PART 4. HIGHWAY TRAFFIC SIGNALS

CHAPTER 4A. GENERAL PAGE

Section 4A.01 Types
Section 4A.02 Definitions Relating to Highway Traffic Signals

CHAPTER 4B. TRAFFIC CONTROL SIGNALS—GENERAL PAGE

Section 4B.01 General
Section 4B.02 Basis of Installation or Removal of Traffic Control Signals
Section 4B.03 Advantages and Disadvantages of Traffic Control Signals
Section 4B.04 Alternatives to Traffic Control Signals
Section 4B.05 Adequate Roadway Capacity

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES PAGE

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals 4-1
Section 4C.02 Warrant 1, Eight Hour Vehicular Volume.....4-5
Section 4C.03 Warrant 2, Four Hour Vehicular Volume
Section 4C.04 Warrant 3, Peak Hour
Section 4C.05 Warrant 4, Pedestrian Volume
Section 4C.06 Warrant 5, School Crossing
Section 4C.07 Warrant 6, Coordinated Signal System
Section 4C.08 Warrant 7, Crash Experience
Section 4C.09 Warrant 8, Roadway Network
Section 4C.10 Warrant 9, Intersection Near a Grade Crossing

CHAPTER 4D. TRAFFIC CONTROL SIGNAL FEATURES PAGE

Section 4D.01 General
Section 4D.02 Responsibility for Operation and Maintenance
Section 4D.03 Provisions for Pedestrians 4-11
Section 4D.04 Meaning of Vehicular Signal Indications 4-11
Section 4D.05 Application of Steady Signal Indications 4-16
Section 4D.06 Signal Indications – Design, Illumination, Color, and Shape
Section 4D.07 Size of Vehicular Signal Indications
Section 4D.08 Positions of Signal Indications Within a Signal Face – General
Section 4D.09 Positions of Signal Indications Within a Vertical Signal Face
Section 4D.10 Positions of Signal Indications Within a Horizontal Signal Face
Section 4D.11 Number of Signal Faces on an Approach

Section 4D.12 Visibility, Aiming, and Shielding of Signal Faces 4-22
Section 4D.13 Lateral Positioning of Signal Faces
Section 4D.14 Longitudinal Positioning of Signal Faces
Section 4D.15 Mounting Height of Signal Faces
Section 4D.16 Lateral Offset (Clearance) of Signal Faces
Section 4D.17 Signal Indications for Left Turn Movements – General
Section 4D.18 Signal Indications for Permissive Only Mode Left Turn Movements 4-25
Section 4D.19 Signal Indications for Protected Only Mode Left Turn Movements 4-28
Section 4D.20 Signal Indications for Protected/Permissive Mode Left Turn Movements
Section 4D.21 Signal Indications for Right Turn Movements – General
Section 4D.22 Signal Indications for Permissive Only Mode Right Turn Movements
Section 4D.23 Signal Indications for Protected Only Mode Right Turn Movements 4-32
Section 4D.24 Signal Indications for Protected/Permissive Mode Right Turn Movements
Section 4D.25 Signal Indications for Approaches With Shared Left Turn/Right Turn Lanes and No Through Movement
Section 4D.26 Yellow Change and Red Clearance Intervals 4-36
Section 4D.27 Preemption and Priority Control of Traffic Control Signals
Section 4D.28 Flashing Operation of Traffic Control Signals – General 4-38
Section 4D.29 Flashing Operation – Transition Into Flashing Mode
Section 4D.30 Flashing Operation – Signal Indications During Flashing Mode
Section 4D.31 Flashing Operation – Transition Out of Flashing Mode
Section 4D.32 Temporary and Portable Traffic Control Signals
Section 4D.33 Lateral Offset of Signal Supports and Cabinets
Section 4D.34 Use of Signs at Signalized Locations
Section 4D.35 Use of Pavement Markings at Signalized Locations
Section 4D.V1 Traffic Control Signal Housing Color 4-39

CHAPTER 4E. PEDESTRIAN CONTROL FEATURES PAGE

Section 4E.01 Pedestrian Signal Heads
Section 4E.02 Meaning of Pedestrian Signal Head Indications
Section 4E.03 Application of Pedestrian Signal Heads
Section 4E.04 Size, Design, and Illumination of Pedestrian Signal Head Indications
Section 4E.05 Location and Height of Pedestrian Signal Heads
Section 4E.06 Pedestrian Intervals and Signal Phases
Section 4E.07 Countdown Pedestrian Signals
Section 4E.08 Pedestrian Detectors
Section 4E.09 Accessible Pedestrian Signals and Detectors – General 4-40
Section 4E.10 Accessible Pedestrian Signals and Detectors – Location

Section 4E.11 Accessible Pedestrian Signals and Detectors – Walk Indications 4-42
Section 4E.12 Accessible Pedestrian Signals and Detectors – Tactile Arrows and Locator Tones 4-45
Section 4E.13 Accessible Pedestrian Signals and Detectors – Extended Pushbutton Press Features

CHAPTER 4F. PEDESTRIAN HYBRID BEACONS PAGE

Section 4F.01 Application of Pedestrian Hybrid Beacons
Section 4F.02 Design of Pedestrian Hybrid Beacons
Section 4F.03 Operation of Pedestrian Hybrid Beacons

CHAPTER 4G. TRAFFIC CONTROL SIGNALS AND HYBRID BEACONS FOR EMERGENCY-VEHICLE ACCESS PAGE

Section 4G.01 Application of Emergency Vehicle Traffic Control Signals and Hybrid Beacons
Section 4G.02 Design of Emergency Vehicle Traffic Control Signals
Section 4G.03 Operation of Emergency Vehicle Traffic Control Signals
Section 4G.04 Emergency Vehicle Hybrid Beacons

CHAPTER 4H. TRAFFIC CONTROL SIGNALS FOR ONE-LANE, TWO-WAY FACILITIES PAGE

Section 4H.01 Application of Traffic Control Signals for One Lane, Two Way Facilities
Section 4H.02 Design of Traffic Control Signals for One Lane, Two Way Facilities
Section 4H.03 Operation of Traffic Control Signals for One Lane, Two Way Facilities

CHAPTER 4I. TRAFFIC CONTROL SIGNALS FOR FREEWAY ENTRANCE RAMPS PAGE

Section 4I.01 Application of Freeway Entrance Ramp Control Signals
Section 4I.02 Design of Freeway Entrance Ramp Control Signals
Section 4I.03 Operation of Freeway Entrance Ramp Control Signals

CHAPTER 4J. TRAFFIC CONTROL FOR MOVABLE BRIDGES PAGE

Section 4J.01 Application of Traffic Control for Movable Bridges
Section 4J.02 Design and Location of Movable Bridge Signals and Gates 4-47
Section 4J.03 Operation of Movable Bridge Signals and Gates

CHAPTER 4K. HIGHWAY TRAFFIC SIGNALS AT TOLL PLAZAS PAGE

Section 4K.01 Traffic Signals at Toll Plazas
Section 4K.02 Lane Use Control Signals at or Near Toll Plazas
Section 4K.03 Warning Beacons at Toll Plazas

CHAPTER 4L. FLASHING BEACONS ..... PAGE

Section 4L.01 General Design and Operation of Flashing Beacons

Section 4L.02 Intersection Control Beacon

Section 4L.03 Warning Beacon

Section 4L.04 Speed Limit Sign Beacon

Section 4L.05 Stop Beacon

CHAPTER 4M. LANE-USE CONTROL SIGNALS PAGE

Section 4M.01 Application of Lane Use Control Signals

Section 4M.02 Meaning of Lane Use Control Signal Indications

Section 4M.03 Design of Lane Use Control Signals

Section 4M.04 Operation of Lane Use Control Signals

CHAPTER 4N. IN-ROADWAY LIGHTS PAGE

Section 4N.01 Application of In Roadway Lights 4-51

Section 4N.02 In Roadway Warning Lights at Crosswalks 4-51

PART 4
HIGHWAY TRAFFIC SIGNALS

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

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

Standard:

01 **An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.**

02 **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**

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

04 **In order for a traffic signal to be justified, evidence of the need for right of way assignment beyond that which could be provided by a stop sign shall be demonstrated. Examples of such a need include: excessive delay, congestion, unfavorable approach conditions, or surrounding conditions that cause driver confusion.**

05 **On any roadway corridor designated by the CTB as a Corridor of Statewide Significance, intersections or new access points which meet warrants for traffic signals shall not have a new traffic signal installed until alternatives such as grade**

separations, parallel service roads, roundabouts, and other possible options have been evaluated and determined not to be appropriate for the location.

Guidance:

06 *Land use planning should also be considered in identifying alternatives to traffic signals along Corridors of Statewide Significance. This could include, but is not limited to, promotion of nodal development patterns in order to minimize strip development and to make the best use of investments in access points.*

Support:

07 The following laws, regulations, and VDOT standards support the above policy statement:

A. The Code of Virginia § 15.2-2222.1: Coordination of state and local transportation planning.
B. The Code of Virginia § 15.2-2223: Comprehensive plan to be prepared and adopted and shall include a scope and purpose.
C. The Code of Virginia § 15.2-2223.1: Comprehensive plan to be prepared and adopted and shall include urban development areas.
D. The Code of Virginia § 33.1-198: Connections over shoulders of highways for intersecting commercial establishment entrances.
E. The Code of Virginia § 33.1-198.1: Comprehensive highway access management standards.
F. The Code of Virginia § 33.1-199: Replacing entrances destroyed by Commissioner.
G. House Joint Resolution 594 of 2003: Encouraging the Department of Transportation to construct more roundabouts instead of signalized intersections.
H. 24 VAC 30-72 Access Management Regulations: Principal Arterials
    1. Section 60: VDOT is not obligated to permit the most convenient access, VDOT may require the applicant to alter the location or design to obtain the best operational characteristics, and any locality standards stricter than VDOT's shall govern.
    2. Section 70: Sites accessed shall be designed to prevent unsafe and inefficient traffic movements from impacting travel on highway. If a proposed entrance will cause a degradation in safety or capacity or an increase in delay, applicant shall submit and fund plan to mitigate impacts, including:
        - Constructing turn lanes,
        - Removing or relocating crossovers,
        - Modification or removal of traffic signals, or
        - Implementing recommendations from adopted corridor studies.
    3. Section 120: Entrances must be designed in accordance with Appendix F of the Road Design Manual. VDOT will determine the improvements needed to preserve the highway. Spacing of entrances and intersections shall comply with spacing standards in Appendix F (exceptions to the standards set out). Traffic

signals are not allowed for entrances if the spacing is below standards. An exception process for the above items is outlined.

I. 24 VAC 30-155 Traffic Impact Analysis Regulations (Chapter 527)
   1. Section 60: Recommendations for improvements contained in a study shall be in accordance with standards contained in the Road Design Manual.

J. Appendix F of Road Design Manual
   1. Section 2: Intersection design and intersection, crossover, and entrance spacing standards. Roundabouts are to be considered when constructing or reconstructing a signalized or an unsignalized intersection. Roundabouts are the preferred alternative if a study shows that they are feasible.
   2. Section 3: Turn lane design and warrants, and median crossover design, including directional median openings.

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

Guidance:

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

10 *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.*

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

12 *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.*

13 *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.*

14 *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.

15 *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.*

16 *For signal warrant analysis, a location with a wide median, even if the median width is greater than 30 feet, should be considered as one intersection.*

Option:

17 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.

18 For signal warrants requiring conditions to be present for a certain number of hours in order to be satisfied, any four sequential 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.

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

Support:

20 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:

21 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, such as elementary schools, playgrounds, hospitals, or nursing homes. This includes 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.

22 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 21:

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:

01 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.

02 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.

03 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:

04 **The need for a traffic control signal shall 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:

05 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:

06 *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:

07 **The need for a traffic control signal shall 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:

08 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.

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

Condition A—Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

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

09 If it is not reasonable or feasible to count actual traffic volumes, such as at a proposed intersection in the preliminary engineering phase and therefore not yet open to traffic, ADT projections may be utilized to satisfy Warrant 1. The ADT values are shown in Table 4C-V1.

Standard:

10 **If used, ADT projections shall be developed utilizing the latest edition of ITE's Trip Generation Manual.**

Table 4C-V1. Traffic Signal Warrant Using Average Daily Traffic Estimate

(To be used only when traffic counts are not available, such as at a future intersection)

Condition A—Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per day on major street (total of both approaches)				Vehicles per day on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	8,000	6,400	5,600	4,480	2,400	1,920	1,680	1,344
2 or more	1	9,600	7,680	6,720	5,376	2,400	1,920	1,680	1,344
2 or more	2 or more	9,600	7,680	6,720	5,376	3,200	2,560	2,240	1,792
1	2 or more	8,000	6,400	5,600	4,480	3,200	2,560	2,240	1,792

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per day on major street (total of both approaches)				Vehicles per day on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	12,000	9,600	8,400	6,720	1,200	960	850	680
2 or more	1	14,400	11,520	10,080	8,064	1,200	960	850	680
2 or more	2 or more	14,400	11,520	10,080	8,064	1,600	1,280	1,120	896
1	2 or more	12,000	9,600	8,400	6,720	1,600	1,280	1,120	896

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

11 **The need for a traffic control signal shall be considered using ADT projections if an engineering study finds that one of the following conditions exist for an average day:**

A. The vehicles per day given in both of the 100 percent columns of Condition A in Table 4C-V1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or

B. The vehicles per day given in both of the 100 percent columns of Condition B in Table 4C-V1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

Option:

12 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-V1 in this Supplement may be used in place of the 100 percent columns.

Guidance:

13 *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:

14 **The need for a traffic control signal shall be considered using ADT projections if an engineering study finds that both of the following conditions exist for an average day:**

A. The vehicles per day given in both of the 80 percent columns of Condition A in Table 4C-V1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and

B. The vehicles per day given in both of the 80 percent columns of Condition B in Table 4C-V1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

Option:

15 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-V1 in this Supplement may be used in place of the 80 percent columns.

Standard:

16 **Warrant 1, Eight-Hour Vehicular Volume, is included in this Supplement. The other warrants in the MUTCD that are not contained in this Supplement are still in effect. In addition to Warrant 1, 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 applicable factors contained in the other eight traffic signal warrants in the MUTCD:**

- **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**

CHAPTER 4D. TRAFFIC CONTROL SIGNAL FEATURES

Section 4D.03 Provisions for Pedestrians

Support:

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

Standard:

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

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

Guidance:

04 *Accessible pedestrian signals (see Sections 4E.09, 4E.11 and Section 4E.12 of this Supplement and Sections 4E.10 and 4E.13 of the MUTCD) 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.*

Support:

05 For more information regarding the evaluation of locations for accessible pedestrian signals, refer to the Virginia Center for Transportation Innovation and Research report, "Guidelines for the Retrofit Installation of Accessible Pedestrian Signals by the Virginia Department of Transportation."

06 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.

07 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 of the MUTCD) should be used if it is not practical to provide a barrier or other physical feature to physically prevent the pedestrian movements.

Section 4D.04 Meaning of Vehicular Signal Indications

Support:

01 The "Uniform Vehicle Code" (see Section 1A.11 of this Supplement) is the primary source for the standards for the meaning of vehicular signal indications to both vehicle

operators and pedestrians as provided in this Section, and the standards for the meaning of separate pedestrian signal head indications as provided in Section 4E.02 of the MUTCD.

02 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 of this Supplement.

Standard:

03 **The following meanings shall be given to 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 or steady right-turn RED ARROW 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 left-turn 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 left-turn 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 left-turn RED ARROW is displayed.**

When a traffic control device is in place permitting a turn on a steady left-turn RED ARROW signal indication, vehicular traffic facing a steady left-turn 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.**

D. **A flashing green signal indication has no meaning and shall not be used.**

E. **Flashing yellow signal indications shall have the following meanings:**

1. **Vehicular traffic, on an approach to an intersection, facing a flashing CIRCULAR YELLOW signal indication is permitted to cautiously enter the intersection to proceed straight through or turn right or left or make a U-turn 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, 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 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, on an approach to an intersection, facing a flashing YELLOW 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 other such 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, shall yield the right-of-way to:

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

   In addition, vehicular traffic turning left or making a U-turn 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.

3. **Pedestrians facing any flashing yellow 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 yellow signal indication is first displayed.

4. **When a flashing CIRCULAR YELLOW 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 or warning requirements of the other traffic control device, which might not be applicable at all times, are currently applicable.**

F. Flashing red signal indications shall have the following meanings:

1. **Vehicular traffic, on an approach to an intersection, facing a flashing CIRCULAR RED 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, at the point nearest the intersecting roadway where the driver has a view of approaching traffic on the intersecting roadway before entering the intersection. The right to proceed shall be subject to the rules applicable after making a stop at a STOP sign.**
2. **Vehicular traffic, on an approach to an intersection, facing a flashing RED ARROW signal indication if intending to turn in the direction indicated by the arrow 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, at the point nearest the intersecting roadway where the driver has a view of approaching traffic on the intersecting roadway before entering the intersection. 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. **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.**

04 **The color amber as referenced in the Code of Virginia § 46.2-833 shall be equivalent to the color yellow as referenced in the MUTCD and the Supplement.**

Support:

05 Unless a sign indicates otherwise, the MUTCD allows right-turn-on-red in the presence of a steady CIRCULAR RED indication and prohibits right-turn-on-red in the presence of a steady right-turn RED ARROW. The Code of Virginia § 46.2-835, however, allows right-turn-on-red for both steady CIRCULAR RED and steady right-turn RED ARROW. Specifically, the code states "except where signs are placed prohibiting turns on steady red, vehicular traffic facing a steady red signal, after coming to a full stop, may cautiously enter the intersection and make a right turn." Although not specifically defined by the statutes, a red signal is implied to be either a steady CIRCULAR RED or RED ARROW.

Guidance:

06 *Steady right-turn RED ARROW signal indications should only be displayed at locations where right-turn-on-red is prohibited. A NO TURN ON RED sign (see Section 2B.54 of the MUTCD) should be installed in conjunction with the steady right-turn RED ARROW.*

Support:

07 To reduce potential motorist confusion and misinterpretation of the meaning of signal indications, and to keep the meaning of the steady right-turn RED ARROW indication consistent with the MUTCD definition, steady right-turn RED ARROW signal indications are not desirable at locations where right-turn-on-red is permitted. The NO TURN ON RED sign is needed to supplement the steady right-turn RED ARROW in order to make the right-turn-on-red prohibition legally binding according to The Code of Virginia § 46.2-835.

Section 4D.05 Application of Steady Signal Indications

Standard:

01 **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.**

02 **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.**

03 **Steady 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 of this Supplement.**
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 of this Supplement), or in protected/permissive**

mode operation with separate turn signal faces (see Sections 4D.20 and 4D.24 of the MUTCD).

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 of the MUTCD).**
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 of the MUTCD) 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 of the MUTCD) 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 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 of this Supplement, turning on a steady RED ARROW signal indication shall not be permitted.

E. 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 Section 4D.18 of this Supplement and Section 4D.20 of the MUTCD 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 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 of the MUTCD) 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 of the MUTCD) 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 CIRCULAR GREEN or flashing YELLOW ARROW signal indication.

F. 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 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 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 7) 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 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.

Support:

04 Unless a sign indicates otherwise, the MUTCD allows right-turn-on-red in the presence of a steady CIRCULAR RED indication and prohibits right-turn-on-red in the presence of a steady right-turn RED ARROW. The Code of Virginia § 46.2-835, however, allows right-turn-on-red for both steady CIRCULAR RED and steady right-turn RED ARROW.

Specifically, the code states "except where signs are placed prohibiting turns on steady red, vehicular traffic facing a steady red signal, after coming to a full stop, may cautiously enter the intersection and make a right turn." Although not specifically defined by the statutes, a red signal is implied to be either a steady CIRCULAR RED or RED ARROW.

Guidance:

05 *Steady right-turn RED ARROW signal indications should only be displayed at locations where right-turn-on-red is prohibited. A NO TURN ON RED sign (see Section 2B.54 of the MUTCD) should be installed in conjunction with the steady right-turn RED ARROW.*

Support:

06 To reduce potential motorist confusion and misinterpretation of the meaning of signal indications, and to keep the meaning of the steady right-turn RED ARROW indication consistent with the MUTCD definition, steady right-turn RED ARROW signal indications are not desirable at locations where right-turn-on-red is permitted. The NO TURN ON RED sign is needed to supplement the steady right-turn RED ARROW in order to make the right-turn-on-red prohibition legally binding according to the Code of Virginia § 46.2-835.

Option:

07 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 of this Supplement).

08 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.

09 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:

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

Standard:

11 **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.

12 **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.**

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

A. CIRCULAR RED with CIRCULAR YELLOW;

B. CIRCULAR GREEN with CIRCULAR RED; or

C. Straight-through GREEN ARROW with CIRCULAR RED;

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

A. The signal face(s) controlling the right-turning movement is visibility-limited from the adjacent through movement or positioned to minimize potential confusion to approaching road users, or

B. A RIGHT TURN SIGNAL (R10-10) sign (see Sections 4D.21, 4D.22, and 4D.24 of the MUTCD and Section 4D.23 in this Supplement) is mounted adjacent to the signal face(s) controlling the right-turning movement.

Option:

15 A right-turn GREEN ARROW may be considered if the right-turning volume exceeds 200 vehicles per hour.

Support:

16 The Code of Virginia, § 46.2-825 requires that U-turns yield to right-turns when a conflict exists. Such conflicts could be avoided for turning vehicles entering the same receiving lanes, by installing either a right-turn GREEN ARROW or allowing a U-turn movement, but not both at the same time entering the same receiving lanes.

Guidance:

17 *When a right-turn GREEN ARROW controls the right-turn movement, a conflicting U-turn movement to the same receiving lanes should be prohibited. If the U-turn movement is necessary or deserves priority based on engineering judgment, then the right-turn GREEN ARROW should not be displayed during the U-turn movement.*

Standard:

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

A. CIRCULAR GREEN with CIRCULAR YELLOW;

B. Straight-through GREEN ARROW with CIRCULAR YELLOW;

C. GREEN ARROW with YELLOW ARROW pointing in the same direction;

D. RED ARROW with YELLOW ARROW pointing in the same direction; or

E. GREEN ARROW with RED ARROW pointing in the same direction.

19 **Except as otherwise provided in Sections 4F.03 and 4G.04 of the MUTCD, the same signal section shall not be used to display both a flashing yellow and a steady yellow indication during steady mode operation. Except as otherwise provided in Section 4D.18 of this Supplement and Sections 4D.20, 4D.22, and 4D.24 of the MUTCD, the same signal section shall not be used to display both a flashing red and a steady red indication during steady mode operation.**

Guidance:

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

A. The movement involves only slight conflict, and

B. Serious traffic delays are substantially reduced by permitting the conflicting movement, and

C. Drivers and pedestrians subjected to the unexpected conflict are effectively warned thereof by a sign.

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

Standard:

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

02 **Road users approaching a signalized intersection or other signalized area, such as a midblock crosswalk, shall be given a clear and unmistakable indication of their right-of-way assignment.**

03 **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 be considered in determining the vertical, longitudinal, and lateral position of the signal face.**

Guidance:

04 *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.*

05 *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").*

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

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

85th-Percentile Speed	Minimum Sight Distance
20 mph	175 feet
25 mph	215 feet
30 mph	270 feet
35 mph	325 feet
40 mph	390 feet
45 mph	460 feet
50 mph	540 feet
55 mph	625 feet
60 mph	715 feet

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

Standard:

07 **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 of the MUTCD) shall be installed to warn approaching traffic of the traffic control signal.**

Option:

08 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 of the MUTCD).

09 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.

10 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:

11 *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.*

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

Standard:

13 **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, 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.**

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

Guidance:

15 *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.*

16 *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:

17 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:

18 *Signal backplates should be installed on all signal faces.*

Standard:

19 **Backplates shall be installed on signal faces if at least one of the following is true: the posted or statutory speed limit or the 85th-percentile speed on an approach to a signalized location is 45 mph or higher, sun glare or bright sky is frequent, or where complex or confusing backgrounds indicate a need for enhanced signal face target value.**

Support:

20 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:

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

Option:

22 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.18 Signal Indications for Permissive Only Mode Left-Turn Movements

Standard:

01 **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.

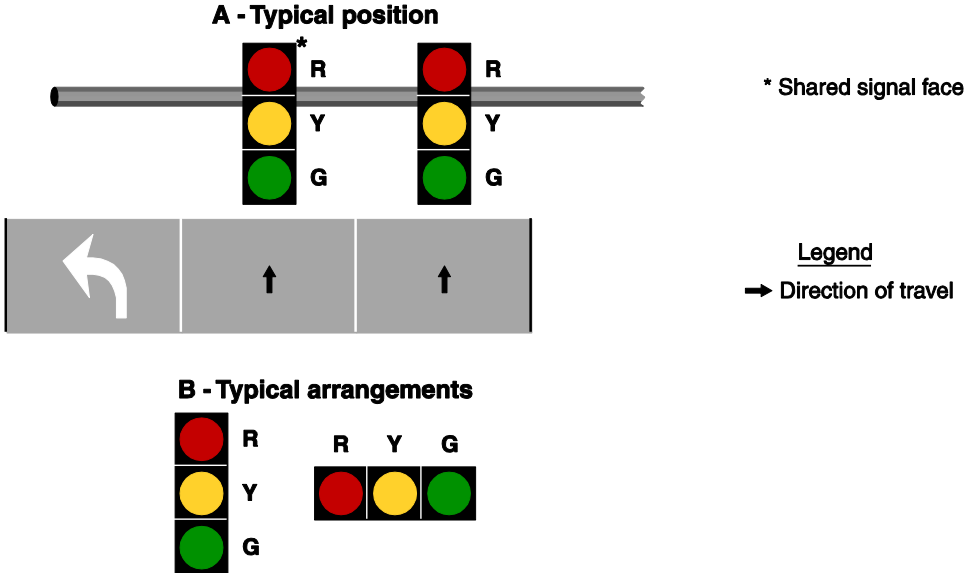
B. During the permissive left-turn movement, a CIRCULAR GREEN signal indication shall be displayed.

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 of the MUTCD) 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.

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

Figure 4D-6. Typical Position and Arrangements of Shared Signal Faces for Permissive Only Mode Left Turns



03 **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(VA) in this Supplement):**

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.

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

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 of the MUTCD) except that the left-turn GREEN ARROW signal indication shall not be displayed when operating in the permissive only mode.

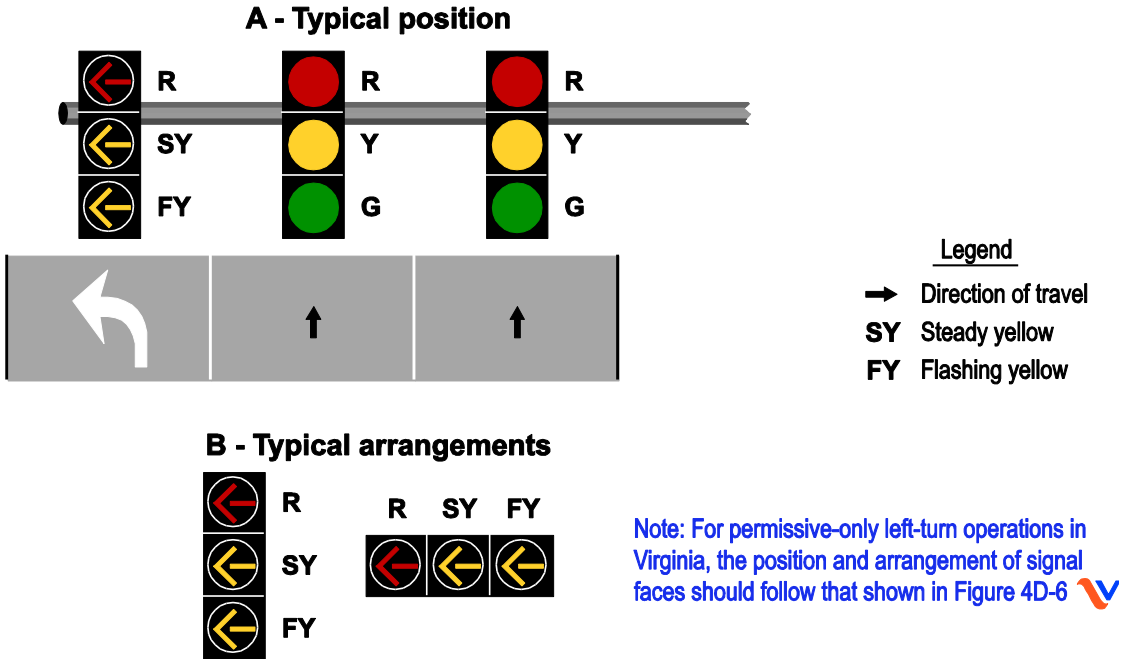
Guidance:

04 *If a left-turn movement is operated in a permissive only mode at all times, a shared signal face with a steady CIRCULAR GREEN signal indication should be used instead of a separate left-turn signal face with a flashing YELLOW ARROW indication.*

Support:

05 NCHRP studies are inconclusive regarding the benefits of flashing YELLOW ARROW for permissive only left-turn situations. In order to maintain uniformity, consistency, and driver expectations, the use of the flashing YELLOW ARROW at permissive only left-turns is discouraged in favor of the steady CIRCULAR GREEN indication. The flashing YELLOW ARROW can still be utilized at protected/permissive mode left-turns (see Section 4D.20 of the MUTCD).

Figure 4D-7(VA). Typical Position and Arrangements of Separate Signal Faces with Flashing Yellow Arrow for Permissive Only Mode Left Turns



Option:

06 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:

07 **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(VA) in this Supplement).

Option:

08 The requirements of Item A in Paragraph 7 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 Signal Indications for Protected Only Mode Left-Turn Movements

Standard:

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

A. It shall be capable of displaying the following signal indications: steady CIRCULAR RED, steady CIRCULAR YELLOW, CIRCULAR GREEN, and left-turn GREEN ARROW. Only one of the three colors shall be displayed at any given time.

B. During the protected left-turn movement, the shared signal face shall simultaneously display both a CIRCULAR GREEN signal indication and a left-turn GREEN ARROW signal indication.

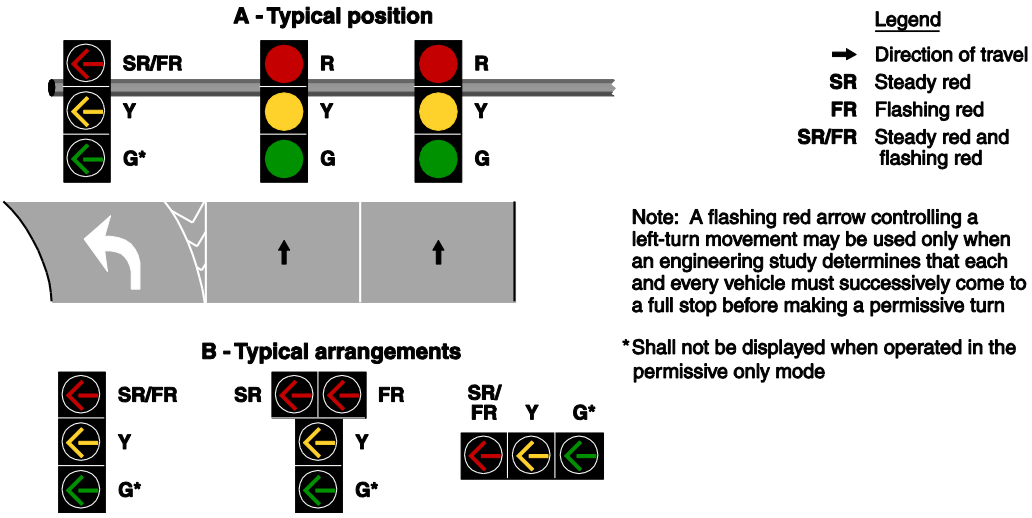
C. The shared signal face shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.

D. If the protected 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 of the MUTCD).

Option:

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

Figure 4D-8. Typical Position and Arrangements of Separate Signal Faces with Flashing Red Arrow for Permissive Only Mode and Protected/Permissive Mode Left Turns



Standard:

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

A. It shall be capable of displaying, the following signal indications: steady 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. A signal instruction sign shall not be required with this set of signal indications. If used, it shall be a LEFT ON GREEN ARROW ONLY (R10-5) sign (see Figure 2B-27(VA) in this Supplement).

B. During the protected left-turn movement, a left-turn GREEN ARROW signal indication shall be displayed.

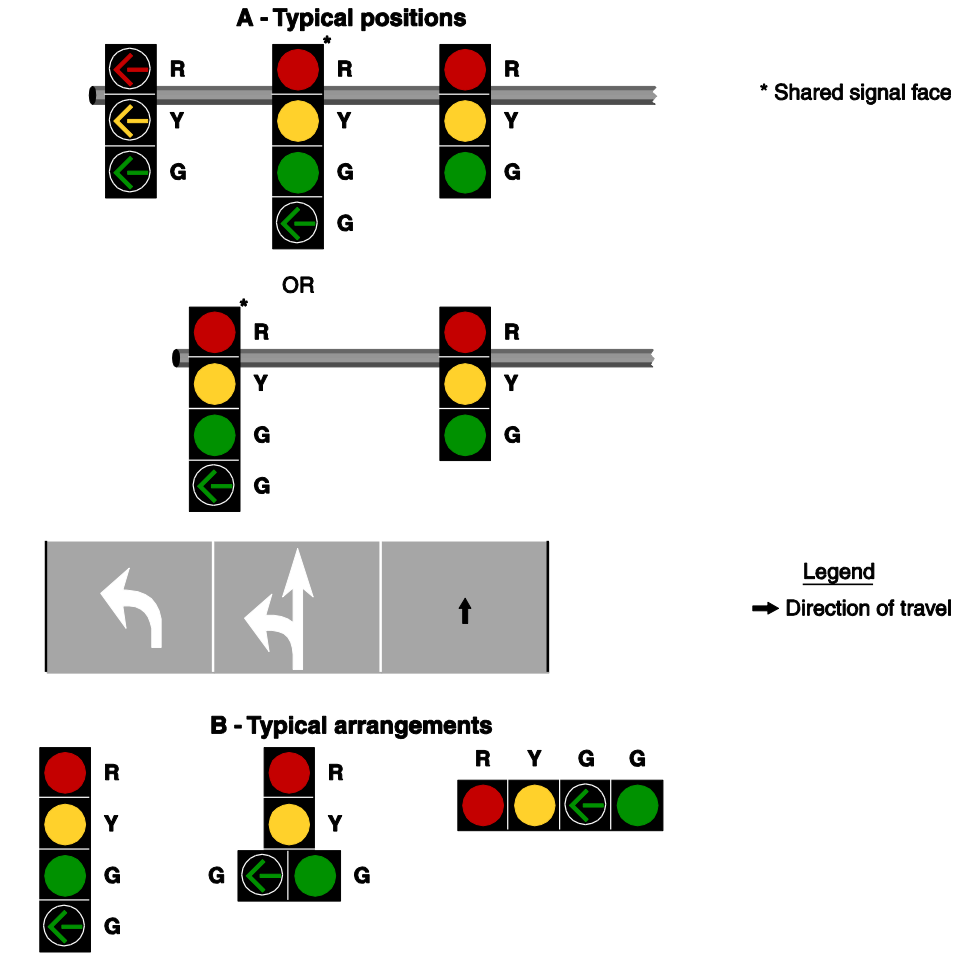
C. A steady left-turn YELLOW ARROW signal indication shall be displayed following the left-turn GREEN ARROW signal indication.

D. If the protected 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 that is used for the protected/permissive mode (see Section 4D.20 of the MUTCD and Figures 4D-8 and 4D-12) except that the flashing left-turn YELLOW ARROW or flashing left-turn RED ARROW signal indication shall not be displayed when operating in the protected only mode.

Guidance:

04 *The LEFT ON GREEN ARROW ONLY sign (R10-5) should be used only after engineering judgment reveals a problem that could be mitigated by the sign.*

Figure 4D-9 Typical Positions and Arrangements of Shared Signal Faces for Protected Only Mode Left Turns



Note: Shared signal faces shall only be used for a protected-only mode left turn if the circular green and green left-turn arrow indications always begin and terminate together

Figure 4D-10 Typical Position and Arrangements of Separate Signal Faces for Protected Only Mode Left Turns

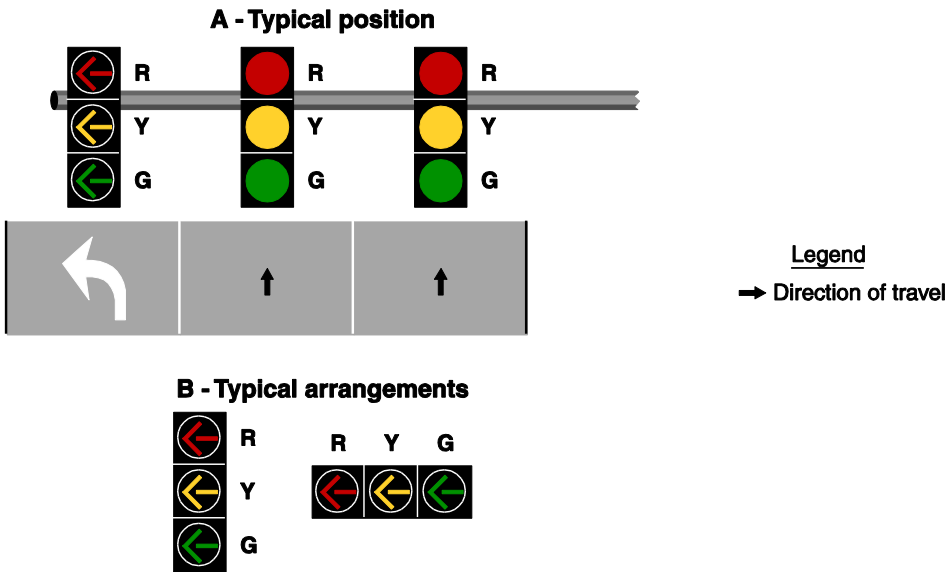
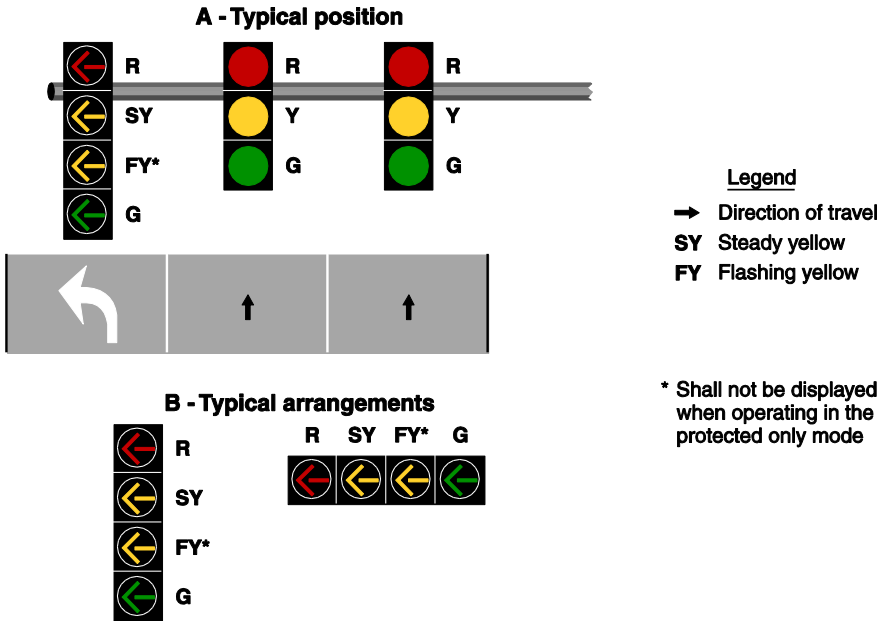


Figure 4D-12. Typical Position and Arrangements of Separate Signal Faces with Yellow Arrow for Protected/Permissive Mode and Protected Only Mode Left Turns



Section 4D.23 Signal Indications for Protected Only Mode Right-Turn Movements

Standard:

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

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

B. During the protected right-turn movement, the shared signal face shall simultaneously display both a CIRCULAR GREEN signal indication and a right-turn GREEN ARROW signal indication.

C. The shared signal face shall always simultaneously display the same color of circular indication that the adjacent through signal face or faces display.

D. If the protected 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 of the MUTCD).

Option:

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

Standard:

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

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 right-turn GREEN ARROW. Only one of the three indications shall be displayed at any given time. A signal instruction sign shall not be required with this set of signal indications. If used, it shall be a RIGHT ON GREEN ARROW ONLY (R10-5a) sign (see Figure 2B-27(VA) in this Supplement). Steady CIRCULAR RED, steady right-turn YELLOW ARROW, and right-turn GREEN ARROW. Only one of 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(VA) in this Supplement) shall be used unless the CIRCULAR RED signal indication 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. When the separate signal face is providing a message to stop and remain stopped, a steady right-turn RED ARROW signal indication, along with the NO TURN ON RED (R10-11a) sign, 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. If the protected 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 that is used for the protected/permissive mode (see Section 4D.24 of the MUTCD and Figure 4D-19) except that a flashing right-turn YELLOW ARROW or flashing right-turn RED ARROW signal indication shall not be displayed when operating in the protected only mode.

Support:

04 Unless a sign indicates otherwise, the MUTCD allows right-turn-on-red in the presence of a steady CIRCULAR RED indication and prohibits right-turn-on-red in the presence of a steady right-turn RED ARROW. The Code of Virginia § 46.2-835, however, allows right-turn-on-red for both steady CIRCULAR RED and steady right-turn RED ARROW. Specifically, the code states "except where signs are placed prohibiting turns on steady red, vehicular traffic facing a steady red signal, after coming to a full stop, may cautiously enter the intersection and make a right turn." Although not specifically defined by the statutes, a red signal is implied to be either a steady CIRCULAR RED or RED ARROW.

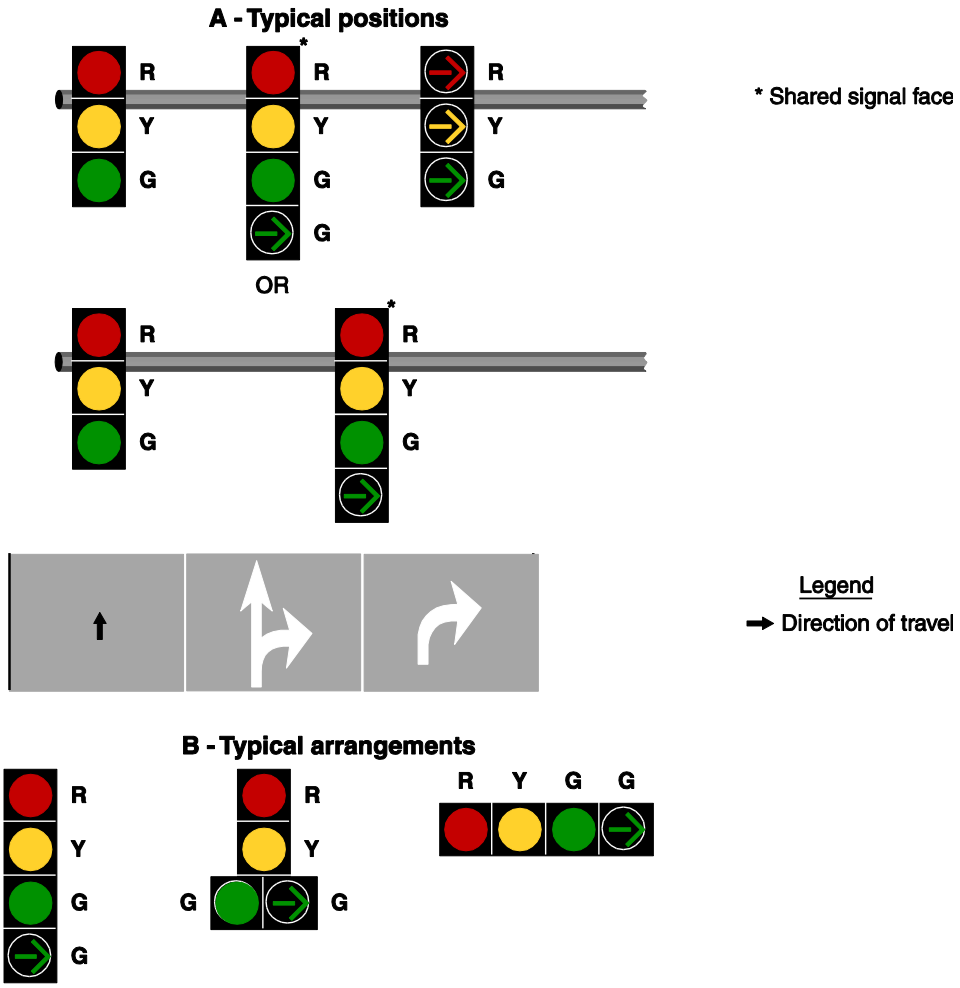
Guidance:

05 *Steady right-turn RED ARROW signal indications should only be displayed at locations where right-turn-on-red is prohibited. A NO TURN ON RED sign (see Section 2B.54 of the MUTCD) should be installed in conjunction with the steady right-turn RED ARROW.*

Support:

06 To reduce potential motorist confusion and misinterpretation of the meaning of signal indications, and to keep the meaning of the steady right-turn RED ARROW indication consistent with the MUTCD definition, steady right-turn RED ARROW signal indications are not desirable at locations where right-turn-on-red is permitted. The NO TURN ON RED sign is needed to supplement the steady right-turn RED ARROW in order to make the right-turn-on-red prohibition legally binding according to the Code of Virginia § 46.2-835.

Figure 4D-16 Typical Positions and Arrangements of Shared Signal Faces for Protected Only Mode Right Turns



Note: Shared signal faces shall only be used for a protected-only mode right turn if the circular green and green right-turn arrow indications always begin and terminate together

Figure 4D-17 Typical Positions and Arrangements of Separate Signal Faces for Protected Only Mode Right Turns

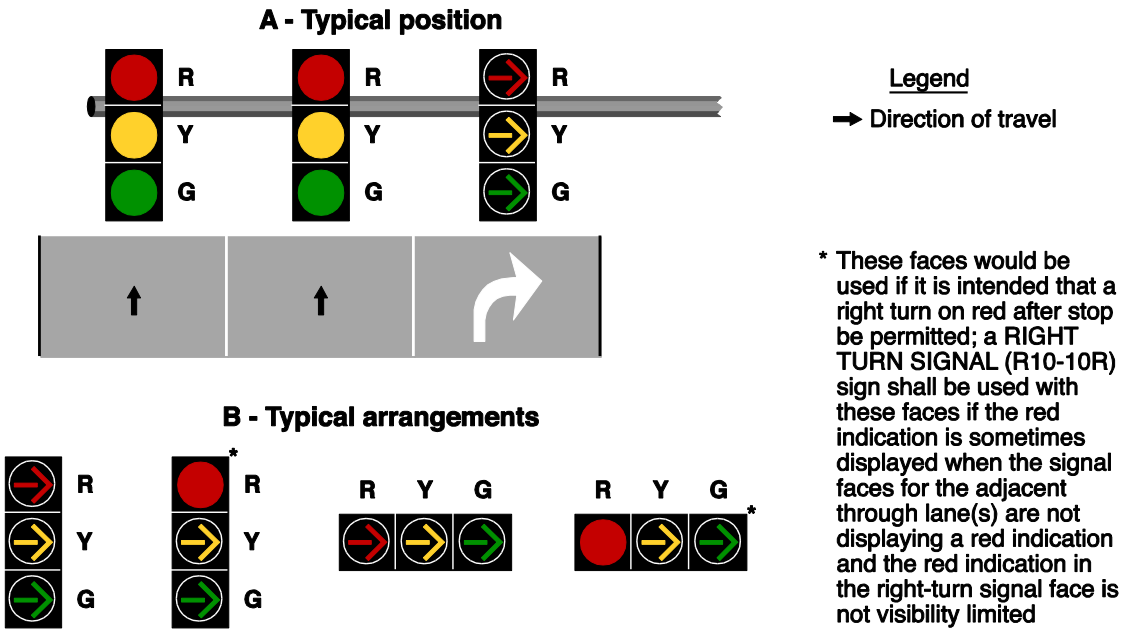
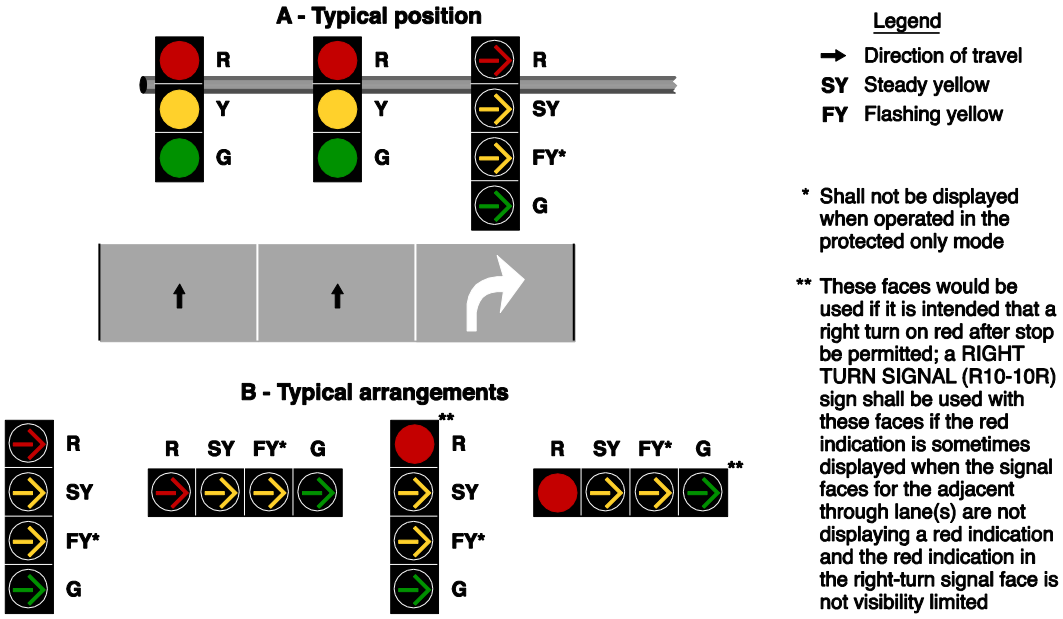


Figure 4D-19 Typical Positions and Arrangements of Separate Signal Faces with Flashing Yellow Arrow for Protected/Permissive Mode and Protected Only Mode Right Turns



Section 4D.26 Yellow Change and Red Clearance Intervals

Standard:

01 **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.**

02 **The exclusive function of the yellow change interval shall be to warn traffic of an impending change in the right-of-way assignment.**

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

Support:

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

Guidance:

05 *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:

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

Support:

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

Guidance:

08 *Clearance intervals should be calculated using guidance in the latest edition of VDOT's Traffic Engineering Memo TE-306 (with the approved Addendum to TE-306 for the Northern Virginia District). A link to TE-306 is provided in Appendix A of this Supplement.*

Standard:

09 **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.**

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

11 **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:

12 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.

13 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.

14 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:

15 *A yellow change interval should have a minimum duration of 3 seconds and a maximum duration of 6 seconds. The longer intervals should be reserved for use on approaches with higher speeds.*

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

Standard:

17 **Except for warning beacons mounted on advance warning signs on the approach to a signalized location (see Section 2C.36 of the MUTCD), 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:

18 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.28 Flashing Operation of Traffic Control Signals – General

Standard:

01 **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.**

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

03 **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.**

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

05 **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.**

06 **A manual switch, a conflict monitor (malfunction management unit) circuit, and, if appropriate, automatic means shall be provided to initiate the flashing mode.**

Option:

07 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:

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

Option:

09 Flashing of traffic signals during periods of low volumes in lieu of normal stop-and-go operations may be considered at non-actuated (fixed time) traffic signal installations as a method to reduce delay times during late night periods.

Standard:

10 **If used for this purpose, the following conditions shall be met:**

A. Configuration of the intersection shall be a 4 leg or T intersection.

B. Motorists on the minor street(s) shall have an unrestricted view of approaching major street traffic.

C. Volumes on the major street shall be less than 200 vph for both directions combined during time periods for flashing operation.

D. Ratio of major street to minor street hourly traffic volumes shall be equal to or greater than 3:1 during time periods for flashing operation. No arterial-to-arterial roadway intersections shall be operated in the flashing mode.

11 **Planned/scheduled flashing operations shall not occur at actuated (semi and fully) traffic signal installations.**

Support:

12 Late night periods are considered to be one hour after the closing times of nighttime establishments in the area until one hour prior to the morning peak hour.

13 While flashing during low volume times might reduce delay times, angle accident potential increases during those times.

Standard:

14 **Any non-actuated traffic signal installations which utilize a flashing condition during late night periods of low volumes shall have the volume and accident data monitored yearly to determine if it would be beneficial to place the signal in full-color operation during all or part of the flashing period.**

15 **Changing a late night flashing operation back to full-color operation based on accident data shall be considered when any of the following conditions are observed:**

A. 3 right angle accidents a year during periods of flashing operation.

B. 2 right angle accidents per million vehicles entering during periods of flashing operation.

C. Severity of the accidents increase during periods of flashing operation.

Section 4D.V1 Traffic Control Signal Housing Color

Standard:

01 **The color of traffic control signal and beacon housings maintained by VDOT shall be Federal Yellow, except for emergency traffic signals, for which the color of the housing shall be red.**

CHAPTER 4E. PEDESTRIAN CONTROL FEATURES

Section 4E.09 Accessible Pedestrian Signals and Detectors – General

Support:

01 Accessible pedestrian signals and detectors provide information in non-visual formats (such as audible tones, speech messages, and/or vibrating surfaces).

02 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.

03 Additional information relating to accessible pedestrian signals can be found in a report by the Virginia Center for Transportation Innovation and Research called, "Guidelines for the Retrofit Installation of Accessible Pedestrian Signals by the Virginia Department of Transportation."

Standard:

04 **If a particular signalized location presents difficulties for pedestrians who have visual disabilities to cross the roadway, an engineering study shall be conducted that evaluates the needs of pedestrians in general, as well as the information needs of pedestrians with visual disabilities. The engineering study shall evaluate 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.

Guidance:

05 *Once a request is received for an accessible pedestrian signal and it is determined that the intersection meets the basic requirements and needs to be evaluated, an evaluation team should be assembled to visit the intersection and conduct the evaluation described in Paragraphs 8 and 9 in order to derive a priority score. This evaluation should be conducted within one month of the date the written request was received.*

06 *Team members should include the requesting blind or visually impaired person, an orientation and mobility specialist (possibly from the Virginia Department of Blind and*

Visually Impaired), a representative from the local city, town, or county and the VDOT Regional Traffic Engineer or designated representative.

Option:

07 The requesting blind or visually impaired individual may, at his or her discretion, invite others to participate in the evaluation as a member of the evaluation team.

Guidance:

08 *During the intersection visit, members of the evaluation team should discuss all possible solutions to address the crossing needs of the requesting blind or visually impaired person. The conditions shown in Table 4E-V1 in this Supplement should be evaluated:*

09 *The VDOT Regional Traffic Engineer should ensure the request for the accessible pedestrian signal is still valid, if a significant amount of time elapses between the intersection's evaluation and the installation of the accessible pedestrian signal.*

Support:

10 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.

11 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:

12 **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.**

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

Option:

14 Accessible pedestrian signal detectors may be pushbuttons or passive detection devices.

15 At locations with pretimed traffic control signals or non-actuated approaches, pedestrian pushbuttons may be used to activate the accessible pedestrian signals.

Support:

16 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 tactile arrow, and can include audible beaconing and other special features.

Table 4E-V1 Accessible Pedestrian Signal Evaluation Factors

Evaluation Factor	Brief Description
1. Configuration of Intersection	Skewed, offset, lacking particular straight through movements
2. Width of Crossing	Width of approach used by requesting party
3. Maximum Posted Speed Limit on Street to Be Crossed	Maximum posted speed limit on street to be used by requesting party
4. Special Traffic Conditions I	Heavy right-turn volumes and right-turn signals or arrows
5. Special Traffic Conditions II	Free flow right-turn lane (with or without a right-turn island)
6. Special Pedestrian Signal Conditions	Lead or exclusive pedestrian phases, mid-block exclusive pedestrian signals
7. Proximity of Intersection to Key Facilities	Distance to pedestrian generators or attractors
8. Need to Cross by Visually Impaired	Work- or school-related trip purpose by requesting party
9. Other Special Traffic and Mobility Conditions	Catchall to account for other concerns, especially if low volumes are a problem

Option:

17 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:

18 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 of this Supplement).

Standard:

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

Section 4E.11 Accessible Pedestrian Signals and Detectors – Walk Indications

Support:

01 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:

02 **Accessible pedestrian signals shall have both audible and vibrotactile walk indications.**

03 **Vibrotactile walk indications shall be provided by a tactile arrow on the pushbutton (see Section 4E.12 of this Supplement) that vibrates during the walk interval.**

04 **Accessible pedestrian signals shall have an audible walk indication during the walk interval only. The audible walk indication shall be audible from the beginning of the associated crosswalk.**

05 **The walk interval tone shall be a percussive tone similar to the locator tone (Section 4E.12 of this Supplement) except repeat at a faster rate. Specifically, the duration of the tone shall repeat 8 to 10 times per second. Walk interval tones shall consist of multiple frequencies with a dominant component of 880 Hz.**

06 **The accessible walk indication shall have the same duration as the pedestrian walk signal except when the pedestrian signal rests in walk.**

Guidance:

07 *If the pedestrian signal rests in walk, the accessible walk indication should be limited to the first 7 seconds of the walk interval. The accessible walk indication should be recalled by a button press during the walk interval provided that the crossing time remaining is greater than the pedestrian change interval.*

Standard:

08 **Where two accessible pedestrian signals are separated by a distance of at least 10 feet, the audible walk indication shall be a percussive tone. Where two accessible pedestrian signals on one corner are not separated by a distance of at least 10 feet, the audible walk indication shall be a speech walk message.**

09 **Audible tone walk indications shall repeat at eight to ten ticks per second. Audible tones used as walk indications shall consist of multiple frequencies with a dominant component at 880 Hz.**

Guidance:

10 *The volume of audible walk indications and pushbutton locator tones (see Section 4E.12 of this Supplement) should be set to be a maximum of 5 dBA louder than ambient sound, except when audible beaconing is provided in response to an extended pushbutton press.*

Standard:

11 **The automatic volume adjustment in response to ambient traffic sound level shall be 2 dBA minimum and 5 dBA maximum above ambient noise level and shall provide up to a maximum volume of 100 dBA.**

Guidance:

12 *The sound level of audible walk indications and pushbutton locator tones should be adjusted to be low enough to avoid misleading pedestrians who have visual disabilities when the following conditions exist:*

A. Where there is an island that allows unsignalized right turns across a crosswalk between the island and the sidewalk.

B. Where multi-leg approaches or complex signal phasing require more than two pedestrian phases, such that it might be unclear which crosswalk is served by each audible tone.

C. At intersections where a diagonal pedestrian crossing is allowed, or where one street receives a WALKING PERSON (symbolizing WALK) signal indication simultaneously with another street.

Option:

13 An alert tone, which is a very brief burst of high-frequency sound at the beginning of the audible walk indication that rapidly decays to the frequency of the walk tone, may be used to alert pedestrians to the beginning of the walk interval.

Support:

14 An alert tone can be particularly useful if the walk tone is not easily audible in some traffic conditions.

15 Speech walk messages communicate to pedestrians which street has the walk interval. Speech messages might be either directly audible or transmitted, requiring a personal receiver to hear the message. To be a useful system, the words and their meaning need to be correctly understood by all users in the context of the street environment where they are used. Because of this, tones are the preferred means of providing audible walk indications except where two accessible pedestrian signals on one corner are not separated by a distance of at least 10 feet.

16 If speech walk messages are used, pedestrians have to know the names of the streets that they are crossing in order for the speech walk messages to be unambiguous. In getting directions to travel to a new location, pedestrians with visual disabilities do not always get the name of each street to be crossed. Therefore, it is desirable to give users of accessible pedestrian signals the name of the street controlled by the pushbutton. This can be done by means of a speech pushbutton information message (see Section 4D.13 of the MUTCD) during the flashing or steady UPRAISED HAND intervals, or by raised print and Braille labels on the pushbutton housing.

17 By combining the information from the pushbutton message or Braille label, the tactile 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:

18 **If speech walk messages are used to communicate the walk interval, they shall provide a clear message that the walk interval is in effect, as well as to which crossing it applies. Speech walk messages shall 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.**

19 **Speech walk messages that are used at intersections having pedestrian phasing that is concurrent with vehicular phasing shall be patterned after the model: "Broadway. Walk sign is on to cross Broadway."**

20 **Speech walk messages that are used at intersections having exclusive pedestrian phasing shall be patterned after the model: "Walk sign is on for all crossings."**

21 **Speech walk messages shall not contain any additional information, except they shall include designations such as "Street" or "Avenue" where this information is necessary to avoid ambiguity at a particular location.**

Guidance:

22 *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:

23 **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.

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

Option:

25 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:

26 **Following the audible walk indication, accessible pedestrian signals shall revert to the pushbutton locator tone (see Section 4E.12 of this Supplement) during the pedestrian change interval.**

Section 4E.12 Accessible Pedestrian Signals and Detectors – Tactile Arrows and Locator Tones

Standard:

01 **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 tactile arrows which crosswalk signal is actuated by each pushbutton. Tactile arrows shall be located on the pushbutton, 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.**

02 **An accessible pedestrian pushbutton shall incorporate a locator tone.**

Support:

03 A 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:

04 **Pushbutton locator tones shall be a percussive tone similar to the interval tone (see Section 4E.11 of this Supplement) except that it shall be at a slower rate and have a duration of 0.15 seconds or less, and shall repeat at 1-second intervals. Locator tones shall consist of multiple frequencies with a dominant component at 880 Hz.**

05 **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.**

06 **Pushbutton locator tones shall have automatic volume adjustment in response to ambient traffic sound levels. The tones shall be 2 dBA minimum and 5 dBA maximum above ambient noise level and shall provide up to a maximum volume of 100 dBA. The tone shall be audible 6 to 12 feet from the pushbutton, or to the building line, whichever is less.**

07 **Pedestrian activation tones shall be a beep, tick, or other percussive tone and begin immediately following the initial button press to confirm that pedestrian signal timing has been activated.**

Support:

08 Section 4E.11 of this Supplement contains additional provisions regarding the volume and sound level of pushbutton locator tones.

CHAPTER 4J. TRAFFIC CONTROL FOR MOVABLE BRIDGES

Section 4J.02 Design and Location of Movable Bridge Signals and Gates

Standard:

01 **The signal faces and mountings of movable bridge signals shall comply with the provisions of Chapter 4D except as provided in this Section.**

02 **Signal faces with 12-inch diameter signal indications shall be used for all new movable bridge signals.**

Option:

03 Existing signal faces with 8-inch diameter lenses may be retained for the remainder of their useful service life.

Standard:

04 **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 of this Supplement).

05 **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 of this Supplement) shall be installed to indicate the point behind which vehicles are required to stop.**

Guidance:

06 *If movable bridge operation is frequent, the use of three-section signal faces should be considered.*

07 *Insofar as practical, the height and lateral placement of signal faces should comply with the requirements for other traffic control signals in accordance with Chapter 4D. They should be located no more than 50 feet in advance of the movable bridge warning gate.*

Option:

08 Movable bridge signals may be supplemented with audible warning devices to provide additional warning to drivers and pedestrians.

Standard:

09 **A DRAW BRIDGE (W3-6) sign (see Section 2C.39 of the MUTCD) shall be used in advance of movable bridge signals and gates to give warning to road users, except in urban conditions where such signing would not be practical.**

10 **If physical conditions prevent a road user from having a continuous view of at least two signal indications for the distance specified in Table 4D-2, an auxiliary device (either a supplemental signal face or the mandatory DRAW BRIDGE (W3-6) sign to which has been added a warning beacon that is interconnected with the movable bridge controller unit) shall be provided in advance of movable bridge signals and gates.**

11 **A BE PREPARED TO STOP (W3-4) sign (see Section 2C.36 of the MUTCD) and WHEN FLASHING (W16-13P) plaque shall be used in advance of movable bridge signals and gates to give warning to road users, except in urban conditions where such signing would not be practical. When used, the BE PREPARED TO STOP sign and WHEN FLASHING plaque shall be supplemented by a crossing bell and two Warning Beacons (see Section 4L.03 of the MUTCD).**

Option:

12 The DRAW BRIDGE (W3-6) sign may be supplemented by a Warning Beacon (see Section 4L.03 of the MUTCD).

Standard:

13 **If two sets of gates (both a warning and a resistance gate) are used for a single direction, highway traffic signals shall not be required to accompany the resistance gate nearest the span opening.**

14 **Movable bridge warning gates, if used, shall be at least standard railroad size, striped with 16-inch alternate vertical, fully reflectorized red and white stripes. Flashing red lights in accordance with the Standards for those on railroad gates (see Section 8C.04 of the MUTCD) shall be included on the gate arm and they shall only be operated if the gate is closed or in the process of being opened or closed. In the horizontal position, the top of the gate shall be approximately 4 feet above the pavement.**

Guidance:

15 *Movable bridge warning gates should be of lightweight construction. In its normal upright position, the gate arm should provide adequate lateral clearance.*

Option:

16 The movable bridge resistance gates may be delineated, if practical, in a manner similar to the movable bridge warning gate.

Standard:

17 **Movable bridge warning gates, if used, shall extend at least across the full width of the approach lanes if movable bridge resistance gates are used. On divided highways in which the roadways are separated by a barrier median, movable bridge warning gates, if used, shall extend across all roadway lanes approaching the span openings.**

Guidance:

18 *If movable bridge resistance gates are not used on undivided highways, movable bridge warning gates, if used, should extend across the full width of the roadway.*

Option:

19 A single full-width gate or two half-width gates may be used.

Support:

20 The locations of movable bridge signals and gates are determined by the location of the movable bridge resistance gate (if used) rather than by the location of the movable spans. The movable bridge resistance gates for high-speed highways are preferably located 50 feet or more from the span opening except for bascule and lift bridges, where they are often attached to, or are a part of, the structure.

Standard:

21 **Except where physical conditions make it impractical, movable bridge warning gates shall be located 100 feet or more from the movable bridge resistance gates or, if movable bridge resistance gates are not used, 100 feet or more from the movable span.**

Guidance:

22 *On bridges or causeways that cross a long reach of water and that might be hit by large marine vessels, within the limits of practicality, traffic should not be halted on a section of the bridge or causeway that is subject to impact.*

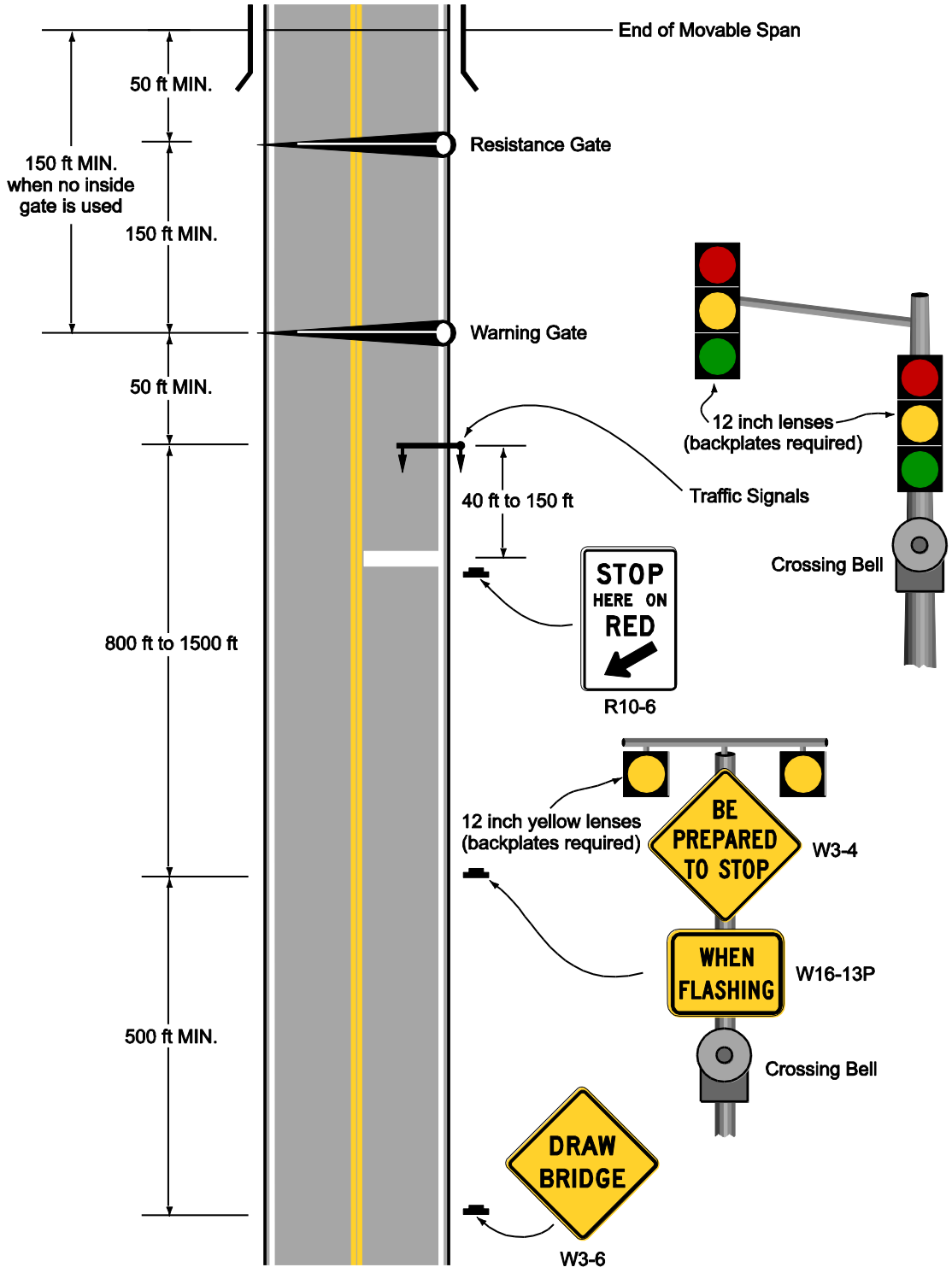
23 *In cases where it is not practical to halt traffic on a span that is not subject to impact, traffic should be halted at least one span from the opening. If traffic is halted by signals and gates more than 330 feet from the movable bridge warning gates (or from the span opening if movable bridge warning gates are not used), a second set of gates should be installed approximately 100 feet from the gate or span opening.*

24 *If the movable bridge is close to a grade crossing and traffic might possibly be stopped on the crossing as a result of the bridge opening, a traffic control device should notify the road users to not stop on the railroad tracks.*

Support:

25 Figure 4J-V1 in this Supplement provides drawbridge protection details for undivided roadways.

Figure 4J-V1. Typical Drawbridge Protection Details Undivided Roadway



CHAPTER 4N. IN-ROADWAY LIGHTS

Section 4N.01 Application of In-Roadway Lights

Support:

01 In-Roadway Lights 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:

02 **In-Roadway Lights shall not be used for any application that is not described in this Chapter.**

03 **If used, In-Roadway Lights shall not exceed a height of 3/4 inch above the roadway surface.**

04 **When used, In-Roadway Lights shall be flashed and shall not be steadily illuminated.**

Support:

05 Steadily illuminated lights installed in the roadway surface are considered to be internally illuminated raised pavement markers (see Section 3B.11 of this Supplement).

Option:

06 In-Roadway Lights 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 of this Supplement).

Support:

07 In-Roadway Lights and guidelines for their installation are discussed in the VDOT document Guidelines for the Installation of In-Roadway Warning Lights. A link to this document can be found in Appendix A of this Supplement.

Section 4N.02 In-Roadway Warning Lights at Crosswalks

Option:

01 In-roadway lights may be installed at certain marked crosswalks, based on an engineering study or engineering judgment, to provide additional warning to road users.

Guidance:

02 *Prior to the installation of in-roadway warning lights at crosswalks, other countermeasures should be carefully considered.*

Standard:

03 **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.**

04 **If In-Roadway Warning Lights are used at a crosswalk, the following requirements shall apply:**

A. Except as provided in Paragraphs 9 and 10, 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 pulses shall 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.

05 **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:

06 *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.*

07 *The location of the In-Roadway Warning Lights within the lanes should be based on engineering judgment.*

Option:

08 On one-way streets, In-Roadway Warning Lights may be omitted on the departure side of the crosswalk.

09 Based on engineering judgment, the In-Roadway Warning Lights on the departure side of the crosswalk on the left side of a median may be omitted.

10 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:

11 *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:

12 **If pedestrian pushbuttons are used to actuate the in-roadway 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.**

13 **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.**