, and CIRCULAR GREEN. Only one of the three indications shall be displayed at any given time.
- B. During the permissive left-turn movement, a CIRCULAR GREEN signal indication shall be displayed.
- C. A permissive only shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
- D. If the permissive only mode is not the only left-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see Section 4D.20) except that the left-turn GREEN ARROW and left-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.

Section 4F.04 Signal Indications for Permissive Only Mode Left-Turn Movements in a Separate Signal Face These paragraphs are from existing Section 4D.18

Standard:

If a separate left-turn signal face is being operated in a permissive only left-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

If a separate left-turn signal face is being operated in a permissive only left-turn mode and a flashing left-turn YELLOW ARROW signal indication is provided, it shall meet the following requirements (see Figure 4D-7):

- A. It shall be capable of displaying the following signal indications: steady left-turn RED ARROW, steady left-turn YELLOW ARROW, and flashing left-turn YELLOW ARROW. Only one of the three indications shall be displayed at any given time.
- B. During the permissive left-turn movement, a flashing left-turn YELLOW ARROW signal indication shall be displayed.
- C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn YELLOW ARROW signal indication.

- D. It shall be permitted to display a flashing left-turn YELLOW ARROW signal indication 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.
- E. 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 unless a signal section capable of alternating between the display of a steady YELLOW ARROW and a flashing YELLOW ARROW signal indication is used. (42.07)
- F. During flashing mode operation (see Section 4D.30), 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.
- G. If the permissive only mode is not the only left-turn mode used for the approach, the signal face shall be the same separate left-turn signal face with a flashing YELLOW ARROW signal indication that is used for the protected/permissive mode (see Section 4D.20) except that the left-turn GREEN ARROW signal indication shall not be displayed when operating in the permissive only mode.

Option:

A separate left-turn signal face with a flashing left-turn RED ARROW signal indication during the permissive left-turn movement may be used for unusual geometric conditions, such as wide medians with offset left-turn lanes, but only when an engineering study determines that each and every vehicle must successively come to a full stop before making a permissive left turn.

Standard:

If a separate left-turn signal face is being operated in a permissive only left-turn mode and a flashing left-turn RED ARROW signal indication is provided, it shall meet the following requirements (see Figure 4D-8):

- A. It shall be capable of displaying the following signal indications: steady or flashing left-turn RED ARROW, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time. The GREEN ARROW indication is required in order to provide a three-section signal face, but shall not be displayed during the permissive only mode.
- B. During the permissive left-turn movement, a flashing left-turn RED ARROW signal indication shall be displayed, thus indicating that each and every vehicle must successively come to a full stop before making a permissive left turn.
- C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn RED ARROW signal indication.
- D. It shall be permitted to display a flashing left-turn RED ARROW signal indication 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.
- E. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON FLASHING RED ARROW AFTER STOP (R10-27) sign (see Figure 2B-27).

Option:

The requirements of Item A in Paragraph 5 may be met by a vertically-arranged signal face with a horizontal cluster of two left-turn RED ARROW signal indications, the left-most of which displays a steady indication and the right-most of which displays a flashing indication (see Figure 4D-8).

Section 4D.19 4F.05 Signal Indications for Protected Only Mode Left-Turn Movements in a Shared Signal Face Paragraphs from existing Section 4D.19 have been placed in new Sections 4F.05 and 4F.06

Standard:

A shared signal face shall not be used for protected only mode left turns unless the CIRCULAR GREEN and left-turn GREEN ARROW signal indications always begin and terminate together. If a

1 shared signal face is provided for a protected only mode left turn, it shall meet the following
2 requirements (see Figure 4D-9):

- 3 A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED,
4 steady CIRCULAR YELLOW, CIRCULAR GREEN, and left-turn GREEN ARROW. Only
5 one of the three colors shall be displayed at any given time.
- 6 B. During the protected left-turn movement, the shared signal face shall simultaneously display
7 both a CIRCULAR GREEN signal indication and a left-turn GREEN ARROW signal
8 indication.
- 9 C. The shared signal face shall always simultaneously display the same color of circular indication
10 that the adjacent through signal face or faces display.
- 11 D. If the protected only mode is not the only left-turn mode used for the approach, the signal face
12 shall be the same shared signal face that is used for the protected/permissive mode (see Section
13 4D.20).

14 Option:

15 A straight-through GREEN ARROW signal indication may be used instead of the CIRCULAR GREEN
16 signal indication in Items A and B in Paragraph 1 on an approach where right turns are prohibited and a
17 straight-through GREEN ARROW signal indication is also used instead of a CIRCULAR GREEN signal
18 indication in the other signal face(s) for through traffic.

19 **Section 4F.06 Signal Indications for Protected Only Mode Left-Turn Movements in a Separate**
20 **Signal Face** These paragraphs are from existing Section 4D.19

21 Standard:

22 If a separate left-turn signal face is provided for a protected only mode left turn, it shall meet the
23 following requirements (see Figure 4D-10):

- 24 A. It shall be capable of displaying, the following signal indications: steady left-turn RED
25 ARROW, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of
26 the three indications shall be displayed at any given time. A signal instruction sign shall not be
27 required with this set of signal indications. If used, it shall be a LEFT ON GREEN ARROW
28 ONLY (R10-5) sign (see Figure 2B-27).
- 29 B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall
30 be displayed.
- 31 C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-
32 turn GREEN ARROW signal indication.
- 33 D. If the protected only mode is not the only left-turn mode used for the approach, the signal face
34 shall be the same separate left-turn signal face that is used for the protected/permissive mode
35 (see Section 4D.20 and Figures 4D-8 and 4D-12) except that the flashing left-turn YELLOW
36 ARROW or flashing left-turn RED ARROW signal indication shall not be displayed when
37 operating in the protected only mode.

38 **Section ~~4D.20~~ 4F.07 Signal Indications for Protected/Permissive Mode Left-Turn Movements in**
39 **a Shared Signal Face** Paragraphs from existing Section 4D.20 have been placed in new
40 **Sections 4F.07 and 4F.08**

41 Standard:

42 If a shared signal face is provided for a protected/permissive mode left turn, it shall meet the
43 following requirements (see Figure 4D-11):

- 44 A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED,
45 steady CIRCULAR YELLOW, CIRCULAR GREEN, steady left-turn YELLOW ARROW, and
46 left-turn GREEN ARROW. Only one of the three circular indications shall be displayed at any
47 given time. Only one of the two arrow indications shall be displayed at any given time. If the
48 left-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s)
49 for the adjacent through movement are always terminated together, the steady left-turn
50 YELLOW ARROW signal indication shall not be required.

- B. During the protected left-turn movement, the shared signal face shall simultaneously display a left-turn GREEN ARROW signal indication and a circular signal indication that is the same color as the signal indication for the adjacent through lane on the same approach as the protected left turn.
- C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication, unless the left-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement are being terminated together. When the left-turn GREEN ARROW and CIRCULAR GREEN signal indications are being terminated together, the required display following the left-turn GREEN ARROW signal indication shall be either the display of a CIRCULAR YELLOW signal indication alone or the simultaneous display of the CIRCULAR YELLOW and left-turn YELLOW ARROW signal indications.
- D. During the permissive left-turn movement, the shared signal face shall display only a CIRCULAR GREEN signal indication.
- E. A protected/permissive shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
- F. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON GREEN (symbolic circular green) (R10-12) sign (see Figure 2B-27).

Section 4F.08 Signal Indications for Protected/Permissive Mode Left-Turn Movements in a Separate Signal Face These paragraphs are from existing Section 4D.20

Standard:

If a separate left-turn signal face is being operated in a protected/permissive left-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

If 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, it shall meet the following requirements (see Figure 4D-12):

- A. It shall 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. ~~It shall be permitted to display a steady left turn RED ARROW signal indication immediately following the steady left turn YELLOW ARROW signal indication to provide a red clearance interval.~~ (13)
- 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.
- F. It shall be permitted to display a flashing left-turn YELLOW ARROW signal indication 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. When a permissive left-turn movement is changing 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 ARROW signal indication and the display of the steady left-turn GREEN ARROW signal indication.
- H. The display shall be either: (42.08)

1. ~~a four-section signal face except that a three-section signal face~~ containing a steady dual arrow left-turn RED ARROW, a steady left-turn YELLOW ARROW, a flashing left-turn YELLOW ARROW, and a left-turn GREEN ARROW, or (42.08)
2. a three-section signal face containing a steady left-turn RED ARROW, a section capable of alternately displaying a steady YELLOW ARROW and a flashing YELLOW ARROW, and a left-turn GREEN 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. Where a single signal section is used to alternately display two different indications, that section~~ ~~The dual arrow signal section, where used, shall display a GREEN steady YELLOW ARROW for the yellow change interval(s) protected left-turn movement (42.08) and a flashing YELLOW ARROW for the~~ permissive left-turn movement.

- I. 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 unless a signal section capable of alternating between the display of a steady YELLOW ARROW and a flashing YELLOW ARROW signal indication is used. (42.08)
- J. During flashing mode operation (see Section 4D.30), 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.

Option:

A separate left-turn signal face with a flashing left-turn RED ARROW signal indication during the permissive left-turn movement may be used for unusual geometric conditions, such as wide medians with offset left-turn lanes, but only when an engineering study determines that each and every vehicle must successively come to a full stop before making a permissive left turn.

A steady left-turn RED ARROW signal indication may be displayed immediately following the steady left-turn YELLOW ARROW signal indication. (13)

Standard:

If a separate left-turn signal face is being operated in a protected/permissive left-turn mode and a flashing left-turn RED ARROW signal indication is provided, it shall meet the following requirements (see Figure 4D-8):

- A. It shall be capable of displaying the following signal indications: steady or flashing left-turn RED ARROW, steady left-turn YELLOW ARROW, and left-turn GREEN ARROW. Only one of the three 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 RED ARROW signal indication shall be displayed.
- E. A steady left-turn YELLOW ARROW signal indication shall be displayed following the flashing left-turn RED 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.
- F. When a permissive left-turn movement is changing 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 RED ARROW signal indication. A steady left-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing left-turn RED ARROW signal indication and the display of the steady left-turn GREEN ARROW signal indication.
- G. It shall be permitted to display a flashing left-turn RED ARROW signal indication 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.
H. A supplementary sign shall not be required. If used, it shall be a LEFT TURN YIELD ON FLASHING RED ARROW AFTER STOP (R10-27) sign (see Figure 2B-27).

Option:

The requirements of Item A in Paragraph 5 may be met by a vertically-arranged signal face with a horizontal cluster of two left-turn RED ARROW signal indications, the left-most of which displays a steady indication and the right-most of which displays a flashing indication (see Figure 4D-8).

Section ~~4D.21~~ 4F.09 Signal Indications for Right-Turn Movements – General

~~Standard~~ Support:

In Sections 4D.21 through 4D.24, provisions applicable to right-turn movements and right-turn lanes ~~shall also apply~~ are also applicable to signal indications for U-turns to the right that are provided at locations where right turns are prohibited or not geometrically possible.

~~Support:~~

Right-turning traffic is controlled by one of four modes as follows:

- A. Permissive Only Mode—turns made on a CIRCULAR GREEN signal indication, a flashing right-turn YELLOW ARROW signal indication, or a flashing right-turn RED ARROW signal indication after yielding to pedestrians, if any.
- B. Protected Only Mode—turns made only when a right-turn GREEN ARROW signal indication is displayed.
- C. Protected/Permissive Mode—both modes occur on an approach during the same cycle.
- D. Variable Right-Turn Mode—the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change.

Standard:

During a permissive right-turn movement, the signal faces, if any, that exclusively control U-turn traffic that conflicts with the permissive right-turn movement (see Item F.1 in Section 4D.05) shall simultaneously display steady U-turn RED ARROW signal indications. If pedestrians crossing the lane or lanes used by the permissive right-turn movement to depart the intersection are controlled by pedestrian signal heads, the signal indications displayed by those pedestrian signal heads shall not be limited to any particular display during the permissive right-turn movement.

During a protected right-turn movement, a GREEN ARROW or a YELLOW ARROW signal indication ~~the signal faces for left turn traffic, if any, on the opposing approach~~ shall not simultaneously ~~be displayed~~ be displayed ~~a steady left turn GREEN ARROW or steady left turn YELLOW ARROW signal indication, to left turn traffic on the opposing approach, except where a separate departure lane is available for each left-turn and right-turn lane with moving traffic and pavement markings or raised channelization clearly indicate which departure lane to use (see Item F.1 in Paragraph 3 in Section 4D.05).~~ and Signal faces, if any, that exclusively control U-turn traffic that conflicts with the protected right-turn movement ~~(see Item F.1 in Section 4D.05)~~ shall simultaneously display steady ~~U-turn~~ RED ARROW signal indications. If pedestrians crossing the lane or lanes used by the protected right-turn movement to depart the intersection are controlled by pedestrian signal heads, the pedestrian signal heads shall display a steady UPRAISED HAND (symbolizing DONT WALK) signal indication during the protected right-turn movement.

If a combined right-turn/through lane exists on an approach, a protected-only mode right-turn movement that does not begin and terminate at the same time as the adjacent through movement, a right-turn GREEN ARROW or right-turn YELLOW ARROW signal indication or a flashing right-turn RED ARROW signal indication shall not be provided on displayed to an approach simultaneously with a CIRCULAR RED signal indication for the through movement unless an exclusive right turn lane exists, and a right-turn RED ARROW signal indication shall not be displayed to the approach simultaneously with a CIRCULAR GREEN or CIRCULAR YELLOW signal indication for the through movement.

~~A yellow change interval for the right turn movement shall not be displayed when the status of the right turn operation is changing from permissive to protected within any given signal sequence. This frequently needs to be done when a RT overlap is the next phase in order to allow opposing permissive LT traffic to clear the intersection~~

If the operating mode changes among the protected only mode and/or the protected/permissive mode and/or the permissive only mode during different periods of the day or as traffic conditions change, the requirements in Sections 4D.22 through 4D.24 that are appropriate to that mode of operation shall be met, subject to the following:

- A. The CIRCULAR GREEN and CIRCULAR YELLOW signal indications shall not be displayed when operating in the protected only mode.
- B. The right-turn GREEN ARROW and right-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.

Option:

When variable-mode right-turn phasing is used for an approach with a combined right-and-through lane and a flashing yellow arrow is used as the permissive turn display, a five-section shared right-turn signal face containing both circular and arrow indications may be used in combination with one or more separate right-turn signal faces for the exclusive right-turn lane(s) on the same approach. The shared signal face may be comprised of five sections and be capable of displaying a total of six indications via a ~~singledual~~ ~~arrow~~ (42.09) signal section that can alternate between a steady right-turn GREEN YELLOW (42.09) ARROW signal indication and a flashing right-turn YELLOW ARROW signal indication.

Additional static signs or changeable message signs may be used to meet the requirements for the variable right-turn mode or to inform drivers that right-turn green arrows will not be available during certain times of the day.

Support:

Sections 4D.21 through 4D.24 describe the use of the following two types of signal faces for controlling right-turn movements:

- A. Shared signal face – This type of signal face controls both the right-turn movement and the adjacent movement (usually the through movement) and can serve as one of the two required primary signal faces for the adjacent movement. A shared signal face always displays the same color of circular indication that is displayed by the signal face or faces for the adjacent movement.
- B. Separate right-turn signal face – This type of signal face controls only the right-turn movement and cannot serve as one of the two required primary signal faces for the adjacent movement (usually the through movement) because it displays signal indications that are applicable only to the right-turn movement. If a separate right-turn signal face is mounted overhead at the intersection, it is positioned over the extension of the right-turn lane. In a separate right-turn signal face, a flashing right-turn YELLOW ARROW signal indication or a flashing right-turn RED ARROW signal indication is used to control permissive right-turning movements.

Section 4D.13 contains provisions regarding the lateral positioning of signal faces that control right-turn movements.

It is not necessary that the same mode of right-turn operation or same type of right-turn signal face be used on every approach to a signalized location. Selecting different modes and types of right-turn signal faces for the various approaches to the same signalized location is acceptable.

Option:

A signal face that is shared by left-turning and right-turning traffic may be provided for a ~~shared~~ combined left-turn/right-turn lane on an approach that has no through traffic (see Section 4D.25).

Section 4D.224F.10 Signal Indications for Permissive Only Mode Right-Turn Movements in a Shared Signal Face Paragraphs from existing Section 4D.22 have been placed in new Sections 4F.10 and 4F.11

Standard:

If a shared signal face is provided for a permissive only mode right turn, it shall meet the following requirements (see Figure 4D-13):

- A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, and CIRCULAR GREEN. Only one of the three indications shall be displayed at any given time.
- B. During the permissive right-turn movement, a CIRCULAR GREEN signal indication shall be displayed.
- C. A permissive only shared signal face, regardless of where it is positioned and regardless of how many adjacent through signal faces are provided, shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.
- D. If the permissive only mode is not the only right-turn mode used for the approach, the signal face shall be the same shared signal face that is used for the protected/permissive mode (see Section 4D.24) except that the right-turn GREEN ARROW and right-turn YELLOW ARROW signal indications shall not be displayed when operating in the permissive only mode.

Section 4F.11 Signal Indications for Permissive Only Mode Right-Turn Movements in a Separate Signal Face These paragraphs are from existing Section 4D.22

Standard:

If a separate right-turn signal face is being operated in a permissive only right-turn mode, a CIRCULAR GREEN signal indication shall not be used in that face.

If a separate right-turn signal face is being operated in a permissive only right-turn mode and a flashing right-turn YELLOW ARROW signal indication is provided, it shall meet the following requirements (see Figure 4D-14):

- A. It shall be capable of displaying one of the following sets of signal indications:
 - 1. Steady right-turn RED ARROW, steady right-turn YELLOW ARROW, and flashing right-turn YELLOW ARROW. Only one of the three indications shall be displayed at any given time.
 - 2. Steady CIRCULAR RED, steady right-turn YELLOW ARROW, and flashing right-turn YELLOW ARROW. Only one of the three indications shall be displayed at any given time. If the CIRCULAR RED signal indication is sometimes displayed when the signal faces for the adjacent through lane(s) are not displaying a CIRCULAR RED signal indication, a RIGHT TURN SIGNAL (R10-10R) sign (see Figure 2B-27) shall be used unless the CIRCULAR RED signal indication in the separate right-turn signal face is shielded, hooded, louvered, positioned, or designed such that it is not readily visible to drivers in the through lane(s).
- B. During the permissive right-turn movement, a flashing right-turn YELLOW ARROW signal indication shall be displayed.
- C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the flashing right-turn YELLOW ARROW signal indication.
- D. When the separate right-turn signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication shall be displayed if it is intended that right turns on red not be permitted (except when a traffic control device is in place permitting a turn on a steady RED ARROW signal indication) or a steady CIRCULAR RED signal indication shall be displayed if it is intended that right turns on red be permitted.
- E. It shall be permitted to display a flashing right-turn YELLOW ARROW signal indication for a permissive right-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications.
- F. During steady mode (stop-and-go) operation, the signal section that displays the steady right-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing right-turn YELLOW ARROW signal indication for permissive right turns unless a signal section capable of alternating between the display of a steady YELLOW ARROW and a flashing YELLOW ARROW signal indication is used. (42.10)
- G. During flashing mode operation (see Section 4D.30), the display of a flashing right-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady right-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.

H. If the permissive only mode is not the only right-turn mode used for the approach, the signal face shall be the same separate right-turn signal face with a flashing YELLOW ARROW signal indication that is used for the protected/permissive mode (see Section 4D.24) except that the right-turn GREEN ARROW signal indication shall not be displayed when operating in the permissive only mode.

Option:

When an engineering study determines that each and every vehicle must successively come to a full stop before making a permissive right turn, a separate right-turn signal face with a flashing right-turn RED ARROW signal indication during the permissive right-turn movement may be used.

Standard:

If a separate right-turn signal face is being operated in a permissive only right-turn mode and a flashing right-turn RED ARROW signal indication is provided, it shall meet the following requirements (see Figure 4D-15):

A. It shall be capable of displaying one of the following sets of signal indications:

1. Steady or flashing right-turn RED ARROW, steady right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time. The GREEN ARROW indication is required in order to provide a three-section signal face, but shall not be displayed during permissive only mode.
2. Steady CIRCULAR RED on the left and steady right-turn RED ARROW on the right of the top position, steady right-turn YELLOW ARROW in the middle position, and right-turn GREEN ARROW in the bottom position. Only one of the four indications shall be displayed at any given time. The GREEN ARROW indication is required in order to provide three vertical positions, but shall not be displayed during permissive only mode. If the CIRCULAR RED signal indication is sometimes displayed when the signal faces for the adjacent through lane(s) are not displaying a CIRCULAR RED signal indication, a RIGHT TURN SIGNAL (R10-10R) sign (see Figure 2B-27) shall be used unless the CIRCULAR RED signal indication in the separate right-turn signal face is shielded, hooded, louvered, positioned, or designed such that it is not readily visible to drivers in the through lane(s).

B. During the permissive right-turn movement, a flashing right-turn RED ARROW signal indication shall be displayed, thus indicating that each and every vehicle must successively come to a full stop before making a permissive right turn.

C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the flashing right-turn RED ARROW signal indication.

D. When the separate right-turn signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication shall be displayed if it is intended that right turns on red not be permitted (except when a traffic control device is in place permitting a turn on a steady RED ARROW signal indication) or a steady CIRCULAR RED signal indication shall be displayed if it is intended that right turns on red be permitted.

E. The display of a flashing right-turn RED ARROW signal indication for a permissive right-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 shall be permitted.

F. A supplementary sign shall not be required. If used, it shall be a RIGHT TURN YIELD ON FLASHING RED ARROW AFTER STOP (R10-27) sign (see Figure 2B-27).

Option:

The requirements of Item A.1 in Paragraph 5 may be met by a vertically-arranged signal face with a horizontal cluster of two right-turn RED ARROW signal indications, the left-most of which displays a steady indication and the right-most of which displays a flashing indication (see Figure 4D-15).

Section 4D.23 4F.12 Signal Indications for Protected Only Mode Right-Turn Movements in a Shared Signal Face Paragraphs from existing Section 4D.23 have been placed in new Sections 4F.12 and 4F.13

Standard:

1 A shared signal face shall not be used for protected only mode right turns unless the CIRCULAR
2 GREEN and right-turn GREEN ARROW signal indications always begin and terminate together. If a
3 shared signal face is provided for a protected only right turn, it shall meet the following requirements
4 (see Figure 4D-16):

- 5 A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED,
6 steady CIRCULAR YELLOW, CIRCULAR GREEN, and right-turn GREEN ARROW. Only
7 one of the three colors shall be displayed at any given time.
- 8 B. During the protected right-turn movement, the shared signal face shall simultaneously display
9 both a CIRCULAR GREEN signal indication and a right-turn GREEN ARROW signal
10 indication.
- 11 C. The shared signal face shall always simultaneously display the same color of circular indication
12 that the adjacent through signal face or faces display.
- 13 D. If the protected only mode is not the only right-turn mode used for the approach, the signal face
14 shall be the same shared signal face that is used for the protected/permissive mode (see Section
15 4D.24).

16 Option:

17 A straight-through GREEN ARROW signal indication may be used instead of the CIRCULAR GREEN
18 signal indication in Items A and B in Paragraph 1 on an approach where left turns are prohibited and a
19 straight-through GREEN ARROW signal indication is also used instead of a CIRCULAR GREEN signal
20 indication in the other signal face(s) for through traffic.

21 **Section 4F.13 Signal Indications for Protected Only Mode Right-Turn Movements in a Separate**
22 **Signal Face** These paragraphs are from existing Section 4D.23

23 Standard:

24 If a separate right-turn signal face is provided for a protected only mode right turn, it shall meet the
25 following requirements (see Figure 4D-17):

- 26 A. It shall be capable of displaying one of the following sets of signal indications:
 - 27 1. Steady right-turn RED ARROW, steady right-turn YELLOW ARROW, and right-turn
28 GREEN ARROW. Only one of the three indications shall be displayed at any given time. A
29 signal instruction sign shall not be required with this set of signal indications. If used, it
30 shall be a RIGHT ON GREEN ARROW ONLY (R10-5a) sign (see Figure 2B-27).
 - 31 2. Steady CIRCULAR RED, steady right-turn YELLOW ARROW, and right-turn GREEN
32 ARROW. Only one of three indications shall be displayed at any given time. If the
33 CIRCULAR RED signal indication is sometimes displayed when the signal faces for the
34 adjacent through lane(s) are not displaying a CIRCULAR RED signal indication, a RIGHT
35 TURN SIGNAL (R10-10R) sign (see Figure 2B-27) shall be used unless the CIRCULAR
36 RED signal indication is shielded, hooded, louvered, positioned, or designed such that it is
37 not readily visible to drivers in the through lane(s).
- 38 B. During the protected right-turn movement, a right-turn GREEN ARROW signal indication
39 shall be displayed.
- 40 C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-
41 turn GREEN ARROW signal indication.
- 42 D. When the separate signal face is providing a message to stop and remain stopped, a steady
43 right-turn RED ARROW signal indication shall be displayed if it is intended that right turns on
44 red not be permitted (except when a traffic control device is in place permitting a turn on a
45 steady RED ARROW signal indication) or a steady CIRCULAR RED signal indication shall be
46 displayed if it is intended that right turns on red be permitted.
- 47 E. If the protected only mode is not the only right-turn mode used for the approach, the signal face
48 shall be the same separate right-turn signal face that is used for the protected/permissive mode
49 (see Section 4D.24 and Figure 4D-19) except that a flashing right-turn YELLOW ARROW or
50 flashing right-turn RED ARROW signal indication shall not be displayed when operating in the
51 protected only mode.

1 **Section ~~4D.24~~4F.14** Signal Indications for Protected/Permissive Mode Right-Turn Movements **in**
2 **a Shared Signal Face** Paragraphs from existing Section 4D.24 have been placed in new
3 **Sections 4F.14 and 4F.15**

4 **Standard:**

5 If a shared signal face is provided for a protected/permissive mode right turn, it shall meet the
6 following requirements (see Figure 4D-18):

- 7 A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED,
8 steady CIRCULAR YELLOW, CIRCULAR GREEN, steady right-turn YELLOW ARROW,
9 and right-turn GREEN ARROW. Only one of the three circular indications shall be displayed
10 at any given time. Only one of the two arrow indications shall be displayed at any given time. If
11 the right-turn GREEN ARROW signal indication and the CIRCULAR GREEN signal
12 indication(s) for the adjacent through movement are always terminated together, the steady
13 right-turn YELLOW ARROW signal indication shall not be required.
- 14 B. During the protected right-turn movement, the shared signal face shall simultaneously display a
15 right-turn GREEN ARROW signal indication and a circular signal indication that is the same
16 color as the signal indication for the adjacent through lane on the same approach as the
17 protected right turn.
- 18 C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-
19 turn GREEN ARROW signal indication, unless the right-turn GREEN ARROW signal
20 indication and the CIRCULAR GREEN signal indication(s) for the adjacent through movement
21 are being terminated together. When the right-turn GREEN ARROW and CIRCULAR
22 GREEN signal indications are being terminated together, the required display following the
23 right-turn GREEN ARROW signal indication shall be either the display of a CIRCULAR
24 YELLOW signal indication alone or the simultaneous display of the CIRCULAR YELLOW
25 and right-turn YELLOW ARROW signal indications.
- 26 D. During the permissive right-turn movement, the shared signal face shall display only a
27 CIRCULAR GREEN signal indication.
- 28 E. A protected/permissive shared signal face, regardless of where it is positioned and regardless of
29 how many adjacent through signal faces are provided, shall always simultaneously display the
30 same color of circular indication that the adjacent through signal face or faces display.

31 **Section 4F.15** Signal Indications for Protected/Permissive Mode Right-Turn Movements **in a**
32 **Separate Signal Face** These paragraphs are from existing Section 4D.24

33 **Standard:**

34 If a separate right-turn signal face is being operated in a protected/permissive right-turn mode, a
35 CIRCULAR GREEN signal indication shall not be used in that face.

36 If a separate right-turn signal face is being operated in a protected/permissive right-turn mode and
37 a flashing right-turn YELLOW ARROW signal indication is provided, it shall meet the following
38 requirements (see Figure 4D-19):

- 39 A. It shall be capable of displaying one of the following sets of signal indications:
- 40 1. Steady right-turn RED ARROW, steady right-turn YELLOW ARROW, flashing right-turn
41 YELLOW ARROW, and right-turn GREEN ARROW. Only one of the four indications
42 shall be displayed at any given time.
- 43 2. Steady CIRCULAR RED, steady right-turn YELLOW ARROW, flashing right-turn
44 YELLOW ARROW, and right-turn GREEN ARROW. Only one of the four indications
45 shall be displayed at any given time. If the CIRCULAR RED signal indication is sometimes
46 displayed when the signal faces for the adjacent through lane(s) are not displaying a
47 CIRCULAR RED signal indication, a RIGHT TURN SIGNAL (R10-10R) sign (see Figure
48 2B-27) shall be used unless the CIRCULAR RED signal indication in the separate right-turn
49 signal face is shielded, hooded, louvered, positioned, or designed such that it is not readily
50 visible to drivers in the through lane(s).
- 51 B. During the protected right-turn movement, a right-turn GREEN ARROW signal indication
52 shall be displayed.

- C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-turn GREEN ARROW signal indication. ~~It shall be permitted to display a steady right-turn RED ARROW signal indication immediately following the steady right-turn YELLOW ARROW signal indication to provide a red clearance interval. (14)~~
- D. During the permissive right-turn movement, a flashing right-turn YELLOW ARROW signal indication shall be displayed.
- E. A steady right-turn YELLOW ARROW signal indication shall be displayed following the flashing right-turn YELLOW ARROW signal indication if the permissive right-turn movement is being terminated and the separate right-turn signal face will subsequently display a steady red indication.
- F. When a permissive right-turn movement is changing to a protected right-turn movement, a right-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing right-turn YELLOW ARROW signal indication. A steady right-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing right-turn YELLOW ARROW signal indication and the display of the steady right-turn GREEN ARROW signal indication.
- G. When the separate right-turn signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication shall be displayed if it is intended that right turns on red not be permitted (except when a traffic control device is in place permitting a turn on a steady RED ARROW signal indication) or a steady CIRCULAR RED signal indication shall be displayed if it is intended that right turns on red be permitted.
- H. It shall be permitted to display a flashing right-turn YELLOW ARROW signal indication for a permissive right-turn movement while the signal faces for the adjacent through movement display steady CIRCULAR RED signal indications.
- I. A ~~three-section~~ signal face containing a ~~single section capable of alternately displaying dual arrow signal section in place of separate flashing right turn YELLOW ARROW and right turn GREEN ARROW signal sections shall be permitted where signal head height limitations (or lateral positioning limitations for a horizontally mounted signal face) are a concern. The dual arrow signal section, where used, shall display a steady YELLOW GREEN ARROW for the yellow change interval(s) protected right turn movement and a flashing YELLOW ARROW for the permissive right-turn movement. (42.11)~~
- J. During steady mode (stop-and-go) operation, the signal section that displays the steady right-turn YELLOW ARROW signal indication during change intervals shall not be used to display the flashing right-turn YELLOW ARROW signal indication for permissive right turns ~~unless a single signal section capable of alternating between the display of a steady YELLOW ARROW and a flashing YELLOW ARROW signal indication is used. (42.11)~~
- K. During flashing mode operation (see Section 4D.30), the display of a flashing right-turn YELLOW ARROW signal indication shall be only from the signal section that displays a steady right-turn YELLOW ARROW signal indication during steady mode (stop-and-go) operation.

Option:

When an engineering study determines that each and every vehicle must successively come to a full stop before making a permissive right turn, a separate signal face that has a flashing right-turn RED ARROW signal indication during the permissive right-turn movement may be used.

A steady right-turn RED ARROW signal indication may be displayed immediately following the steady right-turn YELLOW ARROW signal indication. (14)

Standard:

If a separate right-turn signal face is being operated in a protected/permissive right-turn mode and a flashing right-turn RED ARROW signal indication is provided, it shall meet the following requirements (see Figure 4D-15):

- A. It shall be capable of displaying one of the following sets of signal indications:
1. Steady or flashing right-turn RED ARROW, steady right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time.

2. Steady CIRCULAR RED on the left and steady or flashing right-turn RED ARROW on the right of the top position, steady right-turn YELLOW ARROW in the middle position, and right-turn GREEN ARROW in the bottom position. Only one of the four indications shall be displayed at any given time. If the CIRCULAR RED signal indication is sometimes displayed when the signal faces for the adjacent through lane(s) are not displaying a CIRCULAR RED signal indication, a RIGHT TURN SIGNAL (R10-10R) sign (see Figure 2B-27) shall be used unless the CIRCULAR RED signal indication in the separate right-turn signal face is shielded, hooded, louvered, positioned, or designed such that it is not readily visible to drivers in the through lane(s).

- B. During the protected right-turn movement, a right-turn GREEN ARROW signal indication shall be displayed.
- C. A steady right-turn YELLOW ARROW signal indication shall be displayed following the right-turn GREEN ARROW signal indication.
- D. During the permissive right-turn movement, the separate right-turn signal face shall display a flashing right-turn RED ARROW signal indication.
- E. A steady right-turn YELLOW ARROW signal indication shall be displayed following the flashing right-turn RED ARROW signal indication if the permissive right-turn movement is being terminated and the separate right-turn signal face will subsequently display a steady red indication.
- F. When a permissive right-turn movement is changing to a protected right-turn movement, a right-turn GREEN ARROW signal indication shall be displayed immediately upon the termination of the flashing right-turn RED ARROW signal indication. A steady right-turn YELLOW ARROW signal indication shall not be displayed between the display of the flashing right-turn RED ARROW signal indication and the display of the steady right-turn GREEN ARROW signal indication.
- G. When the separate right-turn signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication shall be displayed if it is intended that right turns on red not be permitted (except when a traffic control device is in place permitting a turn on a steady RED ARROW signal indication) or a steady CIRCULAR RED signal indication shall be displayed if it is intended that right turns on red be permitted.
- H. It shall be permitted to display a flashing right-turn RED ARROW signal indication for a permissive right-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.
- I. A supplementary sign shall not be required. If used, it shall be a RIGHT TURN YIELD ON FLASHING RED ARROW AFTER STOP (R10-27) sign (see Figure 2B-27).

Option:

The requirements of Item A.1 in Paragraph 5 may be met by a vertically-arranged signal face with a horizontal cluster of two right-turn RED ARROW signal indications, the left-most of which displays a steady indication and the right-most of which displays a flashing indication (see Figure 4D-15).

Section ~~4D.25~~ 4F.16 Signal Indications for Approaches with ~~Shared Left Turn/Right Turn Lanes and~~ No Through Movement

Support:

This provisions of this section apply only to approaches where no through movement exists, such as the stem of a T-intersection or where the opposite approach is a one-way roadway in the opposing direction.

Standard:

A minimum of two primary signal faces shall be provided for the signalized turning movement that is considered to be the major movement from the approach (see Section 4D.11).

Option:

The required two primary signal faces and any supplemental primary signal faces may continuously display a steady CIRCULAR RED signal indication during times when the traffic control signal is being operated in the steady (stop-and-go) mode.

1 **Standard:**

2 **CIRCULAR GREEN and CIRCULAR YELLOW signal indications shall not be displayed to an**
3 **approach with no through movement if:**

4 **A. The posted or statutory speed limit on the approach is 35 mph or greater,**

5 **B. The one-way roadway that opposes the approach is an exit ramp from a freeway or expressway,**
6 **or**

7 **C. The one-way roadway that opposes the approach has a posted or statutory speed limit of 35**
8 **mph or greater.**

9 **Support:**

10 A lane ~~that is shared by~~ from which left-turn and right-turn movements can both be made is sometimes
11 provided on an approach that has no through movement, ~~such as the stem of a T-intersection or where the~~
12 ~~opposite approach is a one-way roadway in the opposing direction~~ either as the only approach lane or as one of
13 several approach lanes.

14 **Option:**

15 If all of the lanes on the approach are designated as exclusive turn lanes and no lane is designated as a
16 combined left-turn/right-turn lane, the left-turn and right-turn movements may start and terminate
17 independently, and the left-turn and right-turn movements each may be operated in one or more of the modes
18 of operation as described in Sections 4D.17 through 4D.24.

19 **Standard:**

20 When a ~~shared~~ combined left-turn/right-turn lane exists on a ~~signalized~~ approach, the left-turn and
21 right-turn movements shall start and terminate simultaneously and the red signal indication used in
22 each of the signal faces on the approach shall be a CIRCULAR RED.

23 **Support:**

24 This requirement for the use of CIRCULAR RED signal indications in signal faces for approaches having
25 a ~~shared~~ combined lane for left-turn and right-turn movements is a specific exception to other provisions in this
26 Chapter that would otherwise require the use of RED ARROW signal indications.

27 **Standard:**

28 The signal faces provided for an approach with a ~~shared~~ combined left-turn/right-turn lane and no
29 through movement shall be one of the following:

- 30 A. **Except as provided in Paragraph 2,** two or more signal faces, each capable of displaying
31 CIRCULAR RED, CIRCULAR YELLOW, and CIRCULAR GREEN signal indications, shall
32 be provided for the approach. This display shall be permissible regardless of number of
33 exclusive left-turn and/or right-turn lanes that exist on the approach in addition to the
34 ~~shared~~ combined left-turn/right-turn lane and regardless of whether or not there are pedestrian
35 or opposing vehicular movements that conflict with the left-turn or right-turn movements.
36 However, if there is an opposing approach and the signal phasing protects the left-turn
37 movement on the approach with the ~~shared~~ combined left-turn/right-turn lane from conflicts
38 with the opposing vehicular movements and any signalized pedestrian movements, a left-turn
39 GREEN ARROW signal indication shall also be included in the left-most signal face and shall
40 be displayed simultaneously with the CIRCULAR GREEN signal indication.
- 41 B. If the approach has one or more exclusive turn lanes in addition to the ~~shared~~ combined left-
42 turn/right-turn lane and there is no conflict with a signalized vehicular or pedestrian movement,
43 and GREEN ARROW signal indications are used in place of CIRCULAR GREEN signal
44 indications on the approach, the signal faces for the approach shall be:
- 45 1. A signal face(s) capable of displaying CIRCULAR RED, YELLOW ARROW, and GREEN
46 ARROW signal indications for the exclusive turn lane(s), with the arrows pointing in the
47 direction of the turn, and
 - 48 2. A shared left-turn/right-turn signal face capable of displaying CIRCULAR RED, left-turn
49 YELLOW ARROW, left-turn GREEN ARROW, right-turn YELLOW ARROW, and right-
50 turn GREEN ARROW signal indications, in an arrangement of signal sections that complies
51 with the provisions of Section 4D.09 or 4D.10.

C. If the approach has one or more exclusive turn lanes in addition to the ~~shared~~combined left-turn/right-turn lane and there is a conflict with a signalized vehicular or pedestrian movement, and flashing YELLOW ARROW signal indications are used in place of CIRCULAR GREEN signal indications on the approach, the signal faces for the approach shall be as described in Items B.1 and B.2, except that flashing YELLOW ARROW signal indications shall be used in place of the GREEN ARROW signal indications for the turning movement(s) that conflicts with the signalized vehicular or pedestrian movement.

Support:

Figure 4D-20 illustrates application of these Standards on approaches that have only a ~~shared~~combined left-turn/right-turn lane, and on approaches that have one or more exclusive turn lanes in addition to the ~~shared~~combined left-turn/right-turn lane.

Option:

If the lane-use regulations on an approach are variable such that at certain times all of the lanes on the approach are designated as exclusive turn lanes and no lane is designated as a ~~shared~~combined left-turn/right-turn lane:

- A. During the times that no lane is designated as a ~~shared~~combined left-turn/right-turn lane, the left-turn and right-turn movements may start and terminate independently, and the left-turn and right-turn movements may be operated in one or more of the modes of operation as described in Sections 4D.17 through 4D.24; and
- B. If a protected/permissive mode is used, the shared left-turn/right-turn signal face provided in Paragraph 4 may be modified to include a ~~single~~dual arrow (42.12) signal section capable of displaying both a ~~steady YELLOW GREEN~~ (42.12) ARROW signal indication and a flashing YELLOW ARROW signal indication for a turn movement(s) in order to not exceed the maximum of five sections per signal face provided in Section 4D.08.

Section ~~4D.26~~4F.17 Yellow Change and Red Clearance Intervals

Support:

The exclusive function of the yellow change interval ~~shall be~~ is to warn traffic approaching a signalized location of an impending change in the right-of-way assignment that their permission to proceed is being terminated after which they will be directed to stop, or in the case of a protected/permissive turning movement that their protected movement is being terminated after which they will need to perform their turn in a permissive manner. **The sequence of Paragraphs 1 and 2 was switched**

Standard:

A steady yellow signal indication shall be displayed following every CIRCULAR GREEN or GREEN ARROW signal indication and following every flashing YELLOW ARROW or flashing RED ARROW signal indication displayed as a part of a steady mode operation. This requirement shall not apply when a CIRCULAR GREEN, a flashing YELLOW ARROW, or a flashing RED ARROW signal indication is followed immediately by a GREEN ARROW signal indication.

The duration of the yellow change interval shall be determined using engineering practices.

Support:

~~Because research has shown that the 85th percentile speed for free-flowing vehicles in the through lanes on an approach to a signalized location is typically about 7 mph higher than the posted or statutory speed limit on the approach, both the requirement provided in Paragraph 5 and the recommendation provided in Paragraph 6 are applicable to the minimum duration of a yellow change interval.~~

Standard:

~~The duration of the yellow change interval for a through movement shall not be lower than the value determined by the following formula:~~

$$Y = 1 + (1.47V)/(20 + 64.4g)$$

~~where Y equals the duration of the yellow change interval in seconds; V equals the posted or statutory speed limit in mph on the approach; and g equals the approach grade in percent divided by 100, with negative numbers for downgrades.~~

Guidance:

~~The duration of the yellow change interval for a through movement should not be lower than the value determined by the following formula:~~

$$Y = 1 + (1.47(V + 7)/(20 + 64.4g))$$

~~where Y equals the duration of the yellow change interval in seconds; V equals the posted or statutory speed limit in mph on the approach; and g equals the approach grade in percent divided by 100, with negative numbers for downgrades. If the 85th percentile speed on an approach has been documented by an engineering study to be less than 7 mph higher than the posted or statutory speed limit, the 85th percentile speed in mph should be substituted for the "V + 7" value in the formula.~~ (15)

Support:

Section 4D.05 contains provisions regarding the display of steady CIRCULAR YELLOW signal indications to approaches from which drivers are allowed to make permissive left turns.

Guidance:

When indicated by the application of engineering practices, the yellow change interval should be followed by a red clearance interval to provide additional time before conflicting traffic movements, including pedestrians, are released.

Standard:

When used, the duration of the red clearance interval shall be determined using engineering practices.

Support:

Engineering practices for determining the duration of yellow change and red clearance intervals can be found in ITE's "Traffic Control Devices Handbook" and in ITE's "Manual of Traffic Signal Design" (see Section 1A.11).

Standard:

The durations of yellow change intervals and red clearance intervals shall be consistent with the determined values within the technical capabilities of the controller unit.

The duration of a yellow change interval shall not vary on a cycle-by-cycle basis within the same signal timing plan.

Except as provided in Paragraph 12, the duration of a red clearance interval shall not be decreased or omitted on a cycle-by-cycle basis within the same signal timing plan.

Option:

The duration of a red clearance interval may be extended from its predetermined value for a given cycle based upon the detection of a vehicle that is predicted to violate the red signal indication.

When an actuated signal sequence includes a signal phase for permissive/protected (lagging) left-turn movements in both directions, the red clearance interval may be shown during those cycles when the lagging left-turn signal phase is skipped and may be omitted during those cycles when the lagging left-turn signal phase is shown.

The duration of a yellow change interval or a red clearance interval may be different in different signal timing plans for the same controller unit.

Guidance:

Except as provided for through movement s in Paragraphs 5 and 6, a yellow change interval should have a minimum duration of 3 seconds. A yellow change interval should have ~~and~~ a maximum duration of 6 seconds. The longer intervals should be reserved for use on approaches with higher speeds.

Except when clearing a one-lane, two-way facility (see Section 4H.02) or when clearing an exceptionally wide intersection, a red clearance interval should have a duration not exceeding 6 seconds.

Standard:

Except for warning beacons mounted on advance warning signs on the approach to a signalized location (see Section 2C.36), signal displays that are intended to provide a "pre-yellow warning"

interval, such as flashing green signal indications, vehicular countdown displays, or other similar displays, shall not be used at a signalized location.

Support:

The use of signal displays (other than warning beacons mounted on advance warning signs) that convey a “pre-yellow warning” have been found by research to increase the frequency of crashes.

Section ~~4D.27~~ 4F.18 Preemption and Priority Control of Traffic Control Signals—

General Paragraphs from existing Section 4D.27 have been placed in new Sections 4F.18 through 4F.20

Option:

Traffic control signals may be designed and operated to respond to certain classes of approaching vehicles by altering the normal signal timing and phasing plan(s) during the approach and passage of those vehicles. The alternative plan(s) may be as simple as extending a currently displayed green interval or as complex as replacing the entire set of signal phases and timing.

Support:

Some types or classes of vehicles supersede others when a traffic control signal responds to more than one type or class. In general, a vehicle that is more difficult to control supersedes a vehicle that is easier to control.

Option:

Preemption or priority control of traffic control signals may also be a means of ~~assigning priority right-of-way~~ providing a special message to specified classes of vehicles at certain non-intersection locations, such as on approaches to one-lane bridges and tunnels, movable bridges, highway maintenance and construction activities, metered freeway entrance ramps, and transit operations, that they are permitted to proceed.

Guidance:

When a traffic control signal that is returning to a steady mode from a dark mode (typically upon restoration from a power failure) receives a preemption or priority request, care should be exercised to minimize the possibility of vehicles or pedestrians being misdirected into a conflict with the vehicle making the request.

Option:

During the change from a dark mode to a steady mode under a preemption or priority request, the display of signal indications that could misdirect road users may be prevented by one or more of the following methods:

- A. Having the traffic control signal remain in the dark mode,
- B. Having the traffic control signal remain in the flashing mode,
- C. Altering the flashing mode,
- D. Executing the normal start-up routine before responding, or
- E. Responding directly to initial or dwell period.

Guidance:

Traffic control signals operating under preemption control or under priority control should be operated in a manner designed to keep traffic moving.

Traffic control signals that are designed to respond under preemption or priority control to more than one type or class of vehicle should be designed to respond in the relative order of importance or difficulty in stopping the type or class of vehicle. The order of priority should be: train, boat, heavy vehicle (fire vehicle, emergency medical service), light vehicle (law enforcement), light rail transit, rubber-tired transit.

Option:

If engineering judgment indicates that light rail transit signal indications would reduce road user confusion that might otherwise occur if standard traffic signal indications were used to control these movements, light rail transit signal indications complying with Section 8C.11 and as illustrated in Figure 8C-3 may be used for preemption or priority control of the following exclusive movements at signalized intersections:

- A. Public transit buses in “queue jumper” lanes, and

B. Bus rapid transit in semi-exclusive or mixed-use alignments.

Section 4F.19 Preemption Control of Traffic Control Signals

Support:

Preemption control (see definition in Section 1A.13) is typically given to trains, boats, emergency vehicles, and light rail transit.

Examples of preemption control include the following:

- A. The prompt displaying of green signal indications at signalized locations ahead of fire vehicles, law enforcement vehicles, ambulances, and other official emergency vehicles;
- B. A special sequence of signal phases and timing to expedite and/or provide additional clearance time for vehicles to clear the tracks prior to the arrival of rail traffic; and
- C. A special sequence of signal phases to display a steady red indication to prohibit turning movements toward the tracks during the approach or passage of rail traffic.

Standard:

During the transition into preemption control:

- A. The yellow change interval, and any red clearance interval that follows, shall not be shortened or omitted.
- B. The shortening or omission of any pedestrian walk interval ~~and/or pedestrian change interval~~ shall be permitted.
- C. The shortening or omission of any pedestrian change interval shall be permitted only when the traffic control signal is being preempted because a boat is approaching a movable bridge or because rail traffic is approaching a grade crossing.
- D. The return to the previous green signal indication shall be permitted following a steady yellow signal indication in the same signal face, omitting the red clearance interval, if any.

During preemption control and during the transition out of preemption control:

- A. The shortening or omission of any yellow change interval, and of any red clearance interval that follows, shall not be permitted.
- B. A signal indication sequence from a steady yellow signal indication to a green signal indication shall not be permitted.

Guidance:

Except for traffic control signals interconnected with light rail transit systems, traffic control signals with railroad preemption or coordinated with flashing-light signal systems should be provided with a back-up power supply.

If a traffic control signal or hybrid beacon (16) is installed near or within a grade crossing or if a grade crossing with active traffic control devices is within or near a signalized highway intersection, Chapter 8C should be consulted.

Option:

A distinctive indication may be provided at the intersection to show that an emergency vehicle has been given control of the traffic control signal (see Section 11-106 of the “Uniform Vehicle Code”). In order to assist in the understanding of the control of the traffic signal, a common distinctive indication may be used where drivers from different agencies travel through the same intersection when responding to emergencies.

Section 4F.20 Priority Control of Traffic Control Signals

Support:

Priority control (see definition in Section 1A.13) is typically given to certain non-emergency vehicles such as light-rail transit vehicles operating in a mixed-use alignment and buses.

Examples of priority control include the following:

- A. The displaying of early or extended green signal indications at an intersection to assist public transit vehicles in remaining on schedule, and
- B. Special phasing to assist public transit vehicles in entering the travel stream ahead of the platoon of traffic.

1 **Standard:**

2 **During priority control and during the transition into or out of priority control:**

- 3 **A. The shortening or omission of any yellow change interval, and of any red clearance interval that**
4 **follows, shall not be permitted.**
- 5 **B. The shortening of any pedestrian walk interval below that time described in Section 4E.06 shall**
6 **not be permitted.**
- 7 **C. The omission of a pedestrian walk interval and its associated change interval shall not be**
8 **permitted unless the associated vehicular phase is also omitted or the pedestrian phase is**
9 **exclusive.**
- 10 **D. The shortening or omission of any pedestrian change interval shall not be permitted.**
- 11 **E. A signal indication sequence from a steady yellow signal indication to a green signal indication**
12 **shall not be permitted.**
- 13

CHAPTER 4G. FLASHING OPERATION OF TRAFFIC CONTROL SIGNALS

Section ~~4D.28~~4G.01 Flashing Operation of Traffic Control Signals – General

Standard:

The light source of a flashing signal indication shall be flashed continuously at a rate of not less than 50 or more than 60 times per minute.

The displayed period of each flash shall be a minimum of 1/2 and a maximum of 2/3 of the total flash cycle.

Flashing signal indications shall comply with the requirements of other Sections of this Manual regarding visibility-limiting or positioning of conflicting signal indications, except that flashing yellow signal indications for through traffic shall not be required to be visibility-limited or positioned to minimize visual conflict for road users in separately controlled turn lanes.

Each traffic control signal shall be provided with an independent flasher mechanism that operates in compliance with this Section.

The flashing operation shall not be terminated by removal or turn off of the controller unit or of the conflict monitor (malfunction management unit) or both.

A manual switch, ~~a conflict monitor (malfunction management unit) circuit, and, if appropriate, automatic means~~ shall be provided to initiate the flashing mode. If appropriate, a conflict monitor (malfunction management unit) circuit and/or an automatic means shall also be provided to initiate the flashing mode.

Option:

Based on engineering study or engineering judgment, traffic control signals may be operated in the flashing mode on a scheduled basis during one or more periods of the day rather than operated continuously in the steady (stop-and-go) mode.

Support:

Sections 4E.06 and 4E.09 contain information regarding the operation of pedestrian signal heads and accessible pedestrian signal detector pushbutton locator tones, respectively, during flashing operation.

Section ~~4D.29~~4G.02 Flashing Operation – Transition Into Flashing Mode

~~Standard~~Option:

The transition from steady (stop-and-go) mode to flashing mode, if initiated by a conflict monitor (malfunction management unit) or by a manual switch, ~~shall be permitted to~~ may be made at any time.

Standard:

Programmed changes from steady (stop-and-go) mode to flashing mode shall be made under either of the following circumstances:

- A. At the end of the common major-street red interval (such as just prior to the start of the green in both directions on the major street), or
- B. Directly from a CIRCULAR GREEN signal indication to a flashing CIRCULAR YELLOW signal indication, or from a GREEN ARROW signal indication to a flashing YELLOW ARROW signal indication, or from a flashing YELLOW ARROW signal indication (see Sections 4D.17 to 4D.24) to a flashing YELLOW ARROW signal indication in a different signal section.

During programmed changes into flashing mode, no green signal indication or flashing yellow signal indication shall be terminated and immediately followed by a steady red or flashing red signal indication without first displaying the steady yellow signal indication.

Section ~~4D.30~~4G.03 Flashing Operation – Signal Indications During Flashing Mode

Guidance:

When a traffic control signal is operated in the flashing mode, a flashing yellow signal indication should be used for the major street and a flashing red signal indication should be used for the other approaches unless flashing red signal indications are used on all approaches.

1 **Standard:**

2 When a traffic control signal is operated in the flashing mode, all of the green signal indications at
3 the signalized location shall be dark (non-illuminated) and shall not be displayed in either a steady or
4 flashing manner, except for single-section GREEN ARROW signal indications as provided elsewhere in
5 this Section.

6 Flashing yellow signal indications shall be used on more than one approach to a signalized location
7 only if those approaches do not conflict with each other.

8 Except as provided in Paragraph 5, when a traffic control signal is operated in the flashing mode,
9 one and only one signal indication in every signal face at the signalized location shall be flashed.

10 **Option:**

11 If a signal face has two identical CIRCULAR RED or RED ARROW signal indications (see Section
12 4D.08), both of those identical signal indications may be flashed simultaneously.

13 **Standard:**

14 No steady indications, other than a single-section signal face consisting of a continuously-displayed
15 GREEN ARROW signal indication that is used alone to indicate a continuous movement in the steady
16 (stop-and-go) mode, shall be displayed at the signalized location during the flashing mode. A single-
17 section GREEN ARROW signal indication shall remain continuously-displayed when the traffic control
18 signal is operated in the flashing mode.

19 If a signal face includes both circular and arrow signal indications of the color that is to be flashed,
20 only the circular signal indication shall be flashed.

21 All signal faces that are flashed on an approach shall flash the same color, either yellow or red,
22 except that separate turn signal faces (see Sections 4D.17 and 4D.21) shall be permitted to flash a RED
23 ARROW signal indication when the adjacent through movement signal indications are flashed yellow.
24 Shared signal faces (see Sections 4D.17 and 4D.21) for turn movements shall not be permitted to flash a
25 CIRCULAR RED signal indication when the adjacent through movement signal indications are flashed
26 yellow.

27 The appropriate RED ARROW or YELLOW ARROW signal indication shall be flashed when a
28 signal face consists entirely of arrow indications. A signal face that consists entirely of arrow indications
29 and that provides a protected only turn movement during the steady (stop-and-go) mode or that
30 provides a flashing YELLOW ARROW or flashing RED ARROW signal indication for a permissive
31 turn movement during the steady (stop-and-go) mode shall be permitted to flash the YELLOW
32 ARROW signal indication during the flashing mode if the adjacent through movement signal
33 indications are flashed yellow and if it is intended that a permissive turn movement not requiring a full
34 stop by each turning vehicle be provided during the flashing mode.

35 **Section ~~4D.31~~ 4G.04 Flashing Operation – Transition Out of Flashing Mode**

36 **Standard:**

37 All changes from flashing mode to steady (stop-and-go) mode shall be made under one of the
38 following procedures:

- 39 A. Yellow-red flashing mode: Changes from flashing mode to steady (stop-and-go) mode shall be
40 made at the beginning of the major-street green interval (when a green signal indication is
41 displayed to through traffic in both directions on the major street), or if there is no common
42 major-street green interval, at the beginning of the green interval for the major traffic
43 movement on the major street.
- 44 B. Red-red flashing mode: Changes from flashing mode to steady (stop-and-go) mode shall be
45 made by changing the flashing red indications to steady red indications followed by appropriate
46 green indications to begin the steady mode cycle. These green indications shall be the beginning
47 of the major-street green interval (when a green signal indication is displayed to through traffic
48 in both directions on the major street) or if there is no common major-street green interval, at
49 the beginning of the green interval for the major traffic movement on the major street.

50 *Guidance:*

1 The steady red clearance interval provided during the change from red-red flashing mode to steady (stop-
2 and-go) mode should have a duration of 6 seconds.

3 When changing from the yellow-red flashing mode to steady (stop-and-go) mode at a location where there
4 is a common major-street green interval, the flashing red signal indications for the minor street should
5 immediately change to steady red signal indications, and the flashing yellow signal indications for the
6 through movements on the major street should change to green signal indications in both directions (after the
7 minor-street signal indications have been steady red for a short time, if desired), or the flashing yellow signal
8 indications for the through movements on the major street should change to steady yellow signal indications
9 followed by a steady red clearance interval before changing to green signal indications in both directions.

10 When changing from the yellow-red flashing mode to steady (stop-and-go) mode, ~~if at a location~~
11 ~~where there is no common major-street green interval, the provision of a steady red clearance interval for the~~
12 ~~other approaches before changing from a flashing yellow or a flashing red signal indication to a green signal~~
13 ~~indication on the major approach should be considered~~ the flashing red signal indications for the minor street
14 should immediately change to steady red signal indications, and the flashing yellow signal indications for the
15 through movements on the major street should change to steady yellow signal indications followed by a steady
16 red clearance interval before changing to green signal indications for the major traffic movement on the
17 major street.

18 **Standard:**

19 During programmed changes out of flashing mode, no flashing yellow signal indication shall be
20 terminated and immediately followed by a steady red or flashing red signal indication without first
21 displaying ~~the~~ steady yellow signal indication.

22 **Option:**

23 Because special midblock signals that rest in flashing circular yellow in the position normally occupied by
24 the green signal indication do not have a green signal indication in the signal face, these signals may go
25 directly from flashing circular yellow (in the position normally occupied by the green signal indication) to
26 steady yellow without going first to a green signal indication.

27 ~~Section 4D.32 Temporary and Portable Traffic Control Signals~~ This section has been relocated
28 to Section 4D.10

29 ~~Section 4D.33 Lateral Offset of Signal Supports and Cabinets~~ This section has been relocated to
30 Section 4A.07 because this text applies to all types of highway traffic signals, not just to
31 traffic control signals

32 ~~Section 4D.34 Use of Signs at Signalized Locations~~ This section has been relocated to Section
33 4A.08 because this text applies to all types of highway traffic signals, not just to traffic
34 control signals

35 ~~Section 4D.35 Use of Pavement Markings at Signalized Locations~~ This section has been
36 relocated to Section 4A.09 and the text has been revised to apply to all types of highway
37 traffic signals, not just to traffic control signals

CHAPTER 4H. BICYCLE SIGNALS

Section 4H.01 Application of Bicycle Signals

Section 4H.02 Design of Bicycle Signals

Section 4H.03 Operation of Bicycle Signals

If a determination is made that bicycle signals should be placed in Part 4 rather than in Part 9, a new chapter will be inserted into Part 4 for this device. The provisions of the interim approval in the IA-16 memorandum that is issued in late 2013 will form the basis of this new chapter.

CHAPTER ~~4E.4I~~4I. PEDESTRIAN CONTROL FEATURES

Section ~~4E.01~~4I.01 Pedestrian Signal Heads

Support:

Pedestrian signal heads provide special types of traffic signal indications exclusively intended for controlling pedestrian traffic. These signal indications consist of the illuminated symbols of a WALKING PERSON (symbolizing WALK) and an UPRAISED HAND (symbolizing DONT WALK).

Guidance:

Engineering judgment should determine the need for separate pedestrian signal heads (see Section 4D.03) and accessible pedestrian signals (see Section 4E.09).

Support:

Chapter 4F contains information regarding the use of pedestrian hybrid beacons and Chapter 4N contains information regarding the use of In-Roadway Warning Lights at unsignalized marked crosswalks.

~~Section 4E.02 – Meaning of Pedestrian Signal Head Indications~~ This section has been relocated to Section 4A.06 because this text applies to all types of highway traffic signals, not just to traffic control signals, and to place it immediately following the meanings of vehicular signal indications

Section ~~4E.03~~4I.02 Application of Pedestrian Signal Heads

Standard:

Pedestrian signal heads shall be used in conjunction with vehicular traffic control signals under any of the following conditions:

- A. If a traffic control signal is justified by an engineering study and meets either Warrant 4, Pedestrian Volume or Warrant 5, School Crossing (see Chapter 4C);
- B. If an exclusive signal phase is provided or made available for pedestrian movements in one or more directions, with all conflicting vehicular movements being stopped;
- C. At an established school crossing at any signalized location; or
- D. Where engineering judgment determines that multi-phase signal indications (as with split-phase timing) would tend to confuse or cause conflicts with pedestrians using a crosswalk guided only by vehicular signal indications.

Guidance:

Pedestrian signal heads should be used under any of the following conditions:

- A. *If it is necessary to assist pedestrians in deciding when to begin crossing the roadway in the chosen direction or if engineering judgment determines that pedestrian signal heads are justified to minimize vehicle-pedestrian conflicts;*
- B. *If pedestrians are permitted to cross a portion of a street, such as to or from a median of sufficient width for pedestrians to wait, during a particular interval but are not permitted to cross the remainder of the street during any part of the same interval; and/or*
- C. *If no vehicular signal indications are visible to pedestrians, or if the vehicular signal indications that are visible to pedestrians starting a crossing provide insufficient guidance for them to decide when to begin crossing the roadway in the chosen direction, such as on one-way streets, at T-intersections, or at multi-phase signal operations.*

Option:

Pedestrian signal heads may be used under other conditions based on engineering judgment.

Section ~~4E.04~~4I.03 Size, Design, and Illumination of Pedestrian Signal Head Indications

Standard:

All new pedestrian signal head indications shall be displayed within a rectangular background and shall consist of symbolized messages (see Figure 4E-1), except that existing pedestrian signal head indications with lettered or outline style symbol messages shall be permitted to be retained for the remainder of their useful service life. The symbol designs that are set forth in the “Standard

Highway Signs and Markings” book (see Section 1A.11) shall be used. Each pedestrian signal head indication shall be independently displayed and emit a single color.

If a two-section pedestrian signal head is used, the UPRAISED HAND (symbolizing DONT WALK) signal section shall be mounted directly above the WALKING PERSON (symbolizing WALK) signal section. If a one-section pedestrian signal head is used, the symbols shall be either overlaid upon each other or arranged side-by-side with the UPRAISED HAND symbol to the left of the WALKING PERSON symbol, and a light source that can display each symbol independently shall be used.

The WALKING PERSON (symbolizing WALK) signal indication shall be white, conforming to the publication entitled “Pedestrian Traffic Control Signal Indications” (see Section 1A.11), with all except the symbol obscured by an opaque material.

The UPRAISED HAND (symbolizing DONT WALK) signal indication shall be Portland orange, conforming to the publication entitled “Pedestrian Traffic Control Signal Indications” (see Section 1A.11), with all except the symbol obscured by an opaque material.

Guidance:

When not illuminated, the WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DONT WALK) symbols ~~shall~~ should not be readily visible to pedestrians at the far end of the crosswalk that the pedestrian signal head indications control.

Standard:

For pedestrian signal head indications, the symbols shall be at least 6 inches high.

The light source of a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication shall be flashed continuously at a rate of not less than 50 or more than 60 times per minute. The displayed period of each flash shall be a minimum of 1/2 and a maximum of 2/3 of the total flash cycle.

Guidance:

Pedestrian signal head indications should be conspicuous and recognizable to pedestrians at all distances from the beginning of the controlled crosswalk to a point 10 feet from the end of the controlled crosswalk during both day and night.

For crosswalks where the pedestrian enters the crosswalk more than 100 feet from the pedestrian signal head indications, the symbols should be at least 9 inches high.

If the pedestrian signal indication is so bright that it causes excessive glare in nighttime conditions, some form of automatic dimming should be used to reduce the brilliance of the signal indication.

Option:

An animated eyes symbol may be added to a pedestrian signal head in order to prompt pedestrians to look for vehicles in the intersection during the time that the WALKING PERSON (symbolizing WALK) signal indication is displayed.

Standard:

If used, the animated eyes symbol shall consist of an outline of a pair of white steadily-illuminated eyes with white eyeballs that scan from side to side at a rate of approximately once per second. The animated eyes symbol shall be at least 12 inches wide with each eye having a width of at least 5 inches and a height of at least 2.5 inches. The animated eyes symbol shall be illuminated at the start of the walk interval and shall terminate at the end of the walk interval.

Section 4E.05 4I.04 Location and Height of Pedestrian Signal Heads

~~Standard~~ Guidance:

Pedestrian signal heads ~~shall~~ should be mounted with the bottom of the signal housing including brackets not less than 7 feet or more than 10 feet above sidewalk level, and shall be positioned and adjusted to provide maximum visibility at the beginning of the controlled crosswalk.

If pedestrian signal heads are mounted on the same support as vehicular signal heads, there ~~shall~~ should be a physical separation between them.

~~Section 4E.06 Pedestrian Intervals and Signal Phases~~ This section was relocated to the end of the chapter

Section ~~4E.07~~4I.05 Countdown Pedestrian Signals

Standard:

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 in order to inform pedestrians of the number of seconds remaining in the pedestrian change interval.

Option:

Pedestrian signal heads used at crosswalks where the pedestrian change interval is 7 seconds or less may include a pedestrian change interval countdown display in order to inform pedestrians of the number of seconds remaining in the pedestrian change interval.

Standard:

Where countdown pedestrian signals are used, the countdown shall always be displayed simultaneously with the flashing UPRAISED HAND (symbolizing DONT WALK) signal indication displayed for that crosswalk.

Countdown pedestrian signals shall consist of Portland orange numbers that are at least 6 inches in height on a black opaque background. The countdown pedestrian signal shall be located immediately adjacent to the associated UPRAISED HAND (symbolizing DONT WALK) pedestrian signal head indication (see Figure 4E-1). ~~(17) The second sentence was moved down to Guidance~~

The display of the number of remaining seconds shall begin only at the beginning of the pedestrian change interval (flashing UPRAISED HAND). After the countdown displays zero, the display shall remain dark until the beginning of the next countdown.

The countdown pedestrian signal shall display the number of seconds remaining until the termination of the pedestrian change interval (flashing UPRAISED HAND). Countdown displays shall not be used during the walk interval or during the red clearance interval of a concurrent vehicular phase.

Guidance:

~~The countdown pedestrian signal shall be located immediately adjacent to the associated UPRAISED HAND (symbolizing DONT WALK) pedestrian signal head indication (see Figure 4E-1).~~ ~~(17) This was the second sentence of a Standard statement~~

If used with a pedestrian signal head that does not have a concurrent vehicular phase, the pedestrian change interval (flashing UPRAISED HAND) should be set to be approximately 4 seconds less than the required pedestrian clearance time (see Section 4E.06) and an additional clearance interval (during which a steady UPRAISED HAND is displayed) should be provided prior to the start of the conflicting vehicular phase.

For crosswalks where the pedestrian enters the crosswalk more than 100 feet from the countdown pedestrian signal display, the numbers should be at least 9 inches in height.

Because some technology includes the countdown pedestrian signal logic in a separate timing device that is independent of the timing in the traffic signal controller, care should be exercised by the engineer when timing changes are made to pedestrian change intervals.

If the pedestrian change interval is interrupted or shortened as a part of a transition into a preemption sequence (see Section 4E.06), the countdown pedestrian signal display should be discontinued and go dark immediately upon activation of the preemption transition.

Section ~~4E.08~~4I.06 Pedestrian Detectors

Option:

Pedestrian detectors may be pushbuttons or passive detection devices.

Support:

Passive detection devices register the presence of a pedestrian in a position indicative of a desire to cross, without requiring the pedestrian to push a button. Some passive detection devices are capable of tracking the progress of a pedestrian as the pedestrian crosses the roadway for the purpose of extending or shortening the duration of certain pedestrian timing intervals.

The provisions in this Section place pedestrian pushbuttons within easy reach of pedestrians who are intending to cross each crosswalk and make it obvious which pushbutton is associated with each crosswalk. These provisions also position pushbutton poles in optimal locations for installation of accessible pedestrian signals (see Sections 4E.09 through 4E.13). Information regarding reach ranges can be found in the “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” (see Section 1A.11).

Guidance:

If pedestrian pushbuttons are used, they should be capable of easy activation and conveniently located near each end of the crosswalks. Except as provided in Paragraphs 5 and 6, pedestrian pushbuttons should be located to meet all of the following criteria (see Figure 4E-3):

- A. Unobstructed and adjacent to a level all-weather surface to provide access from a wheelchair;*
- B. Where there is an all-weather surface, a wheelchair accessible route from the pushbutton to the ramp;*
- C. Between the edge of the crosswalk line (extended) farthest from the center of the intersection and the side of a curb ramp (if present), but not greater than 5 feet from said crosswalk line;*
- D. Between 1.5 and 6 feet from the edge of the curb, shoulder, or pavement;*
- E. With the face of the pushbutton parallel to the crosswalk to be used; and*
- F. At a mounting height of approximately 3.5 feet, but no more than 4 feet, above the sidewalk.*

Where there are physical constraints that make it impractical to place the pedestrian pushbutton adjacent to a level all-weather surface, the surface should be as level as feasible.

Where there are physical constraints that make it impractical to place the pedestrian pushbutton between 1.5 and 6 feet from the edge of the curb, shoulder, or pavement, it should not be farther than 10 feet from the edge of curb, shoulder, or pavement.

Except as provided in Paragraph 8, where two pedestrian pushbuttons are provided on the same corner of a signalized location, the pushbuttons should be separated by a distance of at least 10 feet.

Option:

~~The pushbuttons may be placed closer together or on the same pole.~~ *A. Where there are physical constraints on a particular corner that make it impractical to provide the 10-foot separation between the two pedestrian pushbuttons, the pushbuttons may be placed closer together or on the same pole.* *B. When an exclusive pedestrian phase is used at an intersection, and the pedestrian signals controlling the crosswalks on a given corner of the intersection both operate together such that the "Walk" indication is always simultaneous for both crosswalks, the pushbuttons may be placed closer together or on the same pole. (18)*

Support:

Figure 4E-4 shows typical pedestrian pushbutton locations for a variety of situations.

~~Standard~~ *Guidance* ~~Standard:~~ (19)

Signs (see Section 2B.52) shall be mounted adjacent to or integral with pedestrian pushbuttons, explaining their purpose and use.

Option:

At certain locations, a supplemental sign in a more visible location may be used to call attention to the pedestrian pushbutton.

~~Standard~~ *Guidance* ~~Standard:~~ (20)

The positioning of pedestrian pushbuttons and the legends on the pedestrian pushbutton signs shall clearly indicate which crosswalk signal is actuated by each pedestrian pushbutton.

~~Standard:~~ (20)

If the pedestrian clearance time is sufficient only to cross from the curb or shoulder to a median of sufficient width for pedestrians to wait and the signals are pedestrian actuated, an additional pedestrian detector shall be provided in the median.

Guidance:

1 The use of additional pedestrian detectors on islands or medians where a pedestrian might become
2 stranded should be considered.

3 If used, special purpose pushbuttons (to be operated only by authorized persons) should include a housing
4 capable of being locked to prevent access by the general public and do not need an instructional sign.

5 **Standard:**

6 If used, a pilot light or other means of indication installed with a pedestrian pushbutton shall not be
7 illuminated until actuation. Once it is actuated, the pilot light shall remain illuminated until the
8 pedestrian's green or WALKING PERSON (symbolizing WALK) signal indication is displayed.

9 ~~If a pilot light is used at an accessible pedestrian signal location (see Sections 4E.09 through 4E.13),~~
10 ~~each actuation shall be accompanied by the speech message "wait."~~ Repeat of Paragraph 23 in Section
11 4E.11

12 **Option:**

13 At signalized locations with a demonstrated need and subject to equipment capabilities, pedestrians with
14 special needs may be provided with additional crossing time by means of an extended pushbutton press.

15 **Standard:**

16 If additional crossing time is provided by means of an extended pushbutton press, a PUSH
17 BUTTON FOR 2 SECONDS FOR EXTRA CROSSING TIME (R10-32P) plaque (see Figure 2B-26)
18 shall be mounted adjacent to or integral with the pedestrian pushbutton.

19 Section ~~4E.06~~ 4L.07 **Pedestrian Intervals and Signal Phases**

20 **Standard:**

21 At intersections equipped with pedestrian signal heads, the pedestrian signal indications shall be
22 displayed except when the vehicular traffic control signal is being operated in the flashing mode. At
23 those times, the pedestrian signal indications shall not be displayed.

24 Except as provided in Paragraph 3, when the pedestrian signal heads associated with a crosswalk
25 are displaying either a steady WALKING PERSON (symbolizing WALK) or a flashing UPRAISED
26 HAND (symbolizing DONT WALK) signal indication, a steady ~~or a flashing~~ red signal indication shall
27 be shown to any conflicting vehicular movement that is approaching the intersection or midblock
28 location perpendicular or nearly perpendicular to the crosswalk.

29 When the pedestrian signal heads at a pedestrian hybrid beacon (see Chapter 4F) location are
30 displaying a flashing UPRAISED HAND (symbolizing DONT WALK) signal indication, a flashing red
31 signal indication shall be shown to any conflicting vehicular movement that is approaching the
32 intersection or midblock location perpendicular or nearly perpendicular to the crosswalk.

33 When pedestrian signal heads are used, a WALKING PERSON (symbolizing WALK) signal
34 indication shall be displayed only when pedestrians are permitted to leave the curb or shoulder.

35 A pedestrian change interval consisting of a flashing UPRAISED HAND (symbolizing DONT
36 WALK) signal indication shall begin immediately following the WALKING PERSON (symbolizing
37 WALK) signal indication. Following the pedestrian change interval, a buffer interval consisting of a
38 steady UPRAISED HAND (symbolizing DONT WALK) signal indication shall be displayed for at least
39 ~~2~~ 2(21) seconds prior to the release of any conflicting vehicular movement. The sum of the time of the
40 pedestrian change interval and the buffer interval shall not be less than the calculated pedestrian
41 clearance time (see Paragraphs 7 through 16). The buffer interval shall not begin later than the
42 beginning of the red clearance interval, if used.

43 **Option:**

44 During the yellow change interval, the UPRAISED HAND (symbolizing DON'T WALK) signal
45 indication may be displayed as either a flashing indication, a steady indication, or a flashing indication for an
46 initial portion of the yellow change interval and a steady indication for the remainder of the interval.

47 **Support:**

48 Figure 4E-2 illustrates the pedestrian intervals and their possible relationships with associated vehicular
49 signal phase intervals.

50 **Guidance:**

1 *Except as provided in Paragraph 8, the pedestrian clearance time should be sufficient to allow a*
2 *pedestrian crossing in the crosswalk who left the curb or ~~shoulder~~ edge of pavement at the end of the*
3 *WALKING PERSON (symbolizing WALK) signal indication to travel at a walking speed of 3.5 feet per second*
4 *to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait.*

5 Option:

6 A walking speed of up to 4 feet per second may be used to evaluate the sufficiency of the pedestrian
7 clearance time at locations where an extended pushbutton press function has been installed to provide slower
8 pedestrians an opportunity to request and receive a longer pedestrian clearance time. Passive pedestrian
9 detection may also be used to automatically adjust the pedestrian clearance time based on the pedestrian's
10 actual walking speed or actual clearance of the crosswalk.

11 The additional time provided by an extended pushbutton press to satisfy pedestrian clearance time needs
12 may be added to either the walk interval or the pedestrian change interval.

13 *Guidance:*

14 *Where pedestrians who walk slower than 3.5 feet per second, or pedestrians who use wheelchairs,*
15 *routinely use the crosswalk, a walking speed of less than 3.5 feet per second should be considered in*
16 *determining the pedestrian clearance time.*

17 *Except as provided in Paragraph 12, the walk interval should be at least 7 seconds in length so that*
18 *pedestrians will have adequate opportunity to leave the curb or shoulder before the pedestrian clearance time*
19 *begins.*

20 Option:

21 If pedestrian volumes and characteristics do not require a 7-second walk interval, walk intervals as short
22 as 4 seconds may be used.

23 Support:

24 The walk interval is intended for pedestrians to start their crossing. The pedestrian clearance time is
25 intended to allow pedestrians who started crossing during the walk interval to complete their crossing. Longer
26 walk intervals are often used when the duration of the vehicular green phase associated with the pedestrian
27 crossing is long enough to allow it.

28 *Guidance:*

29 *The total of the walk interval and pedestrian clearance time should be sufficient to allow a pedestrian*
30 *crossing in the crosswalk who left the pedestrian detector (or, if no pedestrian detector is present, a location 6*
31 *feet from the face of the curb or from the edge of the pavement) at the beginning of the WALKING PERSON*
32 *(symbolizing WALK) signal indication to travel at a walking speed of 3 feet per second to the far side of the*
33 *traveled way being crossed or to the median if a two-stage pedestrian crossing sequence is used. Any*
34 *additional time that is required to satisfy the conditions of this paragraph should be added to the walk*
35 *interval.*

36 Option:

37 On a street with a median of sufficient width for pedestrians to wait, a pedestrian clearance time that
38 allows the pedestrian to cross only from the curb or shoulder to the median may be provided.

39 **Standard:**

40 **Where the pedestrian clearance time is sufficient only for crossing from the curb or shoulder to a**
41 **median of sufficient width for pedestrians to wait, median-mounted pedestrian signals (with pedestrian**
42 **detectors if actuated operation is used) shall be provided (see Sections 4E.08 and 4E.09) and signing**
43 **such as the R10-3d sign (see Section 2B.52) shall be provided to notify pedestrians to cross only to the**
44 **median to await the next WALKING PERSON (symbolizing WALK) signal indication.**

45 *Guidance:*

46 *Where median-mounted pedestrian signals and detectors are provided, the use of accessible pedestrian*
47 *signals (see Sections 4E.09 through 4E.13) should be considered.*

48 Option:

49 During the transition into preemption, the walk interval and the pedestrian change interval may be
50 shortened or omitted as described in Section 4D.27.

1 At intersections with high pedestrian volumes and high conflicting turning vehicle volumes, a brief
2 leading pedestrian interval, during which an advance WALKING PERSON (symbolizing WALK) indication
3 is displayed for the crosswalk while red indications continue to be displayed to parallel through and/or turning
4 traffic, may be used to reduce conflicts between pedestrians and turning vehicles.

5 *Guidance:*

6 *If a leading pedestrian interval is used, the use of accessible pedestrian signals (see Sections 4E.09*
7 *through 4E.13) should be considered.*

8 *Support:*

9 If a leading pedestrian interval is used without accessible features, pedestrians who are visually impaired
10 can be expected to begin crossing at the onset of the vehicular movement when drivers are not expecting them
11 to begin crossing.

12 *Guidance:*

13 *If a leading pedestrian interval is used, it should be at least 3 seconds in duration and should be timed to*
14 *allow pedestrians to cross at least one lane of traffic or, in the case of a large corner radius, to travel far*
15 *enough for pedestrians to establish their position ahead of the turning traffic before the turning traffic is*
16 *released.*

17 *If a leading pedestrian interval is used, consideration should be given to prohibiting turns across the*
18 *crosswalk during the leading pedestrian interval.*

19 *Support:*

20 At intersections with pedestrian volumes that are so high that drivers have difficulty finding an
21 opportunity to turn across the crosswalk, the duration of the green interval for a parallel concurrent vehicular
22 movement is sometimes intentionally set to extend beyond the pedestrian clearance time to provide turning
23 drivers additional green time to make their turns while the pedestrian signal head is displaying a steady
24 UPRAISED HAND (symbolizing DONT WALK) signal indication after pedestrians have had time to
25 complete their crossings.

CHAPTER 4J. ACCESSIBLE PEDESTRIAN SIGNALS AND DETECTORS

Section ~~4E.09~~ 4J.01 ~~Accessible Pedestrian Signals and Detectors~~ **General**

Support:

Accessible pedestrian signals and detectors provide information in non-visual formats (such as audible tones, speech messages, and/or vibrating surfaces).

The primary technique that pedestrians who have visual disabilities use to cross streets at signalized locations is to initiate their crossing when they hear the traffic in front of them stop and the traffic alongside them begin to move, which often corresponds to the onset of the green interval. The existing environment is often not sufficient to provide the information that pedestrians who have visual disabilities need to cross a roadway at a signalized location.

Guidance:

If a particular signalized location presents difficulties for pedestrians who have visual disabilities to cross the roadway, an engineering study should be conducted that considers the needs of pedestrians in general, as well as the information needs of pedestrians with visual disabilities. The engineering study should consider the following factors:

- A. Potential demand for accessible pedestrian signals;
- B. A request for accessible pedestrian signals;
- C. Traffic volumes during times when pedestrians might be present, including periods of low traffic volumes or high turn-on-red volumes;
- D. The complexity of traffic signal phasing (such as split phases, protected turn phases, leading pedestrian intervals, and exclusive pedestrian phases); and
- E. The complexity of intersection geometry.

Support:

The factors that make crossing at a signalized location difficult for pedestrians who have visual disabilities include: increasingly quiet cars, right turn on red (which masks the beginning of the through phase), continuous right-turn movements, complex signal operations, traffic circles, and wide streets. Furthermore, low traffic volumes might make it difficult for pedestrians who have visual disabilities to discern signal phase changes.

Local organizations, providing support services to pedestrians who have visual and/or hearing disabilities, can often act as important advisors to the traffic engineer when consideration is being given to the installation of devices to assist such pedestrians. Additionally, orientation and mobility specialists or similar staff also might be able to provide a wide range of advice. The U.S. Access Board (www.access-board.gov) provides technical assistance for making pedestrian signal information available to persons with visual disabilities (see Page i for the address for the U.S. Access Board).

Standard:

When used, accessible pedestrian signals shall be used in combination with pedestrian signal timing.

~~Guidance~~ **Standard: (22)**

The information provided by an accessible pedestrian signal ~~shall~~ should ~~shall~~ clearly (22) indicate which pedestrian crossing is served by each device.

Under stop-and-go operation, accessible pedestrian signals ~~shall~~ should ~~shall~~ (22) not be limited in operation by the time of day or day of week.

Option:

Accessible pedestrian signal detectors may be pushbuttons or passive detection devices.

At locations ~~with pretimed traffic control signals or non-actuated approaches~~ where it is not necessary for pedestrians to push a pushbutton detector to receive a WALKING PERSON signal indication, pedestrian pushbuttons may be used to activate the accessible pedestrian signals.

Support:

Accessible pedestrian signals are typically integrated into the pedestrian detector (pushbutton), so the audible tones and/or messages come from the pushbutton housing. They have a pushbutton locator tone and a vibro tactile arrow, and can include audible beaconing and other special features.

Option:

The name of the street to be crossed may also be provided in accessible format, such as Braille or raised print. Tactile maps of crosswalks may also be provided.

Support:

Specifications regarding the use of Braille or raised print for traffic control devices can be found in the “Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)” (see Section 1A.11).

~~Standard~~ ~~Guidance~~ **Standard: (23)**

At accessible pedestrian signal locations where pedestrian pushbuttons are used, each pushbutton ~~shall~~ ~~should~~ **shall (23)** activate both the walk interval and the accessible pedestrian signals.

Section ~~4E.10~~ 4J.02 Accessible Pedestrian Signals and Detectors – Location

Support:

Accessible pedestrian signals that are located as close as possible to pedestrians waiting to cross the street provide the clearest and least ambiguous indication of which pedestrian crossing is served by a device.

Guidance:

Pushbuttons for accessible pedestrian signals should be located in accordance with the provisions of Section 4E.08 and should be located as close as possible to the crosswalk line furthest from the center of the intersection and as close as possible to the curb ramp.

Standard:

Except for the situation described in Item B of Paragraph 8 of Section 4E.08, if two accessible pedestrian pushbuttons are placed less than 10 feet apart or on the same pole (see Paragraphs 7 and 8 in Section 4E.08), each accessible pedestrian pushbutton shall be provided with the following features (see Sections 4E.11 through 4E.13):

- A. A pushbutton locator tone,
- B. A vibrotactile arrow,
- C. A speech walk message for the WALKING PERSON (symbolizing WALK) indication, and
- D. A speech pushbutton information message.

If the pedestrian clearance time is sufficient only to cross from the curb or shoulder to a median of sufficient width for pedestrians to wait and accessible pedestrian signal detectors are used, an additional accessible pedestrian signal detector shall be provided in the median.

Section ~~4E.11~~ 4J.03 Accessible Pedestrian Signals and Detectors – Walk Indications

Support:

Technology that provides different sounds for each non-concurrent signal phase has frequently been found to provide ambiguous information. Research indicates that a rapid tick tone for each crossing coming from accessible pedestrian signal devices on separated poles located close to each crosswalk provides unambiguous information to pedestrians who are blind or visually impaired. Vibrotactile indications provide information to pedestrians who are blind and deaf and are also used by pedestrians who are blind or who have low vision to confirm the walk signal in noisy situations.

Standard:

Accessible pedestrian signals shall have both audible and vibrotactile walk indications.

Vibrotactile walk indications shall be provided by a vibrotactile arrow on the pushbutton (see Section 4E.12) that vibrates during the walk interval.

Accessible pedestrian signals shall have an audible walk indication during the walk interval only.

~~Guidance:~~ **(24)**

The audible walk indication ~~shall~~ ~~should~~ **shall (24)** be audible ~~at~~ ~~from~~ **at from (24)** the beginning of the associated crosswalk.

~~Standard:~~ **(24)**

1 The accessible walk indication shall have the same duration as the pedestrian walk signal except
2 when the pedestrian signal rests in walk.

3 Guidance:

4 If the pedestrian signal rests in walk, the accessible walk indication should be limited to the first 7
5 seconds of the walk interval. The accessible walk indication should be recalled by a button press during the
6 walk interval provided that the crossing time remaining is greater than the pedestrian change interval.

7 Standard:

8 ~~Where two accessible pedestrian signals are separated by a distance of at least 10 feet, the~~
9 ~~audible walk indication shall be a percussive tone.~~ Where two accessible pedestrian signals on
10 one corner that are associated with different phases ~~are not separated by a distance of at~~
11 ~~least~~ placed less than 10 feet apart, the audible walk indication shall be a speech walk message
12 (see Paragraph 3 in Section 4E.10). In all other cases, including at midblock crossings, on
13 corners where only one accessible pedestrian signal is present, and on corners where two
14 accessible pedestrian signals are separated by a distance of at least 10 feet, the audible walk
15 indication shall be a percussive tone.

16 Audible tone walk indications shall repeat at eight to ten ticks per second. Audible tones used as
17 walk indications shall consist of multiple frequencies with a dominant component at 880 Hz.

18 Guidance:

19 The volume of audible walk indications and pushbutton locator tones (see Section 4E.12) should be set to
20 be a maximum of 5 dBA louder than ambient sound, except when audible beaconing is provided in response to
21 an extended pushbutton press.

22 ~~Standard:~~ **Standard: (25)**

23 Automatic volume adjustment up to a maximum volume of 100 dBA in response to ambient traffic
24 sound level ~~shall~~ should ~~shall~~ be provided up to a maximum volume of 100 dBA. **(25)**

25 ~~Guidance:~~ **Guidance: (25)**

26 The sound level of audible walk indications and pushbutton locator tones should be adjusted to be low
27 enough to avoid misleading pedestrians who have visual disabilities when the following conditions exist:

- 28 A. Where there is an island that allows unsignalized right turns across a crosswalk between the island
29 and the sidewalk.
- 30 B. Where multi-leg approaches or complex signal phasing require more than two pedestrian phases,
31 such that it might be unclear which crosswalk is served by each audible tone.
- 32 C. At intersections where a diagonal pedestrian crossing is allowed, or where one street receives a
33 WALKING PERSON (symbolizing WALK) signal indication simultaneously with another street.

34 Option:

35 An alert tone, which is a very brief burst of high-frequency sound at the beginning of the audible walk
36 indication that rapidly decays to the frequency of the walk tone, may be used to alert pedestrians to the
37 beginning of the walk interval.

38 Support:

39 An alert tone can be particularly useful if the walk tone is not easily audible in some traffic conditions.

40 Speech walk messages communicate to pedestrians which street has the walk interval. Speech messages
41 might be either directly audible or transmitted, requiring a personal receiver to hear the message. To be a
42 useful system, the words and their meaning need to be correctly understood by all users in the context of the
43 street environment where they are used. Because of this, tones are the preferred means of providing audible
44 walk indications except where two accessible pedestrian signals on one corner are not separated by a distance
45 of at least 10 feet.

46 If speech walk messages are used, pedestrians have to know the names of the streets that they are crossing
47 in order for the speech walk messages to be unambiguous. In getting directions to travel to a new location,
48 pedestrians with visual disabilities do not always get the name of each street to be crossed. Therefore, it is
49 desirable to give users of accessible pedestrian signals the name of the street controlled by the pushbutton.

50 This can be done by means of a speech pushbutton information message (see Section 4E.13) during the

flashing or steady UPRAISED HAND intervals, or by raised print and Braille labels on the pushbutton housing.

By combining the information from the pushbutton message or Braille label, the vibrotactile arrow aligned in the direction of travel on the relevant crosswalk, and the speech walk message, pedestrians with visual disabilities are able to correctly respond to speech walk messages even if there are two pushbuttons on the same pole.

~~Standard~~ **Guidance:**

*If speech walk messages are used to communicate the walk interval, they ~~shall~~ **should** provide a clear message that the walk interval is in effect, as well as to which crossing it applies. Speech walk messages ~~shall~~ **should** be used only at intersections where it is technically infeasible to install two accessible pedestrian signals at one corner separated by a distance of at least 10 feet.*

*Speech walk messages that are used at intersections having pedestrian phasing that is concurrent with vehicular phasing ~~shall~~ **should** be patterned after the model: “Broadway. Walk sign is on to cross Broadway.”*

*Speech walk messages that are used at intersections having exclusive pedestrian phasing ~~shall~~ **should** be patterned after the model: “Walk sign is on for all crossings.”*

*Speech walk messages ~~shall~~ **should** not contain any additional information, except they ~~shall~~ **should** include designations such as “Street” or “Avenue” where this information is necessary to avoid ambiguity at a particular location.*

~~Guidance:~~

Speech walk messages should not state or imply a command to the pedestrian, such as “Cross Broadway now.” Speech walk messages should not tell pedestrians that it is “safe to cross,” because it is always the pedestrian’s responsibility to check actual traffic conditions.

Standard:

A speech walk message is not required at times when the walk interval is not timing, but, if provided:

A. It shall begin with the term “wait.”

B. It need not be repeated for the entire time that the walk interval is not timing.

~~Guidance~~ **Standard: (26)**

If a pilot light (see Section 4E.08) is used at an accessible pedestrian signal location, each actuation ~~shall~~ **should **shall** (26) be accompanied by the speech message “wait.”**

Option:

Accessible pedestrian signals that provide speech walk messages may provide similar messages in languages other than English, if needed, except for the terms “walk sign” and “wait.”

~~Standard:~~

~~Following the audible walk indication, accessible pedestrian signals shall revert to the pushbutton locator tone (see Section 4E.12) during the pedestrian change interval.~~ **Incorporated into Paragraph 4 of existing Section 4E.12**

~~Section 4E.12~~ **4J.04 Accessible Pedestrian Signals and Detectors – Vibrotactile Arrows and Locator Tones**

~~Standard~~ ~~Guidance:~~ **Standard: (27)**

To enable pedestrians who have visual disabilities to distinguish and locate the appropriate pushbutton at an accessible pedestrian signal location, pushbuttons ~~shall~~ **should **shall** clearly indicate by means of vibrotactile arrows which crosswalk signal is actuated by each pushbutton. Vibrotactile arrows ~~shall~~ **should** **shall** be located on the button (plunger) of the pushbutton assembly or immediately adjacent to the button (plunger) on the same surface of the pushbutton assembly housing, ~~should~~ **shall** have high visual contrast (light on dark or dark on light), and ~~shall~~ **should** **shall** be aligned parallel to the direction of travel on the associated crosswalk.** (27)

~~Standard:~~ **(26)**

An accessible pedestrian pushbutton shall incorporate a locator tone.

Support: 7A pushbutton locator tone is a repeating sound that informs approaching pedestrians that a pushbutton to actuate pedestrian timing or receive additional information exists, and that enables pedestrians with visual disabilities to locate the pushbutton.

~~Standard~~ ~~Guidance~~ **Standard: (28)**

Pushbutton locator tones ~~shall~~should**shall (28)** have a duration of 0.15 seconds or less ~~and~~
~~and~~ ~~Except (28)~~ as provided in Paragraph 6, pushbutton locator tones shall should shall (28) repeat at 1-second intervals at all times that the audible walk indication is not active, including during the pedestrian change interval and during the time that the pedestrian signal is resting in walk (see Paragraph 6 in Section 4E.11).

Option:

The pushbutton locator tone may default to a deactivated mode if a passive pedestrian detection system is implemented that activates the locator tone at all times (other than when the audible walk indication is active) that a pedestrian is present within a 12-foot radius from the pushbutton location. Where pedestrian facilities (such as sidewalks) are present, the passive detection requirement may be reduced such that it only applies to pedestrians who are on the pedestrian facilities within the 12-foot radius from the pushbutton location.

Standard:

Pushbutton locator tones shall be deactivated when the traffic control signal is operating in a flashing mode. This requirement shall not apply to traffic control signals or pedestrian hybrid beacons that are activated from a flashing or dark mode to a stop-and-go mode by pedestrian actuations.

~~Guidance~~ **(29)**

Pushbutton locator tones ~~shall~~should**shall (29)** be intensity responsive to ambient sound. , and be audible 6 to 12 feet from the pushbutton, or to the building line, whichever is less. ~~and be audible 6 to 12 feet from the pushbutton, or to the building line, whichever is less. (29)~~

Guidance:

Pushbutton locator tones should be audible 6 to 12 feet from the pushbutton, or to the building line, whichever is less. (29)

Support:

Section 4E.11 contains additional provisions regarding the volume and sound level of pushbutton locator tones.

~~Section 4E.13~~ ~~J.05 Accessible Pedestrian Signals and Detectors~~ **Extended Pushbutton Press Features**

Option:

Pedestrians may be provided with additional features such as increased crossing time, audible beaconing, or a speech pushbutton information message as a result of an extended pushbutton press.

~~Standard~~ ~~Guidance~~ **Standard (30)**

If an extended pushbutton press is used to provide any additional feature(s), a pushbutton press of less than one second ~~shall~~should**shall (30)** actuate only the pedestrian timing and any associated accessible walk indication, and a pushbutton press of one second or more ~~shall~~should**shall (30)** actuate the pedestrian timing, any associated accessible walk indication, and any additional feature(s).

Standard: (30)

If additional crossing time is provided by means of an extended pushbutton press, a PUSH BUTTON FOR 2 SECONDS FOR EXTRA CROSSING TIME (R10-32P) plaque (see Figure 2B-26) shall be mounted adjacent to or integral with the pedestrian pushbutton.

Support:

Audible beaconing is the use of an audible signal in such a way that pedestrians with visual disabilities can home in on the signal that is located on the far end of the crosswalk as they cross the street.

Not all crosswalks at an intersection need audible beaconing; ~~audible beaconing can actually cause confusion if used at all crosswalks at some intersections. (31)~~ Audible beaconing is not appropriate at locations with channelized turns or split phasing, because of the possibility of confusion.

Guidance:

Audible beaconing should ~~only~~ **(31)** be considered following an engineering study at:

- A. Crosswalks longer than 70 feet, unless ~~they~~ those crosswalks **(31)** are divided by a median that has another accessible pedestrian signal with a locator tone;
- B. Crosswalks that are skewed;
- C. Intersections with irregular geometry, such as more than four legs;
- D. Crosswalks where audible beaconing is requested by an individual with visual disabilities; or
- E. Other locations where a study indicates audible beaconing would be beneficial.

~~Option~~ Guidance: **(31)**

Audible beaconing ~~may be provided in several ways, any of which are~~ should be **(31)** initiated by an extended pushbutton press.

~~Standard~~ Guidance: Standard: **(31)**

If audible beaconing is used, the volume of the pushbutton locator tone during the pedestrian change interval of the called pedestrian phase ~~shall~~ should **(31)** be increased to a maximum of 100 dBA, and shall come from a loudspeaker that is mounted at a height of 7 to 10 feet above the pavement at the far end of the crosswalk as pedestrians cross the street. ~~operated in one of the following ways:~~

- ~~A. The louder audible walk indication and louder locator tone comes from the far end of the crosswalk, as pedestrians cross the street,~~
- ~~B. The louder locator tone comes from both ends of the crosswalk, or~~
- ~~C. The louder locator tone comes from an additional speaker that is aimed at the center of the crosswalk and that is mounted on a pedestrian signal head. **(31)**~~

Guidance:

The loudspeaker mounted at the far end of the crosswalk should be within the width of the crosswalk. **(31)**

Support:

When the locator tone is active during the pedestrian change interval at a traffic control signal where audible beaconing is used, both the audible beaconing speaker and the accessible pedestrian signal emit the tone. **(31)**

Option:

The sound level of the accessible pedestrian signal walk indication and subsequent pushbutton locator tone may be increased by an extended button press. **(31)**

Speech pushbutton information messages may provide intersection identification, as well as information about unusual intersection signalization and geometry, such as notification regarding exclusive pedestrian phasing, leading pedestrian intervals, split phasing, diagonal crosswalks, and medians or islands.

Standard:

If speech pushbutton information messages are made available by actuating the accessible pedestrian signal detector, they shall only be actuated when the walk interval is not timing. They shall begin with the term “Wait,” followed by intersection identification information modeled after: “Wait to cross Broadway at Grand.” If information on intersection signalization or geometry is also given, it shall follow the intersection identification information.

Guidance:

Speech pushbutton information messages should not be used to provide landmark information or to inform pedestrians with visual disabilities about detours or temporary traffic control situations.

Support:

Additional information on the structure and wording of speech pushbutton information messages is included in ITE’s “Electronic Toolbox for Making Intersections More Accessible for Pedestrians Who Are Blind or Visually Impaired,” which is available at ITE’s website (see Page i).

CHAPTER ~~4F~~4K. PEDESTRIAN HYBRID BEACONS

Section ~~4F.01~~4K.01 Application of Pedestrian Hybrid Beacons

Support:

A pedestrian hybrid beacon is 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.

Option:

A pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants (see Chapter 4C), or at a location that meets traffic signal warrants under Sections 4C.05 and/or 4C.06 but a decision is made to not install a traffic control signal.

Standard:

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.

Guidance:

If one of the signal warrants of Chapter 4C is met and a traffic control signal is justified by an engineering study, and if a decision is made to install a traffic control signal, it should be installed based upon the provisions of Chapters 4D and 4E.

If a traffic control signal is not justified under the signal warrants of Chapter 4C and if gaps in traffic are not adequate to permit pedestrians to cross, or if the speed for vehicles approaching on the major street is too high to permit pedestrians to cross, or if pedestrian delay is excessive, the need for a pedestrian hybrid beacon should be considered on the basis of an engineering study that considers major-street volumes, speeds, widths, and gaps in conjunction with pedestrian volumes, walking speeds, and delay.

For a major street where the posted or statutory speed limit or the 85th-percentile speed is 35 mph or less, the need for a pedestrian hybrid beacon should be considered if the engineering study finds that the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4F-1 for the length of the crosswalk.

For a major street where the posted or statutory speed limit or the 85th-percentile speed exceeds 35 mph, the need for a pedestrian hybrid beacon should be considered if the engineering study finds that the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding total of all pedestrians crossing the major street for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4F-2 for the length of the crosswalk.

For crosswalks that have lengths other than the four that are specifically shown in Figures 4F-1 and 4F-2, the values should be interpolated between the curves.

Option:

The criteria for the pedestrian volume crossing the major street shown in Figures 4F-1 and 4F-2 may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.

Section ~~4F.02~~4K.02 Design of Pedestrian Hybrid Beacons

Standard:

Except as otherwise provided in this Section, a pedestrian hybrid beacon shall meet the provisions of Chapters 4D and 4E.

A pedestrian hybrid beacon face shall consist of three signal sections, with a CIRCULAR YELLOW signal indication centered below two horizontally aligned CIRCULAR RED signal indications (see Figure 4F-3).

When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:

- A. At least two pedestrian hybrid beacon faces shall be installed for each approach of the major street,**
- B. A stop line shall be installed for each approach to the crosswalk,**

- C. A pedestrian signal head conforming to the provisions set forth in Chapter 4E shall be installed at each end of the marked crosswalk, ~~and~~
- D. The pedestrian hybrid beacon shall be pedestrian actuated, and
- E. If the pedestrian hybrid beacon is installed at or immediately adjacent to an intersection with a minor street, a STOP sign shall be installed for each minor-street approach.

Guidance:

When an engineering study finds that installation of a pedestrian hybrid beacon is justified, then:

~~A. The pedestrian hybrid beacon should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs.~~

A. Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk, or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance,

B. The installation should include suitable standard signs and pavement markings, and

C. If installed within a signal system, the pedestrian hybrid beacon should be coordinated.

On approaches having posted or statutory speed limits or 85th-percentile speeds in excess of 35 mph and on approaches having traffic or operating conditions that would tend to obscure visibility of roadside hybrid beacon face locations, both of the minimum of two pedestrian hybrid beacon faces should be installed over the roadway.

On multi-lane approaches having posted or statutory speed limits or 85th-percentile speeds of 35 mph or less, either a pedestrian hybrid beacon face should be installed on each side of the approach (if a median of sufficient width exists) or at least one of the pedestrian hybrid beacon faces should be installed over the roadway.

A pedestrian hybrid beacon should comply with the signal face location provisions described in Sections 4D.11 through 4D.16.

Accessible pedestrian signals should be installed in conjunction with a pedestrian hybrid beacon. (32)

Standard Option (33)

A CROSSWALK STOP ON RED (symbolic circular red) (R10-23) sign (see Section 2B.53) ~~shall~~ may (33) be mounted adjacent to a pedestrian hybrid beacon face on each major street approach.

Guidance:

If an overhead pedestrian hybrid beacon face is provided and an associated sign is used (33), the sign ~~shall~~ should be mounted adjacent to the overhead signal face.

Option:

A Pedestrian (W11-2) warning sign (see Section 2C.50) with an AHEAD (W16-9P) supplemental plaque may be placed in advance of a pedestrian hybrid beacon. A warning beacon may be installed to supplement the W11-2 sign.

Guidance:

If a warning beacon supplements a W11-2 sign in advance of a pedestrian hybrid beacon, it should be programmed to flash only when the pedestrian hybrid beacon is not in the dark mode.

Standard:

If a warning beacon is installed to supplement the W11-2 sign, the design and location of the warning beacon shall comply with the provisions of Sections 4L.01 and 4L.03.

Section ~~4F.03~~ 4K.03 Operation of Pedestrian Hybrid Beacons

Standard:

Pedestrian hybrid beacon indications shall be dark (not illuminated) during periods between actuations.

~~Upon~~ Following an (34) actuation by a pedestrian, a pedestrian hybrid beacon face shall display a flashing CIRCULAR YELLOW signal indication, followed by a steady CIRCULAR YELLOW signal indication, followed by both steady CIRCULAR RED signal indications during the pedestrian walk interval, followed by alternating flashing CIRCULAR RED signal indications during the pedestrian

1 **changeinterval (see Figure 4F-3). Upon termination of the pedestrian changeinterval, the pedestrian**
2 **hybrid beacon faces shall revert to a dark (not illuminated) condition.**

3 **Except as provided in Paragraph 4, the pedestrian signal heads shall continue to display a steady**
4 **UPRAISED HAND (symbolizing DONT WALK) signal indication when the pedestrian hybrid beacon**
5 **faces are either dark or displaying flashing or steady CIRCULAR YELLOW signal indications. The**
6 **pedestrian signal heads shall display a WALKING PERSON (symbolizing WALK) signal indication**
7 **when the pedestrian hybrid beacon faces are displaying steady CIRCULAR RED signal indications.**
8 **The pedestrian signal heads shall display a flashing UPRAISED HAND (symbolizing DONT WALK)**
9 **signal indication when the pedestrian hybrid beacon faces are displaying alternating flashing**
10 **CIRCULAR RED signal indications. Upon termination of the pedestrian change interval, the**
11 **pedestrian signal heads shall revert to a steady UPRAISED HAND (symbolizing DONT WALK) signal**
12 **indication.**

13 **Option:**

14 **Where the pedestrian hybrid beacon is installed adjacent to a roundabout to facilitate crossings by**
15 **pedestrians with visual disabilities and an engineering study determines that pedestrians without visual**
16 **disabilities can be allowed to cross the roadway without actuating the pedestrian hybrid beacon, the pedestrian**
17 **signal heads may be dark (not illuminated) when the pedestrian hybrid beacon faces are dark.**

18 **Guidance:**

19 *The duration of the flashing yellow interval should be determined by engineering judgment.*

20 *If the pedestrian hybrid beacon is coordinated as a part of a signal system:*

21 *A. The duration of the flashing yellow interval should not vary on a cycle-by-cycle basis.*

22 *B. The pedestrian hybrid beacon should remain in the dark condition after a pedestrian actuation has*
23 *been received until the point in the background cycle when the predetermined duration of the flashing*
24 *yellow interval needs to be initiated in order to achieve the appropriate coordinated offset.*

25 **Standard:**

26 **The duration of the steady yellow change interval shall be determined using engineering practices**
27 **in accordance with the provisions in Section 4D.26.**

28 **Guidance:**

29 *Except as provided in Paragraphs 5 and 6 of Section 4D.26, a yellow change interval should have a*
30 *minimum duration of 3 seconds. A yellow change interval should have*~~and~~*a maximum duration of 6*
31 *seconds*~~(see Section 4D.26)~~*. The longer intervals should be reserved for use on approaches with higher*
32 *speeds.*

33 **Option:**

34 *A steady red clearance interval may be used after the steady yellow change interval.*

35 *The alternating flashing CIRCULAR RED signal indications may continue to flash for a short period after*
36 *the pedestrian change interval has terminated to provide a buffer interval for pedestrians.*

CHAPTER 4L.RECTANGULAR RAPID FLASHING BEACONS

Section 4L.01Application of Rectangular Rapid Flashing Beacons

Section 4L.02Design of Rectangular Rapid Flashing Beacons

Section 4L.03Operation of Rectangular Rapid Flashing Beacons

The NCUTCD recommends that the following language be included if a rapid flashing beacon chapter is added:

STANDARD (35)

An audible information device used in conjunction with a RRFB or a CRFB shall not use vibrotactile indications or percussive indications. (35)

Guidance: (35)

If an audible information device is used in conjunction with an RRFB or a CRFB, the audible message should be a speech message that says, "Yellow lights are flashing". The audible message should be spoken twice. (35)

If the patent issues regarding the rectangular rapid flashing beacon are resolved prior to the finalization of the next Notice of Proposed Amendments, a new chapter will be inserted into Part 4 for this device. The provisions of the interim approval in the IA-11 memorandum and the many subsequent official interpretations will form the basis of this new chapter.

CHAPTER ~~4G.4~~4M. TRAFFIC CONTROL SIGNALS ~~AND HYBRID BEACONS~~ FOR EMERGENCY-VEHICLE ACCESS

Section ~~4G.01~~4M.01 Application of Emergency-Vehicle Traffic Control Signals and Hybrid Beacons

Support:

An emergency-vehicle traffic control signal is a special traffic control signal that ~~assigns the right-of-way to~~directs all conflicting traffic to stop in order to permit the driver of an authorized emergency vehicle ~~to~~safely ~~(36)~~proceed into the roadway or intersection.

Option:

An emergency-vehicle traffic control signal may be installed at a location that does not meet other traffic signal warrants such as at an intersection or other location to permit direct access from a building housing the emergency vehicle.

An emergency-vehicle hybrid beacon may be installed instead of an emergency-vehicle traffic control signal under conditions described in Section ~~4G.04~~4N.01.

Guidance:

If a traffic control signal is not justified under the signal warrants of Chapter 4C and if gaps in traffic are not adequate to permit the timely entrance of emergency vehicles, or the stopping sight distance for vehicles approaching on the major street is insufficient for emergency vehicles, installing an emergency-vehicle traffic control signal should be considered. If one of the signal warrants of Chapter 4C is met and a traffic control signal is justified by an engineering study, and if a decision is made to install a traffic control signal, it should be installed based upon the provisions of Chapter 4D.

The sight distance determination should be based on the location of the visibility obstruction for the critical approach lane for each street or drive and the posted or statutory speed limit or 85th-percentile speed on the major street, whichever is higher.

Section ~~4G.02~~4M.02 Design of Emergency-Vehicle Traffic Control Signals

Standard:

Except as otherwise provided in this Section, an emergency-vehicle traffic control signal shall meet the requirements of this Manual.

An Emergency Vehicle (W11-8) sign (see Section 2C.49) with an EMERGENCY SIGNAL AHEAD (W11-12P) supplemental plaque shall be placed in advance of all emergency-vehicle traffic control signals. If a warning beacon is installed to supplement the W11-8 sign, the design and location of the beacon shall comply with the Standards of Sections 4L.01 and 4L.03.

Guidance:

At least one of the two required signal faces for each approach on the major street should be located over the roadway.

The following size signal indications should be used for emergency-vehicle traffic control signals: 12-inch diameter for steady red and steady yellow circular signal indications and any arrow indications, and 8-inch diameter for green or flashing yellow circular signal indications.

Standard:

An EMERGENCY SIGNAL (R10-13) sign shall be mounted adjacent to a signal face on each major street approach (see Section 2B.53).

Guidance:

If an overhead signal face is provided, the EMERGENCY SIGNAL sign ~~shall~~should be mounted adjacent to the overhead signal face.

Option:

An approach that only serves emergency vehicles may be provided with only one signal face consisting of one or more signal sections.

Besides using an 8-inch diameter signal indication, other appropriate means to reduce the flashing yellow light output may be used.

Section ~~4G.03~~4M.03 Operation of Emergency-Vehicle Traffic Control Signals

Standard:

~~Right-of-way~~ **Green signal indications** for emergency vehicles at signalized locations operating in the steady (stop-and-go) mode shall be obtained as provided in Section 4D.27.

As a minimum, the signal indications, sequence, and manner of operation of an emergency-vehicle traffic control signal installed at a midblock location shall be as follows:

- A. The signal indication, between emergency-vehicle actuations, shall be either green or flashing yellow. If the flashing yellow signal indication is used instead of the green signal indication, it shall be displayed in the normal position of the green signal indication, while the steady red and steady yellow signal indications shall be displayed in their normal positions.
- B. When an emergency-vehicle actuation occurs, a steady yellow change interval followed by a steady red interval shall be displayed to traffic on the major street.
- C. A yellow change interval is not required following the green interval for the emergency-vehicle driveway.

Guidance:

Emergency-vehicle traffic control signals located at intersections ~~shall~~ **should** either be operated in the flashing mode between emergency-vehicle actuations (see Sections 4D.28 and 4D.30) or be full-actuated or semi-actuated to accommodate normal vehicular and pedestrian traffic on the streets.

Warning beacons, if used with an emergency-vehicle traffic control signal, ~~shall~~ **should** be flashed only:

- A. For an appropriate time in advance of and during the steady yellow change interval for the major street; and
- B. During the steady red interval for the major street.

~~Guidance:~~

The duration of the steady red interval for traffic on the major street should be determined by on-site test-run time studies, but should not exceed 1.5 times the time required for the emergency vehicle to clear the path of conflicting vehicles.

Option:

An emergency-vehicle traffic control signal sequence may be initiated manually from a local control point such as a fire station or law enforcement headquarters or from an emergency vehicle equipped for remote operation of the signal.

CHAPTER 4N. HYBRID BEACONS FOR EMERGENCY-VEHICLE ACCESS

Section ~~4G.04~~ 4N.01 Application of Emergency-Vehicle Hybrid Beacons Paragraphs from existing Section 4G.04 have been placed in new Sections 4N.01 through 4N.03

Standard:

Emergency-vehicle hybrid beacons shall be used only in conjunction with signs to warn and control traffic at an unsignalized location where emergency vehicles enter or cross a street or highway. Emergency-vehicle hybrid beacons shall be actuated only by authorized emergency or maintenance personnel.

Guidance:

Emergency-vehicle hybrid beacons should only be used when all of the following criteria are satisfied:

- A. The conditions justifying an emergency-vehicle traffic control signal (see Section 4G.01) are met; and
- B. An engineering study, considering the road width, approach speeds, and other pertinent factors, determines that emergency-vehicle hybrid beacons can be designed and located in compliance with the requirements contained in this Section and in Section 4L.01, such that they effectively warn and control traffic at the location; and
- C. The location is not at or within 100 feet from an intersection or driveway where the side road or driveway is controlled by a STOP or YIELD sign.

Section 4N.02 Design of Emergency-Vehicle Hybrid Beacons

Standard:

Except as otherwise provided in this Section, an emergency-vehicle hybrid beacon shall meet the requirements of this Manual.

An emergency-vehicle hybrid beacon face shall consist of three signal sections, with a CIRCULAR YELLOW signal indication centered below two horizontally aligned CIRCULAR RED signal indications (see Figure 4G-1).

At least two emergency-vehicle hybrid beacon faces shall be installed for each approach of the major street ~~and a stop line shall be installed for each approach of the major street.~~

Guidance:

On approaches having posted or statutory speed limits or 85th-percentile speeds in excess of 40 mph, and on approaches having traffic or operating conditions that would tend to obscure visibility of roadside beacon faces, both of the minimum of two emergency-vehicle hybrid beacon faces should be installed over the roadway.

On multi-lane approaches having posted or statutory speed limits or 85th-percentile speeds of 40 mph or less, either an emergency-vehicle hybrid beacon face should be installed on each side of the approach (if a median of sufficient width exists) or at least one of the emergency-vehicle hybrid beacon faces should be installed over the roadway.

An emergency-vehicle hybrid beacon should comply with the signal face location provisions described in Sections 4D.11 through 4D.16.

Standard:

Stop lines and EMERGENCY SIGNAL—STOP ON FLASHING RED (R10-14 or R10-14a) signs (see Figure 2B-27) shall be used with emergency-vehicle hybrid beacons for each approach of the major street.

Option:

If needed for extra emphasis, a STOP HERE ON FLASHING RED (R10-14b) sign (see Figure 2B-27) may be installed with an emergency-vehicle hybrid beacon.

Emergency-vehicle hybrid beacons may be equipped with a light or other display visible to the operator of the egressing emergency vehicle to provide confirmation that the beacons are operating.

Emergency-vehicle hybrid beacons may be supplemented with an advance warning sign, which may also be supplemented with a Warning Beacon (see Section 4L.03).

Guidance:

1 *If a Warning Beacon is used to supplement the advance warning sign, it should be programmed to flash*
2 *only when the emergency-vehicle hybrid beacon is not in the dark mode.*

3 Section 4N.03 Operation of Emergency-Vehicle Hybrid Beacons

4 **Standard:**

5 Emergency-vehicle hybrid beacons shall be placed in a dark mode (no indications displayed) during
6 periods between actuations.

7 Upon actuation by authorized emergency personnel, the emergency-vehicle hybrid beacon faces
8 shall each display a flashing yellow signal indication, followed by a steady yellow change interval, prior
9 to displaying two CIRCULAR RED signal indications in an alternating flashing array for a duration of
10 time adequate for egress of the emergency vehicles. The alternating flashing red signal indications shall
11 only be displayed when it is required that drivers on the major street stop and then proceed subject to
12 the rules applicable after making a stop at a STOP sign. Upon termination of the flashing red signal
13 indications, the emergency-vehicle hybrid beacons shall revert to a dark mode (no indications
14 displayed) condition.

15 *Guidance:*

16 *The duration of the flashing yellow interval should be determined by engineering judgment.*

17 **Standard:**

18 The duration of the steady yellow change interval shall be determined using engineering practices in
19 accordance with the provisions in Section 4D.26.

20 *Guidance:*

21 Except as provided in Paragraphs 5 and 6 of Section 4D.26, the yellow change interval should have a
22 minimum duration of 3 seconds. A yellow change interval should have ~~and~~ a maximum duration of 6
23 seconds ~~(see Section 4D.26)~~. The longer intervals should be reserved for use on approaches with higher
24 speeds.

25 **Option:**

26 A steady red clearance interval may be used after the steady yellow change interval.

CHAPTER ~~4H.01~~4O. TRAFFIC CONTROL SIGNALS FOR ONE-LANE, TWO-WAY FACILITIES

Section ~~4H.01~~4O.01 Application of Traffic Control Signals for One-Lane, Two-Way Facilities

Support:

A traffic control signal at a narrow bridge, tunnel, or roadway section is a special signal that ~~assigns the right-of-way for~~ alternates which direction of vehicles passing over a bridge or through a tunnel or roadway section that is not of sufficient width for two opposing vehicles to pass is directed to stop and which direction is permitted to proceed.

Temporary traffic control signals (see Sections 4D.32 and 6F.84) are the most frequent application of one-lane, two-way facilities.

Guidance:

Sight distance across or through the one-lane, two-way facility should be considered as well as the approach speed and sight distance approaching the facility when determining whether traffic control signals should be installed.

Option:

At a narrow bridge, tunnel, or roadway section where a traffic control signal is not justified under the conditions of Chapter 4C, a traffic control signal may be used if gaps in opposing traffic do not permit the flow of traffic through the one-lane section of roadway.

Section ~~4H.02~~4O.02 Design of Traffic Control Signals for One-Lane, Two-Way Facilities

Standard:

The provisions of Chapter 4D shall apply to traffic control signals for one-lane, two-way facilities, except that:

- A. Durations of red clearance intervals shall be adequate to clear the one-lane section of conflicting vehicles.
- B. Adequate means, such as interconnection, shall be provided to prevent conflicting signal indications, such as green and green, at opposite ends of the section.

Section ~~4H.03~~4O.03 Operation of Traffic Control Signals for One-Lane, Two-Way Facilities

~~Standard~~ Guidance:

Traffic control signals at one-lane, two-way facilities ~~shall~~ should operate in a manner consistent with traffic requirements.

Standard:

When in the flashing mode, the signal indications shall flash red.

Guidance:

Adequate time should be provided to allow traffic to clear the narrow facility before opposing traffic is allowed to move. Engineering judgment should be used to determine the proper timing for the signal.

CHAPTER ~~4I.01~~4P.01.TRAFFIC CONTROL SIGNALS FOR FREEWAY ENTRANCE RAMP

Section ~~4I.01~~4P.01Application of Freeway Entrance Ramp Control Signals

Support:

Ramp control signals are traffic control signals that control the flow of traffic entering the freeway facility. This is often referred to as “ramp metering.”

Freeway entrance ramp control signals are sometimes used if controlling traffic entering the freeway could reduce the total expected delay to traffic in the freeway corridor, including freeway ramps and local streets.

Guidance:

The installation of ramp control signals should be preceded by an engineering study of the physical and traffic conditions on the highway facilities likely to be affected. The study should include the ramps and ramp connections and the surface streets that would be affected by the ramp control, as well as the freeway section concerned.

Support:

Information on conditions that might justify freeway entrance ramp control signals, factors to be evaluated in traffic engineering studies for ramp control signals, design of ramp control signals, and operation of ramp control signals can be found in the FHWA’s “Ramp Management and Control Handbook” (see Section 1A.11).

Section ~~4I.02~~4P.02Design of Freeway Entrance Ramp Control Signals

The sequence of paragraphs in this section has been revised

Standard:

Ramp control signals shall meet all of the standard design specifications for traffic control signals, except as otherwise provided in this Section.

The signal face for freeway entrance ramp control signals shall be either a two-section signal face containing red and green signal indications or a three-section signal face containing red, yellow, and green signal indications.

Option:

Ramp control signals may be placed in the dark mode (no indications displayed) when not in use.

Ramp control signals may be used to control some, but not all, lanes on a ramp, such as when non-metered HOV bypass lanes are provided on a ramp.

Standard:

If only one controlled lane is present on an entrance ramp, or if more than one controlled lane is present on an entrance ramp and the ramp control signals are operated such that green signal indications are always displayed simultaneously to all of the controlled lanes on the ramp, then a minimum of two signal faces per ramp shall face entering traffic.

If ~~more than one lane is~~ two controlled lanes are present on an entrance ramp and the ramp control signals are operated such that green signal indications are not always displayed simultaneously to ~~all both~~ of the controlled lanes on the ramp, then at least one signal face shall be provided ~~over the approximate center of~~ for each separately-controlled lane.

If three or more controlled lanes are present on an entrance ramp and the ramp control signals are operated such that green signal indications are not always displayed simultaneously to all of the controlled lanes on the ramp, then one signal face shall be provided over the approximate center of each separately-controlled lane.

Guidance:

Additional side-mounted signal faces should be considered for ramps with two or more separately-controlled lanes.

Option:

~~The required signal faces, if located at the side of the ramp roadway, may be mounted such that the height above the pavement grade at the center of the ramp roadway to the bottom of the signal housing of the lowest signal face is between 4.5 and 6 feet.~~ **This paragraph was incorporated into the next paragraph**

For entrance ramps with only one controlled lane, the two required signal faces may both be mounted at the side of the roadway on a single pole (as a specific exception to the normal 8-foot minimum lateral separation of signal faces required by Section 4D.13), with ~~one face at the normal mounting height and one the lower signal face mounted lower as provided in Paragraph 9~~ installed at a minimum mounting height of 4.5 feet, ~~as a specific exception to the normal 8-foot minimum lateral separation of signal faces required by Section 4D.13.~~

For entrance ramps with two or more controlled lanes, if two signal faces are installed for the right-hand lane or for the left-hand lane, the two signal faces for that lane may both be mounted at the closest side of the roadway on a single pole (as a specific exception to the normal 8-foot minimum lateral separation of signal faces required by Section 4D.13), with the lower signal face installed at a minimum mounting height of 4.5 feet.

Guidance:

Ramp control signals ~~shall~~ should be located and designed to minimize their viewing by mainline freeway traffic.

Regulatory signs with legends appropriate to the control, such as XX VEHICLE(S) PER GREEN or XX VEHICLE(S) PER GREEN EACH LANE (see Section 2B.56), should be installed adjacent to the ramp control signal faces.

When ramp control signals are installed on a freeway-to-freeway ramp, special consideration should be given to assuring adequate visibility of the ramp control signals, and multiple advance warning signs with flashing warning beacons should be installed to warn road users of the metered operation. **This paragraph was separated from the previous paragraph**

Section ~~4L.03~~ 4P.03 Operation of Freeway Entrance Ramp Control Signals

Guidance:

Operational strategies for ramp control signals, such as periods of operation, metering rates and algorithms, and queue management, should be determined by the operating agency prior to the installation of the ramp control signals and should be closely monitored and adjusted as needed thereafter.

When the ramp control signals are operated only during certain periods of the day, a RAMP METERED WHEN FLASHING (W3-8) sign (see Section 2C.37) should be installed in advance of the ramp control signal near the entrance to the ramp, or on the arterial on the approach to the ramp, to alert road users to the presence and operation of ramp meters.

Standard:

The RAMP METERED WHEN FLASHING sign shall be supplemented with a warning beacon (see Section 4L.03) that flashes when the ramp control signal is in operation.

A three-section freeway entrance ramp signal face containing red, yellow, and green signal indications shall not be operated in a manner that displays only the red and green signal indications and that omits the display of the yellow signal indication. If the signal faces for a freeway entrance ramp control signal are three-section signal faces containing red, yellow, and green signal indications, a steady yellow signal indication shall be displayed following a green signal indication in the same signal face.

CHAPTER ~~4J~~4Q.TRAFFIC CONTROL FOR MOVABLE BRIDGES

Section ~~4J.01~~4Q.01Application of Traffic Control for Movable Bridges

Support:

Traffic control signals for movable bridges are a special type of highway traffic signal installed at movable bridges to notify road users to stop because of a road closure rather than alternately ~~giving the right of way to~~controlling the flow of conflicting traffic movements. The signals are operated in coordination with the opening and closing of the movable bridge, and with the operation of movable bridge warning and resistance gates, or other devices and features used to warn, control, and stop traffic.

Movable bridge warning gates installed at movable bridges decrease the likelihood of vehicles and pedestrians passing the stop line and entering an area where potential hazards exist because of bridge operations.

A movable bridge resistance gate is sometimes used at movable bridges and located downstream of the movable bridge warning gate. A movable bridge resistance gate provides a physical deterrent to road users when placed in the appropriate position. The movable bridge resistance gates are considered a design feature and not a traffic control device; requirements for them are contained in AASHTO's "Standard Specifications for Movable Highway Bridges" (see Page i for AASHTO's address).

Standard:

Traffic control at movable bridges shall include both signals and gates, except in the following cases:

- A. Neither is required if other traffic control devices or measures considered appropriate are used under either of the following conditions:**
 - 1. On low-volume roads (roads of less than 400 vehicles average daily traffic), or**
 - 2. At manually operated bridges if electric power is not available.**
- B. Only signals are required in urban areas if intersecting streets or driveways make gates ineffective.**
- C. Only movable bridge warning gates are required if a traffic control signal that is controlled as part of the bridge operations exists within 500 feet of the movable bridge resistance gates and no intervening traffic entrances exist.**

Section ~~4J.02~~4Q.02Design and Location of Movable Bridge Signals and Gates

Standard:

The signal faces and mountings of movable bridge signals shall comply with the provisions of Chapter 4D except as provided in this Section.

Signal faces with 12-inch diameter signal indications shall be used for all new movable bridge signals.

Option:

Existing signal faces with 8-inch diameter lenses may be retained for the remainder of their useful service life.

Standard:

Since movable bridge operations cover a variable range of time periods between openings, the signal faces shall be one of the following types:

- A. Three-section signal faces with red, yellow, and green signal indications; or**
- B. Two one-section signal faces with red signal indications in a vertical array separated by a STOP HERE ON RED (R10-6) sign (see Section 2B.53).**

Regardless of which signal type is selected, at least two signal faces shall be provided for each approach to the movable span and a stop line (see Section 3B.16) shall be installed to indicate the point behind which vehicles are required to stop.

Guidance:

If movable bridge operation is frequent, the use of three-section signal faces should be considered.

1 Insofar as practical, the height and lateral placement of signal faces should comply with the requirements
2 for other traffic control signals in accordance with Chapter 4D. They should be located no more than 50 feet
3 in advance of the movable bridge warning gate.

4 Option:

5 Movable bridge signals may be supplemented with audible warning devices to provide additional warning
6 to drivers and pedestrians.

7 ~~Standard~~ Guidance:

8 A DRAWBRIDGE (W3-6) sign (see Section 2C.39) ~~shall~~ should be used in advance of movable bridge
9 signals and gates to give warning to road users, except in urban conditions where such signing would not be
10 practical.

11 Standard:

12 If physical conditions prevent a road user from having a continuous view of at least two signal
13 indications for the distance specified in Table 4D-2, an auxiliary device (either a supplemental signal
14 face or the mandatory DRAW BRIDGE (W3-6) sign to which has been added a warning beacon that is
15 interconnected with the movable bridge controller unit) shall be provided in advance of movable bridge
16 signals and gates.

17 Option:

18 The DRAWBRIDGE(W3-6) sign may be supplemented by a Warning Beacon (see Section 4L.03).

19 ~~Standard~~ Support:

20 If two sets of gates (both a warning and a resistance gate) are used for a single direction, highway traffic
21 signals ~~shall~~ are not ~~be~~ required to accompany the resistance gate nearest the span opening.

22 Standard:

23 Movable bridge warning gates, if used, shall be at least standard railroad size, striped with 16-inch
24 alternate vertical, fully reflectorized red and white stripes. Flashing red lights in accordance with the
25 Standards for those on railroad gates (see Section 8C.04) shall be included on the gate arm and they
26 shall only be operated if the gate is closed or in the process of being opened or closed.

27 Guidance:

28 In the horizontal position, the top of the gate ~~shall~~ should be approximately 4 feet above the pavement.

29 ~~Guidance~~:

30 Movable bridge warning gates should be of lightweight construction. In its normal upright position, the
31 gate arm should provide adequate lateral clearance.

32 Option:

33 The movable bridge resistance gates may be delineated, if practical, in a manner similar to the movable
34 bridge warning gate.

35 ~~Standard~~ Guidance:

36 Movable bridge warning gates, if used, ~~shall~~ should extend at least across the full width of the approach
37 lanes if movable bridge resistance gates are used. On divided highways in which the roadways are separated
38 by a barrier median, movable bridge warning gates, if used, ~~shall~~ should extend across all roadway lanes
39 approaching the span openings.

40 ~~Guidance~~:

41 If movable bridge resistance gates are not used on undivided highways, movable bridge warning gates, if
42 used, should extend across the full width of the roadway.

43 Option:

44 A single full-width gate or two half-width gates may be used.

45 Support:

46 The locations of movable bridge signals and gates are determined by the location of the movable bridge
47 resistance gate (if used) rather than by the location of the movable spans. The movable bridge resistance gates
48 for high-speed highways are preferably located 50 feet or more from the span opening except for bascule and
49 lift bridges, where they are often attached to, or are a part of, the structure.

1 ~~Standard~~Guidance:

2 Except where physical conditions make it impractical, movable bridge warning gates ~~shall~~should be
3 located 100 feet or more from the movable bridge resistance gates or, if movable bridge resistance gates are
4 not used, 100 feet or more from the movable span.

5 ~~Guidance~~:

6 On bridges or causeways that cross a long reach of water and that might be hit by large marine vessels,
7 within the limits of practicality, traffic should not be halted on a section of the bridge or causeway that is
8 subject to impact.

9 In cases where it is not practical to halt traffic on a span that is not subject to impact, traffic should be
10 halted at least one span from the opening. If traffic is halted by signals and gates more than 330 feet from the
11 movable bridge warning gates (or from the span opening if movable bridge warning gates are not used), a
12 second set of gates should be installed approximately 100 feet from the gate or span opening.

13 If the movable bridge is close to a grade crossing and traffic might possibly be stopped on the crossing as
14 a result of the bridge opening, a traffic control device should notify the road users to not stop on the railroad
15 tracks.

16 **Section ~~4J.03~~4Q.03 Operation of Movable Bridge Signals and Gates**

17 **Standard:**

18 Traffic control devices at movable bridges shall be coordinated with the movable spans, so that the
19 signals, gates, and movable spans are controlled by the bridge tender through an interlocked control.

20 If the three-section type of signal face is used, the green signal indication shall be displayed at all
21 times between bridge openings, except that if the bridge is not expected to open during continuous
22 periods in excess of 5 hours, a flashing yellow signal indication shall be permitted to be used. The signal
23 shall display a steady red signal indication when traffic is required to stop. The duration of the yellow
24 change interval between the display of the green and steady red signal indications, or flashing yellow
25 and steady red signal indications, shall be determined using engineering practices (see Section 4D.26).

26 If the vertical array of red signal indications is the type of signal face selected, the red signal
27 indications shall flash alternately only when traffic is required to stop.

28 *Guidance:*

29 The yellow change interval should have a minimum duration of 3 seconds and a maximum duration of 6
30 seconds. The longer intervals should be reserved for use on approaches with higher speeds.

31 Traffic control signals on adjacent streets and highways should be interconnected with the drawbridge
32 control if indicated by engineering judgment. When such interconnection is provided, the traffic control
33 signals at adjacent intersections should be preempted by the operation of the movable bridge in the manner
34 described in Section 4D.27.

CHAPTER ~~4K~~4R. HIGHWAY TRAFFIC SIGNALS AT TOLL PLAZAS

Section ~~4K.01~~4R.01 Traffic Signals at Toll Plazas

Standard:

Traffic control signals or devices that closely resemble traffic control signals that use red or green circular indications shall not be used at toll plazas to indicate the open or closed status of the toll plaza lanes.

Guidance:

Traffic control signals or devices that closely resemble traffic control signals that use red or green circular indications should not be used for new or reconstructed installations at toll plazas to indicate the success or failure of electronic toll payments or to alternately direct drivers making cash toll payments to stop and then proceed.

Section ~~4K.02~~4R.02 Lane-Use Control Signals at or Near Toll Plazas

If Chapter 4M is relocated to Part 2, then this section would also be relocated to Part 2.

Standard:

Lane-use control signals used at toll plazas shall comply with the provisions of Chapter 4M except as otherwise provided in this Section.

At toll plazas with multiple lanes where one or more lanes is sometimes closed to traffic, a lane-use control signal shall be installed above the center of each toll plaza lane to indicate the open or closed status of the controlled lane.

Option:

The bottom of the signal housing of a lane-use control signal above a toll plaza lane having a canopy may be mounted lower than 15 feet above the pavement, but not lower than the vertical clearance of the canopy structure.

Lane-use control signals may also be used to indicate the open or closed status of an Open-Road ETC lane as a supplement to other devices used for the temporary closure of a lane (see Part 6).

Section ~~4K.03~~4R.03 Warning Beacons at Toll Plazas

Standard:

Warning Beacons used at toll plazas shall comply with the provisions of Chapter 4L except as otherwise provided in this Section.

Guidance:

Warning Beacons, if used with a toll plaza canopy sign (see Section 2F.16) to assist drivers of such vehicles in locating the dedicated ETC Account-Only lane(s), should be installed in a manner such that the beacons are distinctly separate from the lane-use control signals (see Section 4M.01) for the toll plaza lane.

Option:

Warning Beacons that are mounted on toll plaza islands, behind impact attenuators in front of toll plaza islands, and/or on toll booth pylons (ramparts) to identify them as objects in the roadway may be mounted at a height that is appropriate for viewing in a toll plaza context, even if that height is lower than the normal minimum of 8 feet above the pavement.

CHAPTER ~~4L~~4S.FLASHING BEACONS

Section ~~4L.01~~4S.01General Design and Operation of Flashing Beacons

Support:

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 (see Section 4L.02) or it can provide warning when used in other applications (see Sections 4L.03, 4L.04, and 4L.05).

Standard:

Flashing Beacon units and their mountings shall comply with the provisions of Chapter 4D, except as otherwise provided in this Chapter.

Beacons shall be flashed at a rate of not less than 50 or more than 60 times per minute. The illuminated period of each flash shall be a minimum of 1/2 and a maximum of 2/3 of the total cycle.

A beacon shall not be included within the border of a sign except for Interchange Exit Direction signs with advisory speed panels (see Figure 2E-27) ~~School Speed Limit Sign Beacons (see Sections 4L.04 and 7B.15).~~

There shall be two nominal diameter sizes for flashing beacon signal indications: 8 inches and 12 inches.

Guidance:

If used to supplement a warning or regulatory sign, the edge of the beacon signal housing should normally be located no closer than 12 inches outside of the nearest edge of the sign or from the nearest edge of any of the signs and plaques in a sign assembly.

Option:

An automatic dimming device may be used to reduce the brilliance of flashing yellow signal indications during night operation.

Section ~~4L.02~~4S.02Intersection Control Beacon

Standard:

An Intersection Control Beacon shall consist of one or more signal faces directed toward each approach to an intersection. Each signal face shall consist of one or more signal sections of a standard traffic signal face, with flashing CIRCULAR YELLOW or CIRCULAR RED signal indications in each signal face. They shall be installed and used only at an intersection to control two or more directions of travel.

Application of Intersection Control Beacon signal indications shall be limited to the following:

- A. Yellow on one route (normally the major street) and red for the remaining approaches, and
- B. Red for all approaches (if ~~the warrant described in Section 2B.07 for~~ **(37)** exists ~~is satisfied~~ **(37)**).

Flashing yellow signal indications shall not face conflicting vehicular approaches.

A STOP sign shall be used on approaches to which a flashing red signal indication is displayed on an Intersection Control Beacon (see Section 2B.04).

If two horizontally aligned red signal indications are used on an approach for an Intersection Control Beacon, they shall be flashed simultaneously to avoid being confused with grade crossing flashing-light signals. If two vertically aligned red signal indications are used on an approach for an Intersection Control Beacon, they shall be flashed alternately.

Twelve-inch signal indications shall be used for Intersection Control Beacons facing approaches where:

- A. Road users view both flashing beacon and lane-use control signal indications simultaneously; or
- B. The nearest flashing beacon signal face is more than 120 feet beyond the stop line, unless a supplemental near-side flashing beacon signal face is provided.

Guidance:

Twelve-inch signal indications should be used for Intersection Control Beacons facing approaches where:

- 1 A. The posted or statutory speed limit or the 85th-percentile approach speed is higher than 40 mph; or
2 B. Where only post-mounted flashing beacon signal faces are used.

3 *An Intersection Control Beacon should not be mounted on a pedestal in the roadway unless the pedestal is*
4 *within the confines of a traffic or pedestrian island.*

5 Option:

6 Supplemental signal indications may be used on one or more approaches in order to provide adequate
7 visibility to approaching road users.

8 Intersection Control Beacons may be used at intersections where traffic or physical conditions do not
9 justify conventional traffic control signals but crash rates indicate the possibility of a special need.

10 An Intersection Control Beacon is generally located over the center of an intersection; however, it may be
11 used at other suitable locations.

12 **Section ~~4L.03~~ 4S.03 Warning Beacon**

13 Support:

14 Typical applications of Warning Beacons include the following:

- 15 A. ~~As supplemental emphasis to signs or object markers on or in front of~~ obstructions that are in or
16 immediately adjacent to the roadway;
17 B. As supplemental emphasis to warning signs;
18 C. As emphasis for midblock crosswalks;
19 D. As supplemental emphasis to regulatory signs, except STOP, DO NOT ENTER, WRONG WAY, and
20 SPEED LIMIT signs; and
21 E. In conjunction with a regulatory or warning sign that includes the phrase WHEN FLASHING in its
22 legend to indicate that the regulation is in effect or that the condition is present only at certain times.

23 **Standard:**

24 **A Warning Beacon shall consist of one or more signal sections of a standard traffic signal face with**
25 **a flashing CIRCULAR YELLOW signal indication in each signal section.**

26 **A Warning Beacon shall be used only to supplement an appropriate warning or regulatory sign or**
27 **marker.**

28 **Warning Beacons, if used at intersections, shall not face conflicting vehicular approaches.**

29 ~~If a Warning Beacon is suspended over the roadway, the clearance above the pavement shall be a~~
30 ~~minimum of 15 feet and a maximum of 19 feet.~~ **Not needed because this is covered in Paragraph 2 in**
31 **Section 4L.01**

32 *Guidance:*

33 *The condition or regulation justifying Warning Beacons should largely govern their location with respect*
34 *to the roadway.*

35 *If an obstruction is in or adjacent to the roadway, illumination of the lower portion or the beginning of the*
36 *obstruction or illumination of ~~the~~ sign on or in front of the obstruction, in addition to the beacon, should be*
37 *considered.*

38 *Warning Beacons should be operated only during those periods or times when the condition or regulation*
39 *exists.*

40 Option:

41 Warning Beacons that are actuated by pedestrians, bicyclists, or other road users may be used as
42 appropriate to provide additional warning to vehicles approaching a crossing or other location.

43 If Warning Beacons have more than one signal section, they may be flashed either alternately or
44 simultaneously.

45 **Standard: (38)**

46 An audible information device used in conjunction with a pedestrian actuated warning beacon
47 supplementing a sign installed at a pedestrian crossing, including an S1-1 School Zone sign, shall not
48 use vibrotactile indications or percussive indications. (38)

49 Guidance: (38)

If an audible information device is used in conjunction with a pedestrian actuated warning beacon supplementing a sign installed at a pedestrian crossing, including an S1-1 School Zone sign, the audible message should be a speech message that says, "Yellow lights are flashing" The audible message should be spoken twice. (38)

Option: (38)

A flashing yellow beacon interconnected with a traffic signal controller assembly may be used with a traffic signal warning sign (see Section 2C.36).

Section ~~4L.04~~4S.04 Speed Limit Sign Beacon

Standard:

A Speed Limit Sign Beacon shall be used only to supplement a Speed Limit sign.

A Speed Limit Sign Beacon shall consist of one or more signal sections of a standard traffic control signal face, with a flashing CIRCULAR YELLOW signal indication in each signal section. ~~The signal indications shall have a nominal diameter of not less than 8 inches.~~ If two signal indications are used, they shall be vertically aligned, except that they shall be permitted to be horizontally aligned if the Speed Limit (R2-1) sign is longer horizontally than vertically. If two signal indications are used, they shall be alternately flashed.

Option:

A Speed Limit Sign Beacon may be used with a fixed or variable Speed Limit sign. If applicable, a flashing Speed Limit Sign Beacon (with an appropriate accompanying sign) may be used to indicate that the displayed speed limit is in effect.

~~A Speed Limit Sign Beacon may be included within the border of a School Speed Limit (S5-1) sign (see Section 7B.15).~~

Section ~~4L.05~~4S.05 Stop Beacon

Standard:

A Stop Beacon shall be used only to supplement a STOP sign, a DO NOT ENTER sign, or a WRONG WAY sign.

A Stop Beacon shall consist of one or more signal sections of a standard traffic signal face with a flashing CIRCULAR RED signal indication in each signal section. If two horizontally aligned signal indications are used for a Stop Beacon, they shall be flashed simultaneously to avoid being confused with grade crossing flashing-light signals. If two vertically aligned signal indications are used for a Stop Beacon, they shall be flashed alternately.

Guidance:

The bottom of the signal housing of a Stop Beacon ~~shall~~ should be not less than 12 inches or more than 24 inches above the top of a STOP sign, a DO NOT ENTER sign, or a WRONG WAY sign.

CHAPTER ~~4M.01~~4T. LANE-USE CONTROL SIGNALS

Consideration is being given to relocating this chapter to Part 2 because these devices are similar to changeable message signs, and are not similar to any other type of highway traffic signal. If this chapter is relocated to Part 2, these devices would be called “Changeable Lane-Use Control Signs”. The NCUTCD recommends that this Chapter remain in Part 4.(39)

Section ~~4M.01~~4T.01 Application of Lane-Use Control Signals

Support:

Lane-use control signals are special overhead signals that permit or prohibit the use of specific lanes of a street or highway or that indicate the impending prohibition of their use. Lane-use control signals are distinguished by placement of special signal faces over a certain lane or lanes of the roadway and by their distinctive shapes and symbols. Supplementary signs are sometimes used to explain their meaning and intent.

Lane-use control signals are most commonly used for reversible-lane control, but are also used in certain non-reversible lane applications and for toll plaza lanes (see Section 4K.02).

Guidance:

An engineering study should be conducted to determine whether a reversible-lane operation can be controlled satisfactorily by static signs (see Section 2B.26) or whether lane-use control signals are necessary. Lane-use control signals should be used to control reversible-lane operations if any of the following conditions are present:

- A. *More than one lane is reversed in direction;*
- B. *Two-way or one-way left turns are allowed during peak-period reversible operations, but those turns are from a different lane than used during off-peak periods;*
- C. *Other unusual or complex operations are included in the reversible-lane pattern;*
- D. *Demonstrated crash experience occurring with reversible-lane operation controlled by static signs that can be corrected by using lane-use control signals at the times of transition between peak and off-peak patterns; and/or*
- E. *An engineering study indicates that the safety and efficiency of the traffic operations of a reversible-lane system would be improved by lane-use control signals.*

Standard:

Pavement markings (see Section 3B.03) shall be used in conjunction with reversible-lane control signals.

Option:

Lane-use control signals may also be used if there is no intent or need to reverse lanes, but there is a need to indicate the open or closed status of one or more lanes, such as:

- A. On a freeway, if it is desired to close certain lanes at certain hours to facilitate the merging of traffic from a ramp or other freeway;
- B. On a freeway, near its terminus, to indicate a lane that ends;
- C. On a freeway or long bridge, to indicate that a lane may be temporarily blocked by a crash, breakdown, construction or maintenance activities, or similar temporary conditions; and
- D. On a conventional road or driveway, at access or egress points to or from a facility, such as a parking garage, where one or more lanes of the access or egress are opened or closed at various times.

[A USE LANE\(S\) WITH GREEN ARROW \(R10-8\) sign \(see Section 2B.53 and Figure 2B-27\) may be used in conjunction with lane-use control signals.](#)

Section ~~4M.02~~4T.02 Meaning of Lane-Use Control Signal Indications

Standard:

The meanings of lane-use control signal indications shall be as follows:

- A. **A steady DOWNWARD GREEN ARROW signal indication shall mean that a road user is permitted to drive in the lane over which the arrow signal indication is located.**

- B. A steady YELLOW X signal indication shall mean that a road user is to prepare to vacate the lane over which the signal indication is located because a lane control change is being made to a steady RED X signal indication.
- C. A steady WHITE TWO-WAY LEFT-TURN ARROW signal indication (see Figure 4M-1) shall mean that a road user is permitted to use a lane over which the signal indication is located for a left turn, but not for through travel, with the understanding that common use of the lane by oncoming road users for left turns is also permitted.
- D. A steady WHITE ONE WAY LEFT-TURN ARROW signal indication (see Figure 4M-1) shall mean that a road user is permitted to use a lane over which the signal indication is located for a left turn (without opposing turns in the same lane), but not for through travel.
- E. A steady RED X signal indication shall mean that a road user is not permitted to use the lane over which the signal indication is located and that this signal indication shall modify accordingly the meaning of other traffic controls present.

Section ~~4M.03~~ 4T.03 Design of Lane-Use Control Signals

Standard:

All lane-use control signal indications shall be in units with rectangular signal faces and shall have opaque backgrounds. Nominal minimum height and width of each DOWNWARD GREEN ARROW, YELLOW X, and RED X signal face shall be 18 inches for typical applications. The WHITE TWO-WAY LEFT-TURN ARROW and WHITE ONE WAY LEFT-TURN ARROW signal faces shall have a nominal minimum height and width of 30 inches.

Each lane to be reversed or closed shall have signal faces with at least a DOWNWARD GREEN ARROW and a RED X symbol.

Each reversible lane that also operates as a two-way or one-way left-turn lane during certain periods shall have signal faces that also include the applicable WHITE TWO-WAY LEFT-TURN ARROW or WHITE ONE WAY LEFT-TURN ARROW symbol.

Each non-reversible lane immediately adjacent to a reversible lane shall have signal indications that display a DOWNWARD GREEN ARROW to traffic traveling in the permitted direction and a RED X to traffic traveling in the opposite direction.

If in separate signal sections, the relative positions, from left to right, of the signal indications shall be RED X, YELLOW X, DOWNWARD GREEN ARROW, WHITE TWO-WAY LEFT-TURN ARROW, WHITE ONE WAY LEFT-TURN ARROW.

Guidance:

The color of lane-use control signal indications ~~shall~~ should be clearly visible for 2,300 feet at all times under normal atmospheric conditions, unless otherwise physically obstructed.

Lane-use control signal faces ~~shall~~ should be located approximately over the center of the lane controlled.

If the area to be controlled is more than 2,300 feet in length, or if the vertical or horizontal alignment is curved, intermediate lane-use control signal faces ~~shall~~ should be located over each controlled lane at frequent intervals. This location ~~shall~~ should be such that road users will at all times be able to see at least one signal indication and preferably two along the roadway, and will have a definite indication of the lanes specifically reserved for their use.

All lane-use control signal faces ~~shall~~ should be located in a straight line across the roadway approximately at right angles to the roadway alignment.

On roadways having intersections controlled by traffic control signals, the lane-use control signal face ~~shall~~ should be located sufficiently far in advance of or beyond such traffic control signals to prevent them from being misconstrued as traffic control signals.

Standard:

Except as provided in Paragraph 12, the bottom of the signal housing of any lane-use control signal face shall be a minimum of 15 feet and a maximum of 19 feet above the pavement grade.

Option:

The bottom of a lane-use control signal housing may be lower than 15 feet above the pavement if it is mounted on a canopy or other structure over the pavement, but not lower than the vertical clearance of the structure.

Except for lane-use control signals at toll plazas (see Section 4K.02), in areas with minimal visual clutter and with speeds of less than 40 mph, lane-use control signal faces with nominal height and width of 12 inches may be used for the DOWNWARD GREEN ARROW, YELLOW X, and RED X signal faces, and lane-use control signal faces with nominal height and width of 18 inches may be used for the WHITE TWO-WAY LEFT-TURN ARROW and WHITE ONE-WAY LEFT-TURN ARROW signal faces.

Other sizes of lane-use control signal faces larger than 18 inches with message recognition distances appropriate to signal spacing may be used for the DOWNWARD GREEN ARROW, YELLOW X, and RED X signal faces.

Non-reversible lanes not immediately adjacent to a reversible lane on any street so controlled may also be provided with signal indications that display a DOWNWARD GREEN ARROW to traffic traveling in the permitted direction and a RED X to traffic traveling in the opposite direction.

The signal indications provided for each lane may be in separate signal sections or may be superimposed in the same signal section.

Section ~~4M.04~~ 4T.04 Operation of Lane-Use Control Signals

Standard:

All lane-use control signals shall be coordinated so that all the signal indications along the controlled section of roadway are operated uniformly and consistently. The lane-use control signal system shall be designed to reliably guard against showing any prohibited combination of signal indications to any traffic at any point in the controlled lanes.

For reversible-lane control signals, the following combination of signal indications shall not be simultaneously displayed over the same lane to both directions of travel:

- A. DOWNWARD GREEN ARROW in both directions,
- B. YELLOW X in both directions,
- C. WHITE ONE WAY LEFT-TURN ARROW in both directions,
- D. DOWNWARD GREEN ARROW in one direction and YELLOW X in the other direction,
- E. WHITE TWO-WAY LEFT-TURN ARROW or WHITE ONE WAY LEFT-TURN ARROW in one direction and DOWNWARD GREEN ARROW in the other direction,
- F. WHITE TWO-WAY LEFT-TURN ARROW in one direction and WHITE ONE WAY LEFT-TURN ARROW in the other direction, and
- G. WHITE ONE WAY LEFT-TURN ARROW in one direction and YELLOW X in the other direction.

A moving condition in one direction shall be terminated either by the immediate display of a RED X signal indication or by a YELLOW X signal indication followed by a RED X signal indication.

Guidance:

In either case, the duration of the RED X signal indication ~~shall~~ should be sufficient to allow clearance of the lane before any moving condition is allowed in the opposing direction.

Standard:

Whenever a DOWNWARD GREEN ARROW signal indication is changed to a WHITE TWO-WAY LEFT-TURN ARROW signal indication, the RED X signal indication shall continue to be displayed to the opposite direction of travel for an appropriate duration to allow traffic time to vacate the lane being converted to a two-way left-turn lane.

If an automatic control system is used, a manual control to override the automatic control shall be provided.

Guidance:

The type of control provided for reversible-lane operation should be such as to permit either automatic or manual operation of the lane-use control signals.

Standard:

1 **If used, lane-use control signals shall be operated continuously, except that lane-use control signals**
2 **that are used only for special events or other infrequent occurrences and lane-use control signals on**
3 **non-reversible freeway lanes ~~shall be~~are permitted to be darkened when not in operation. The change**
4 **from normal operation to non-operation shall occur only when the lane-use control signals display**
5 **signal indications that are appropriate for the lane use that applies when the signals are not operated.**
6 **The lane-use control signals shall display signal indications that are appropriate for the existing lane**
7 **use when changed from non-operation to normal operations. Also, traffic control devices shall clearly**
8 **indicate the proper lane use when the lane control signals are not in operation.**

9 Support:

10 Section 2B.26 contains additional information concerning considerations involving left-turn prohibitions
11 in conjunction with reversible-lane operations.

CHAPTER ~~4N~~4U. IN-ROADWAY WARNINGLIGHTS

Consideration is being given to relocating this chapter to Part 3 because these devices are similar to internally-illuminated raised pavement markers, and are not similar to any other type of highway traffic signal. These devices function as an enhancement to pavement markings. The NCUTCD recommends that this Chapter remain in Part 4. Although they physically look like illuminated pavement markers, their function is like a warning beacon. (40)

Section ~~4N.01~~4U.01 Application of In-Roadway WarningLights

Support:

In-Roadway WarningLights are special types of highway traffic signals 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. This includes situations warning of marked school crosswalks, marked midblock crosswalks, marked crosswalks on uncontrolled approaches, marked crosswalks in advance of roundabouts as described in Chapter 3C, and other roadway situations involving pedestrian crossings.

Standard:

In-Roadway WarningLights shall not be used for any application that is not described in this Chapter.

When used, In-Roadway WarningLights shall be flashed and shall not be steadily illuminated.

Support:

Steadily illuminated lights installed in the roadway surface are considered to be internally illuminated raised pavement markers (see Section 3B.11).

Option:

In-Roadway WarningLights may be flashed in a manner that includes a continuous flash of varying intensity and time duration that is repeated to provide a flickering effect (see Section 4N.02).

Guidance:

If used, In-Roadway WarningLights ~~shall~~should not exceed a height of 3/4 inch above the roadway surface. **This paragraph was relocated from earlier in this section**

Section ~~4N.02~~4U.02 In-Roadway Warning Lights at Crosswalks

Option:

In-Roadway Warning Lights may be installed at certain marked crosswalks, based on an engineering study or engineering judgment, to provide additional warning to road users.

Standard:

If used, In-Roadway Warning Lights at crosswalks shall be installed only at marked crosswalks with applicable warning signs. They shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic control signals.

If In-Roadway Warning Lights are used at a crosswalk, the following requirements shall apply:

- A. Except as provided in Paragraphs 7 and 8, they shall be installed along both sides of the crosswalk and shall span its entire length.
- B. They shall initiate operation based on pedestrian actuation and shall cease operation at a predetermined time after the pedestrian actuation or, with passive detection, after the pedestrian clears the crosswalk.
- C. They shall display a flashing yellow light when actuated. The flash rate shall be at least 50, but no more than 60, flash periods per minute. If they are flashed in a manner that includes a continuous flash of varying intensity and time duration that is repeated to provide a flickering effect, the flickers or pulseshall not repeat at a rate that is between 5 and 30 per second to avoid frequencies that might cause seizures.
- D. They shall be installed in the area between the outside edge of the crosswalk line and 10 feet from the outside edge of the crosswalk.

E. They shall face away from the crosswalk if unidirectional, or shall face away from and across the crosswalk if bidirectional.

If used on one-lane, one-way roadways, a minimum of two In-Roadway Warning Lights shall be installed on the approach side of the crosswalk. If used on two-lane roadways, a minimum of three In-Roadway Warning Lights shall be installed along both sides of the crosswalk. If used on roadways with more than two lanes, a minimum of one In-Roadway Warning Light per lane shall be installed along both sides of the crosswalk.

Guidance:

If used, In-Roadway Warning Lights should be installed in the center of each travel lane, at the center line of the roadway, at each edge of the roadway or parking lanes, or at other suitable locations away from the normal tire track paths.

The location of the In-Roadway Warning Lights within the lanes should be based on engineering judgment.

Option:

On one-way streets, In-Roadway Warning Lights may be omitted on the departure side of the crosswalk.

Based on engineering judgment, the In-Roadway Warning Lights on the departure side of the crosswalk on the left-hand side of a median may be omitted.

Unidirectional In-Roadway Warning Lights installed at crosswalk locations may have an optional, additional yellow light indication in each unit that is visible to pedestrians in the crosswalk to indicate to pedestrians in the crosswalk that the In-Roadway Warning Lights are in fact flashing as they cross the street. These yellow lights may flash with and at the same flash rate as the light module in which each is installed.

Guidance:

If used, the period of operation of the In-Roadway Warning Lights following each actuation should be sufficient to allow a pedestrian crossing in the crosswalk to leave the curb or shoulder and travel at a walking speed of 3.5 feet per second to at least the far side of the traveled way or to a median of sufficient width for pedestrians to wait. Where pedestrians who walk slower than 3.5 feet per second, or pedestrians who use wheelchairs, routinely use the crosswalk, a walking speed of less than 3.5 feet per second should be considered in determining the period of operation.

Standard:

If pedestrian pushbuttons are used to actuate the In-Roadway **Warning** Lights, a **PUSH BUTTON TO TURN ON WARNING LIGHTS** (with pushbutton symbol)(R10-25) sign (see Figure 2B-26) shall be mounted adjacent to or integral with each pedestrian pushbutton.

Where the period of operation is sufficient only for crossing from a curb or shoulder to a median of sufficient width for pedestrians to wait, median-mounted pedestrian actuators shall be provided.

An audible information device used in conjunction with In-Roadway Warning Lights shall not use vibrotactile indications or percussive indications.(41)

Guidance:(41)

If an audible information device is used in conjunction with In-Roadway Warning Lights, the audible message should be a speech message that says, "Yellow lights are flashing" The audible message should be spoken twice.(41)

If accessible pedestrian signal features (see Section 4E.09) are used in conjunction with In-Roadway Warning Lights, the audible message during the time that the lights are flashing should be a speech message that says, "Flashing yellow lights are on." (41)

Standard:(41)

If accessible pedestrian signal features are used in conjunction with In-Roadway Warning Lights, the vibrotactile indications that are required for walk indications (see Paragraph 2 in Section 4E.11) shall not be used.(41)