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# Manual on Uniform Traffic Control Devices (MUTCD): Overview of Highway Traffic Signals



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**COURSE DESCRIPTION**

The Manual on Uniform Traffic Control Devices (MUTCD) (1) provides national standards and guidance with respect to location, shape, size, and color for roadway signs, markings, and signals. Such guidance and standards are intended to enhance transportation safety and efficiency and provide uniformity of such devices to drivers across the United States.

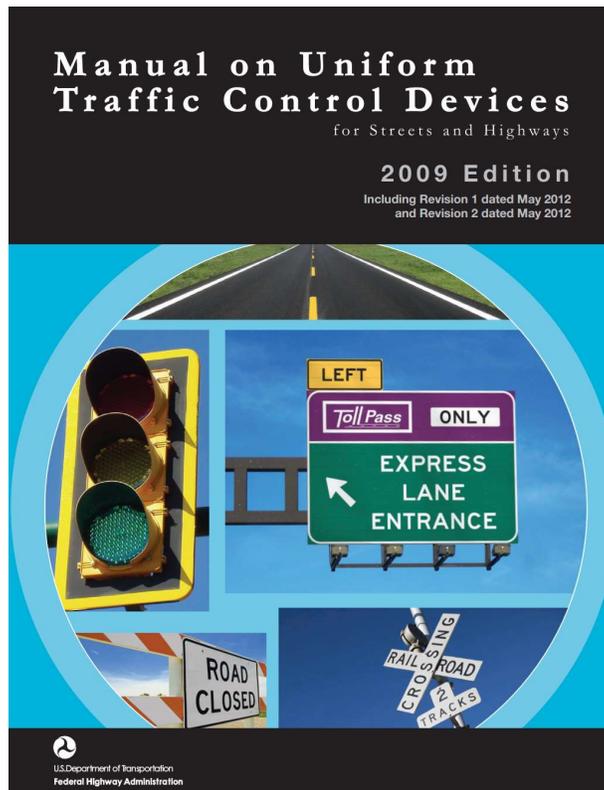


Figure 1. Manual on Uniform Traffic Control Devices 2009 Edition Cover

In this course, you will learn about:

- General guidelines for highway traffic signals
- Highway traffic signal functions and purposes
- Highway traffic signal types and designs

*Sources of artwork in this document: MUTCD 2009 Edition, denoted in figure caption; otherwise, Scott or Leslie Washburn. All photos taken by Scott or Leslie Washburn.*



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## INTRODUCTION AND HISTORY

With the arrival of the automobile, people and goods started to travel farther on roadways. To keep the automobile method of travel safe and efficient, traffic control devices were developed. A centerline pavement marking was first painted in Michigan in 1911 and the first stop sign was erected in Detroit in 1915. (2) Before long, a national need to standardize these devices led to the first edition of the Manual on Uniform Traffic Control Devices (MUTCD), published in 1935. Ten editions over 80 years followed as the dynamic document changed from research, implementation, and experiment. In 1979 the Federal Highway Administration (FHWA) took over management of the MUTCD and established a formal amendment process. The National Committee on Uniform Traffic Control Devices (4) advises the FHWA on the content of the MUTCD and its interpretation. Traffic control devices today include signs, signals, markings, and other devices used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, pedestrian facility, bikeway, or private road open to public travel (see definition in MUTCD Section 1A.13.) While private roadways are exempt from regulation by the MUTCD, it is recommended that its guidance be followed.

In accordance with 23 U.S.C. 109(d) and 402(a), the MUTCD is incorporated by reference in 23 Code of Federal Regulations (CFR), Part 655, Subpart F (3) and shall be recognized as the national standard for all traffic control devices and can be found on the U.S. Department of Transportation Federal Highway Administration website at [https://mutcd.fhwa.dot.gov/hfm/2009r1r2/html\\_index.htm](https://mutcd.fhwa.dot.gov/hfm/2009r1r2/html_index.htm). Since the MUTCD is a federal regulation, it has legal authority, which guides government agencies such as states, counties, and cities to prevent or limit liability in a crash.

The manual is structured into nine parts:

- Part 1. General
- Part 2. Signs
- Part 3. Markings
- Part 4. Highway Traffic Signals
- Part 5. Traffic Control Devices for Low-Volume Roads
- Part 6. Temporary Traffic Control
- Part 7. Traffic Control for School Areas
- Part 8. Traffic Control for Railroad and Light Rail Transit Grade Crossings
- Part 9. Traffic Control for Bicycle Facilities



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This course focuses on Part 4 Highway Traffic Signals. Also available are the courses “Manual on Uniform Traffic Control Devices (MUTCD): Introduction and Overview of Signs and Introduction to Pavement Markings.”

Part 4 includes the following chapters:

- A. General
- B. Traffic Control Signals—General
- C. Traffic Control Signal Needs Studies
- D. Traffic Control Signal Features
- E. Pedestrian Control Features
- F. Pedestrian Hybrid Beacons
- G. Traffic Control Signals and Hybrid Beacons for Emergency Vehicle Access
- H. Traffic Control Signals for one-Lane, Two-Way Facilities
- I. Traffic Control Signals for Freeway Entrance Ramps
- J. Traffic Control for Movable Bridges
- K. Highway Traffic Signals at Toll Plazas
- L. Flashing Beacons
- M. Lane-use Control Signals
- N. In-Roadway Lights

This document covers sections A, B, and D. A course on Chapter 4C covering warrants is forthcoming.

**Definitions of Headings, Words, and Phrases in the MUTCD (Section 1A.13)**

Text headings in the MUTCD have specific meaning based on the following wording:

**Standard (Shall)**—is a standard statement that is required, mandatory or a specifically prohibitive practice typically using the verb shall. The verbs “should” and “may” are not used in standard statements. All standard statements are labeled, and the text appears in bold type.

**Guidance (Should)**—is a guidance statement of recommendation, but not mandatory, practice in typical situations, with deviations allowed if justified by engineering judgment or study typically using the verb should. The verbs “shall” and “may” are not used in guidance statements.

**Option (May)**—is a statement of practice that is a permissive condition and carries no requirement or recommendation typically using the verb may. Option statements sometime



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contain allowable modifications to a standard or guidance statement. The verbs “shall” and “should” are not used in option statements.

Support—a support statement is informational and does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. The verbs “shall,” “should,” and “may” are not used in support statements.

Note that text excerpts from the MUTCD contained in the remainder of this document are not labeled with the above terms. However, the appropriate category can be inferred from the terms ‘shall’, ‘should’, and ‘may’ used within the text. It should also be noted that some of the text excerpted from the MUTCD has been reformatted to improve the presentation of the material and/or fit better within the layout constraints of this document; however, the wording is usually repeated verbatim so as not to potentially introduce any unintentional change in meaning to the MUTCD language. The wording in the MUTCD is not always grammatically optimal but is intended to be written in such a way as to convey a precise meaning.

### **CHAPTER 4A GENERAL**

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

There are many different types of traffic control signals used in varied situations including:

- traffic control signals (4B)
- pedestrian signals (4E, 4F)
- hybrid beacons (4F)
- emergency-vehicle signals (4G)
- traffic control signals for one-lane, two-way facilities (4H)
- traffic control signals for freeway entrance ramps (4I)
- traffic control signals for movable bridges (4J)
- toll plaza traffic signals (4K)
- flashing beacons (4L)
- lane-use control signals (4M)
- in-roadway lights (4N)

Highway traffic signals definitions and acronyms are provided in section 1A.13 and 1A.14 of the MUTCD.



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## CHAPTER 4B TRAFFIC CONTROL SIGNALS—GENERAL

### Section 4B.01 General

The standardization of traffic control signals is critical for roadway user's safety. Familiarity is needed for users especially the elderly, vision impaired and distracted individuals.

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

Engineering studies and judgement should be used in decisions to install or remove traffic control signals. Signal warrants that outline the minimum conditions for installing a traffic signal are described in in section 4C. If removal of a traffic signal is justified by a traffic study and engineering judgement, the following steps should be used for removal.

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

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

Traffic control devices are used for vehicles and pedestrian traffic and when used correctly they direct traffic flow movement by defining right-of-way. Proper design, location, operation, and maintenance of traffic control signals provide advantages:

- A. They provide for the orderly movement of traffic.
- B. They increase the traffic-handling capacity of the intersection if:
  1. Proper physical layouts and control measures are used, and
  2. The signal operational parameters are reviewed and updated (if needed) on a regular basis (as engineering judgment determines that significant traffic flow and/or land use changes have occurred) to maximize the ability of the traffic control signal to satisfy current traffic demands.
- C. They reduce the frequency and severity of certain types of crashes, especially right-angle collisions.
- D. They are coordinated to provide for continuous or nearly continuous movement of traffic at a definite speed along a given route under favorable conditions.



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- E. They are used to interrupt heavy traffic at intervals to permit other traffic, vehicular or pedestrian, to cross.

Traffic control devices are not always the solution and may cause adverse effects on traffic flow and safety. Traffic control devices are often installed where studies demonstrate a need; however, if designed poorly, installed incorrectly, or have operation or maintenance issues disadvantages to the signal will arise such as:

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

**Section 4B.04 Alternatives to Traffic Control Signals**

Consideration should be given to traffic control devices where a device could cause delay or increase the frequency of crashes even where signal warrants have been met.

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

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



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- K. If the warrant is satisfied, installing multi-way STOP sign control;
- L. Installing a pedestrian hybrid beacon (see Chapter 4F) or In-Roadway Warning Lights (see Chapter 4N) if pedestrian safety is the major concern;
- M. Installing a roundabout; and
- N. Employing other alternatives, depending on conditions at the intersection.

**Section 4B.05 Adequate Roadway Capacity**

Delays at traffic control signal intersections can often be reduced by widening roadways. If the minor roadway is widened it may reduce the minor roadway green time which improved the major roadway traffic. In urban areas at least two lanes on each approach to a signal is desirable. This can be accomplished by eliminating parking or changing pavement markings. Consideration should be taken for impacts to both pedestrians and bicycle travel.

**CHAPTER 4D TRAFFIC CONTROL SIGNAL FEATURES**

**Section 4D.01 General**

In order to maintain roadway safety and efficiency, the location, design and meaning of signals must be uniform. When a signal is not in use the signal faces shall be covered, turned, or taken down to avoid any confusion that the traffic control signal is not operational.

A traffic control signal shall control traffic only at the intersection or midblock location where the signal faces are placed. Midblock crosswalks shall not be signalized if they are located within 300 feet from the nearest traffic control signal unless the proposed traffic control signal will not restrict the progressive movement of traffic.

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Figure 2. Newly installed traffic control signal, not yet in service

### Section 4D.02 Responsibility for Operation and Maintenance

Prior to installation of a traffic control signal the responsible agency should be identified for operation and maintenance of the signal. The agency should be responsible for the appurtenances, hardware, software, and the timing plan(s).

The agency should:

- Check and maintain the predetermined timing schedule for every controller
- Clean and service the equipment as frequently as needed
- Have a plan for if the equipment malfunctions or fails, with spare equipment and properly skilled maintenance personnel available



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Figure 3. Faded paint on signal heads

### Section 4D.03 Provisions for Pedestrians

Pedestrians shall be taken into consideration in the design and operation of traffic control signals. If engineering judgement 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 of the MUTCD) or a vehicular signal face(s) for a concurrent vehicular movement.

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Figure 4. Pedestrian crossing features

Sufficient time to cross a roadway should be provided by adjusting signal operations and timing for every cycle or providing pedestrian detectors.

Based on engineering judgement, non-visual pedestrian formats should be provided where appropriate. These may consist of audible tones, speech messages, and/or vibrating surfaces. In some cases, pedestrian crossing should be prohibited for safety. A barrier should be used and when not practical a no pedestrian crossing sign as shown in Figure 5.



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Figure 5. No pedestrian crossing sign (MUTCD R9-3.)

**Section 4D.04 Meaning of Vehicular Signal Indications**

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

Meanings of Steady Green Signal Indications for Vehicles
<u>Circular</u>
<p>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.</p> <p>Such vehicular traffic, including vehicles turning right or left or making a U-turn movement, shall yield the right-of-way to:</p> <ul style="list-style-type: none"> <li>(a) Pedestrians lawfully within an associated crosswalk, and</li> <li>(b) Other vehicles lawfully within the intersection.</li> </ul> <p>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.</p>



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Arrow

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.

**Meanings of Steady Yellow Signal Indications for Vehicles**

Circular

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.

Arrow

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.

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**Meanings of Steady Red Signal Indications for Vehicles**

Circular

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

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

Arrow

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

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

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**Meanings of Flashing Green Signal Indications for Vehicles**

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



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**Meanings of Flashing Yellow Signal Indications for Vehicles**

Circular

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.

When a flashing CIRCULAR YELLOW signal indication(s) is displayed as a beacon (see Chapter 4L of MUTCD) 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.

Arrow

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) 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.



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**Meanings of Flashing Red Signal Indications for Vehicles**

Circular

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.

When a flashing CIRCULAR RED signal indication(s) is displayed as a beacon (see Chapter 4L of MUTCD) 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.

Arrow

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.

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<b>Meanings of Steady Green Signal Indications for Pedestrians</b>
<u>Circular</u>
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.
<u>Arrow</u>
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>Meanings of Steady Yellow Signal Indications for Pedestrians</b>
<u>Circular and Arrow</u>
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.
<b>Meanings of Steady Red Signal Indications for Pedestrians</b>
<u>Circular and Arrow</u>
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.
<b>Meanings of Flashing Yellow Signal Indications for Pedestrians</b>
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.
<b>Meanings of Flashing Red Signal Indications for Pedestrians</b>
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.



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**Section 4D.05 Application of Steady Signal Indications**

When a traffic control signal is being operated in a steady (stop-and-go) mode, at least one indication in each signal face shall be displayed at any given time. A signal face(s) that controls a particular vehicular movement during any interval of a cycle shall control that same movement during all intervals of the cycle.

<b>Application of Steady Green Signal Indications</b>
<u>Circular</u>
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.
<u>Arrow</u>
<ol style="list-style-type: none"><li>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.</li><li>2. Shall be displayed on a signal face that controls a left-turn movement when said movement is not in conflict with other vehicles moving on a green or yellow signal indication (except for the situation regarding U-turns provided in Paragraph 4) and is not in conflict with pedestrians crossing in compliance with a WALKING PERSON (symbolizing WALK) or flashing UPRAISED HAND (symbolizing DONT WALK) signal indication. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate departing lane, and pavement markings or raised channelization clearly indicate which departure lane to use.</li><li>3. Shall not be required on the stem of a T-intersection or for turns from a one-way street.</li></ol>

<b>Application of Steady Yellow Signal Indications</b>
<u>Circular</u>
<ol style="list-style-type: none"><li>1. Shall be displayed following a CIRCULAR GREEN or straight-through GREEN ARROW signal indication in the same signal face.</li><li>2. Shall not be displayed in conjunction with the change from the CIRCULAR RED signal indication to the CIRCULAR GREEN signal indication.</li></ol>



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

Arrow

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.



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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 MUTCD Sections 4D.18 and 4D.20 shall be permitted to be displayed when a CIRCULAR YELLOW signal indication is displayed for the opposing through movement. Vehicles departing in the same direction shall not be considered in conflict if, for each turn lane with moving traffic, there is a separate departing lane, and pavement markings or raised channelization clearly indicate which departure lane to use.
5. Shall not be displayed to terminate a flashing arrow signal indication on an approach from which drivers are turning left permissively or making a U-turn to the left permissively unless one of the following conditions exists:
  - (a) A steady CIRCULAR YELLOW signal indication is also simultaneously being displayed to the opposing approach;
  - (b) An engineering study has determined that, because of unique intersection conditions, the condition described in Item (a) cannot reasonably be implemented without causing significant operational or safety problems and that the volume of impacted left-turning or U-turning traffic is relatively low, and those left-turning or U-turning drivers are advised that a steady CIRCULAR YELLOW signal indication is not simultaneously being displayed to the opposing traffic if this operation occurs continuously by the installation near the left-most signal head of a W25-1 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC HAS EXTENDED GREEN; or
  - (c) Drivers are advised of the operation if it occurs only occasionally, such as during a preemption sequence, by the installation near the left-most signal head of a W25-2 sign (see Section 2C.48) with the legend ONCOMING TRAFFIC MAY HAVE EXTENDED GREEN.
6. Shall be terminated by a RED ARROW signal indication for the same direction or a CIRCULAR RED signal indication except:



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- (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.

**Application of Steady Red Signal Indications**

Circular

1. Shall be displayed when it 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 Section 4D.04 of the MUTCD.
2. Shall be displayed with the appropriate GREEN ARROW signal indications when it is intended to 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 MUTCD Sections 4D.19 and 4D.23), or in protected/permissive mode operation with separate permit turn signal faces (see MUTCD Sections 4D.20 and 4D.24)

Arrow

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 MUTCD Item C.2 in Paragraph 3 of Section 4D.04, turning on a steady RED ARROW signal indication shall not be permitted.

**Section 4D.06 Signal Indications – Design, Illumination, Color, and Shape**

Design

- A signal indication shall be circular or an arrow except for lane-use control signals and pedestrian signal heads.
- Letters and numbers shall not be displayed as part of a vehicular indication, including those associated with countdown displays.
- Strobes shall not be used within or adjacent to any signal indication.
- Flashing displays shall not be used within or adjacent to any signal indications. (Except for the flashing signal indications and the pre-emption confirmation lights that are expressly allowed by the provisions of this Chapter 4 of the MUTCD.)



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Color

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

Illumination and Shape

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

- A. Vertically upward to indicate a straight-through movement (Figure 6), or
- B. Horizontally in the direction of the turn to indicate a turn at approximately or greater than a right angle, or
- C. Upward with a slope at an angle approximately equal to that of the turn if the angle of the turn is substantially less than a right angle, or
- D. In a manner that directs the driver through the turn if a U-turn arrow is used Figure 7



Figure 6. Vertical upward arrow to indicate straight-through movement



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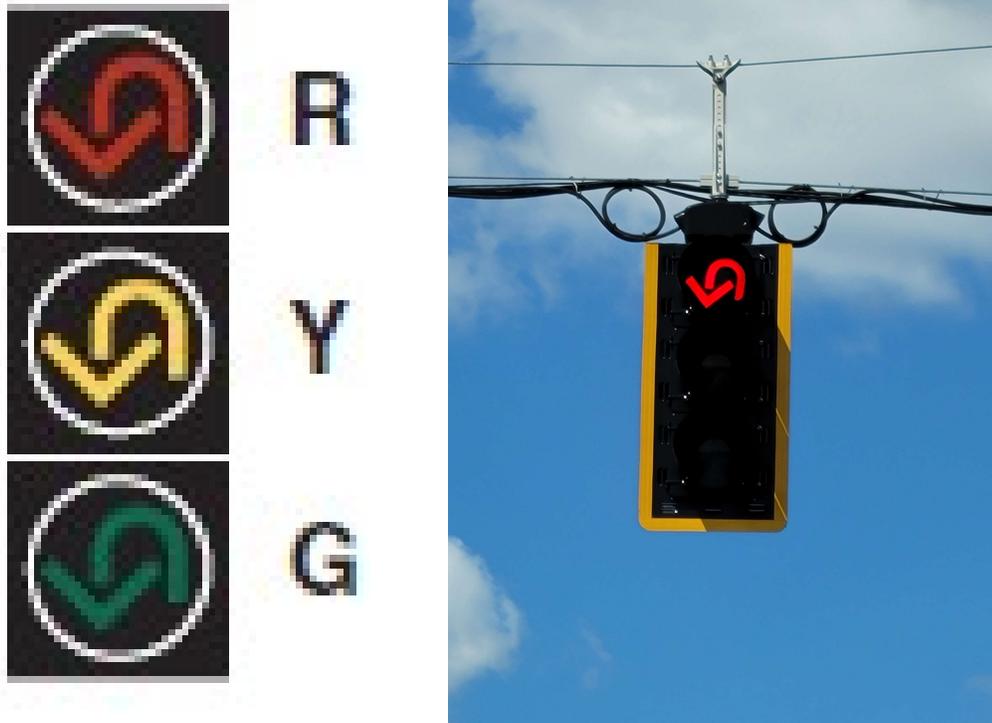


Figure 7. Example of U-Turn Sign Face (MUTCD Figure 4D-1.)

The signal head design that affects the display of the signal indications shall be meet the requirements set forth in “Vehicle Traffic Control Signal Heads” (5) The intensity and distribution of light from each signal lens should comply the reference about as well as “Traffic Signal Lamps” (6).

#### Section 4D.07 Size of Vehicular Signal Indications

There shall be two nominal diameter sizes for vehicular signal indications: 8 inches and 12 inches. 12-inch signal indications shall be used for all signal sections in all new <sup>per hgt</sup> signal faces except eight-inch circular signal indications may be used in new signal faces only for:

- A. The green or flashing yellow signal indications in an emergency-vehicle traffic control signal (see Section 4G.02),
- B. The circular indications in signal faces controlling the approach to the downstream location where two adjacent signalized locations are close to each other and it is not practical because of factors such as high approach speeds, horizontal or vertical curves, or other geometric factors to install visibility-limited signal faces for the downstream approach;



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- C. The circular indications in a signal face that is located less than 120 feet from the stop line on a roadway with a posted or statutory speed limit of 30 mi/h or less;
- D. The circular indications in a supplemental near-side signal face;
- E. The circular indications in a supplemental signal face installed for the sole purpose of controlling pedestrian movements (see Section 4D.03) rather than vehicular movements; and
- F. The circular indications in a signal face installed for the sole purpose of controlling a bikeway or a bicycle movement.

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



Figure 8. 12-inch lens within 14-inch enclosure



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### **Section 4D.08 Positions of Signal Indications Within A Signal Face-General**

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

- Unless otherwise provided in the MUTCD for a particular application, each signal face at a signalized location shall have three, four, or five signal sections. Unless otherwise provided in the MUTCD for a particular application, if a vertical signal face includes a cluster (see MUTCD Section 4D.09), the signal face shall have at least three vertical positions.
- A Single-section signal face shall be permitted at a traffic control signal if it consists of a continuously displayed GREEN ARROW signal indication that is being used to indicate a continuous movement.
- The signal sections in a signal face shall be arranged in a vertical or horizontal straight line, except as otherwise provided in MUTCD Section 4D.09.
- The arrangement of adjacent signal sections in a signal face shall follow the relative positions listed in MUTCD Sections 4D.09 or 4D.10, as applicable.
- If a signal section that displays a CIRCULAR YELLOW signal indication is used, it shall be located between the signal section that displays the red signal indication and all other signal sections.
- If a U-turn arrow signal section is used in a signal face for a U-turn to the left, its position in the signal face shall be the same as stated in MUTCD Sections 4D.09 and 4D.10 for a left-turn arrow signal section of the same color. If a U-turn arrow signal section is used in a signal face for a U-turn to the right, its position in the signal face shall be the same as stated in MUTCD Sections 4D.09 and 4D.10 for a right-turn arrow signal section of the same color.
- A U-turn arrow signal indication pointing to the left shall not be used in a signal face that also contains a left-turn arrow signal indication. A U-turn arrow signal indication pointing to the right shall not be used in a signal face that also contains a right-turn arrow signal indication.

### **Section 4D.09 Positions of Signal Indications Within a Vertical Signal Face**

In each vertically-arranged signal face, all signal sections that display red signal indications shall be located above all signal sections that display yellow and green signal indications. In vertically-arranged signal faces, each signal section that displays a YELLOW ARROW signal indication shall be located above the signal section that displays the GREEN ARROW signal indication to which it applies.



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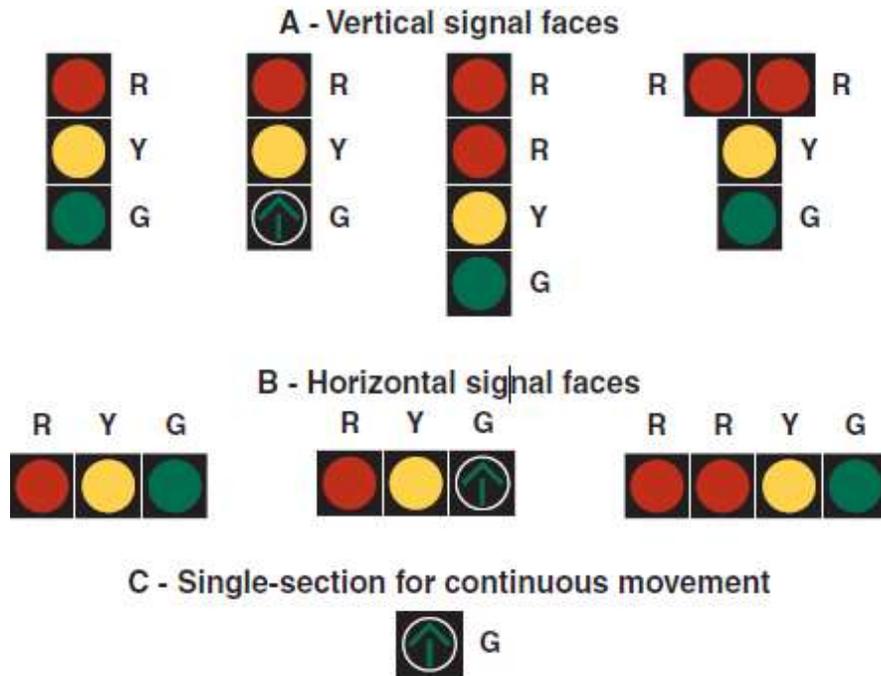


Figure 9. Typical arrangement of signal sections in signal faces that do not control turning movements (MUTCD Figure 4D-2.)

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

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



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**Section 4D.10 Positions of Signal Indications Within a Horizontal Signal Face**

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

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

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

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

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

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

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



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

The primary consideration in signal face placement, aiming, and adjustment shall be to optimize the visibility of signal indications to approaching traffic. Road users approaching a signalized intersection or other signalized area, such as a midblock crosswalk, shall be given a clear and unmistakable indication of their right-of-way assignment.

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.

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 shall be installed to warn approaching traffic of the traffic control signal.

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

Table 1. Minimum Sight Distance for Signal Visibility (MUTCD Table 4D-2.)

Note: Distances in this table are derived from stopping sight distance plus an assumed queue

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.



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Figure 10. Right-side approach signal indications not visible to traffic on left-side approach

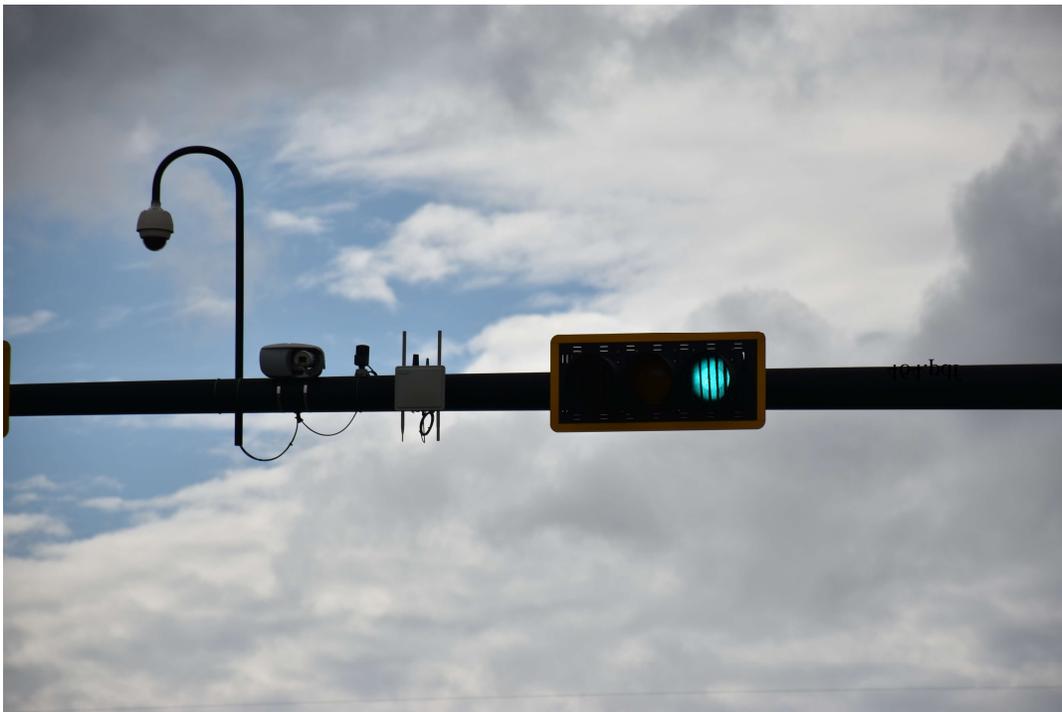


Figure 11. Signal lens with louvers



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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. An example is shown in Figure 12.



Figure 12. Signal head backplates with retroreflective strips

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Section 4D.13 Lateral Positioning of Signal Faces and Section 4D.14 Longitudinal Positioning of Signal Faces are not covered in this course.

#### **Section 4D.15 Mounting Height of Signal Faces**

The top of the signal housing of a vehicular signal face located over any portion of a highway that can be used by motor vehicles shall not be more than 25.6 feet above the pavement. For viewing distances between 40 and 53 feet from the stop line, the maximum mounting height to the top of the signal housing shall be as shown in Figure 13.



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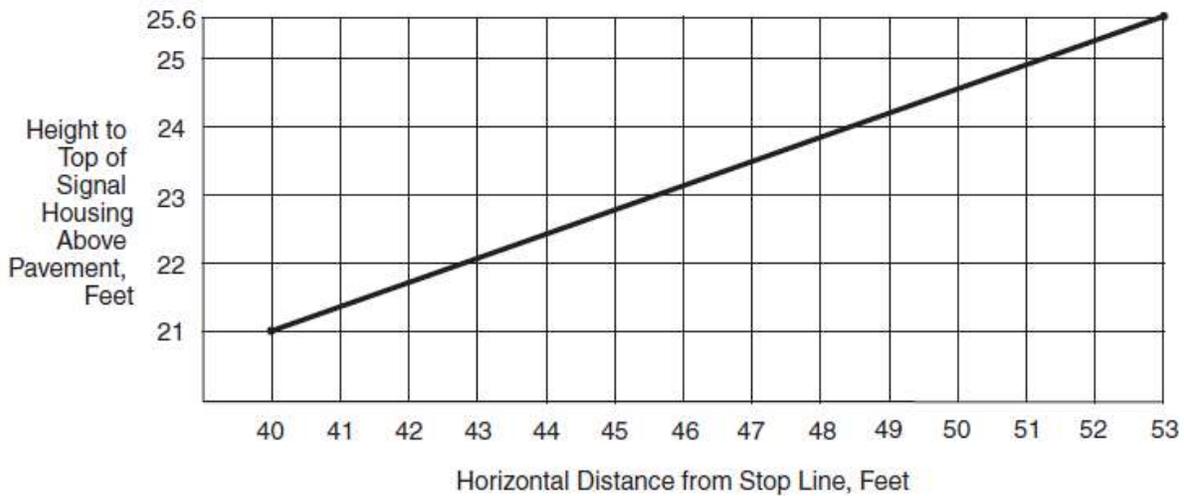


Figure 13. Maximum Mounting Height of Signal Faces Located Between 40 Feet and 53 Feet from Stop Line, (MUTCD Figure 4D.5.)

The bottom of the signal housing and any related attachments to a vehicular signal face located over any portion of a highway that can be used by motor vehicles shall be at least 15 feet above the pavement. The bottom of the signal housing (including brackets) of a vehicular signal face that is vertically arranged and not located over a roadway:

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

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

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

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

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



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Section 4D.17-4D.25 are not covered in this course.

**Section 4D.26 Yellow Change and Red Clearance Intervals**

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

The exclusive function of the yellow change interval shall be to warn traffic of an impending change in the right-of-way assignment. The duration of the yellow change interval shall be determined using engineering practices. When used, the duration of the red clearance interval shall be determined using engineering practices. The durations of yellow change intervals and red clearance intervals shall be consistent with the determined values within the technical capabilities of the controller unit. The duration of a yellow change interval shall not vary on a cycle-by-cycle basis within the same signal timing plan. For more information about calculation of yellow and all-red interval times see (7).

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. A red clearance interval should have a duration not exceeding 6 seconds with the exception of 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.

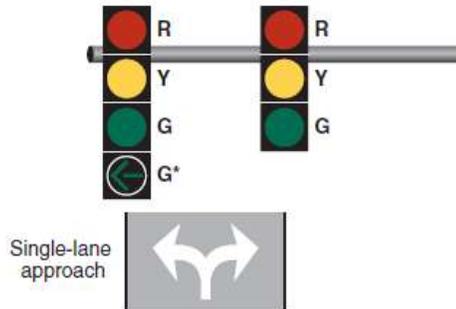
Except for warning beacons mounted on advance warning signs on the approach to a signalized location, signal displays that are intended to provide a “pre-yellow warning” interval, such as flashing green signal indications, vehicular countdown displays, or other similar displays, shall not be used at a signalized location.

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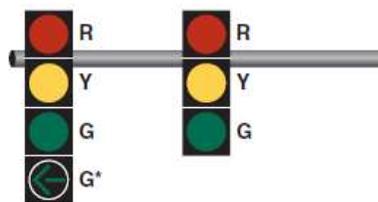
A - No conflicting vehicular or pedestrian movements



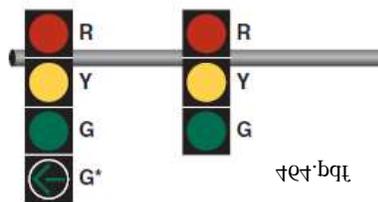
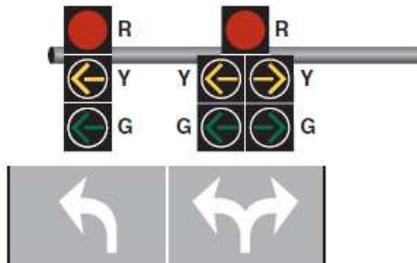
\* Left-turn GREEN ARROW section shall be included if there is an opposing one-way approach and the signal phasing eliminates conflicts.

Notes:

1. Horizontally-aligned signal faces may also be used.
2. Shared signal faces may also be 5 sections in a vertical straight line instead of a cluster.



OR



OR

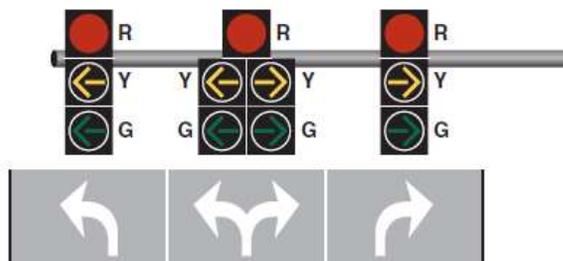
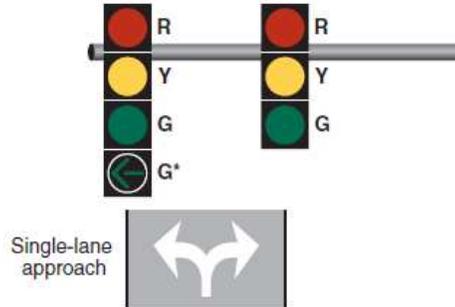


Figure 14. Signal indications with a shared left-turn/right turn lane and no through movement (1)



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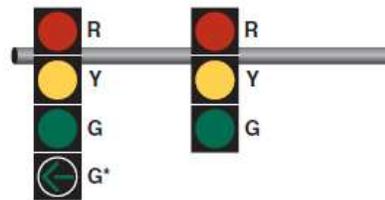
B - Pedestrian or vehicular conflict with one turn movement



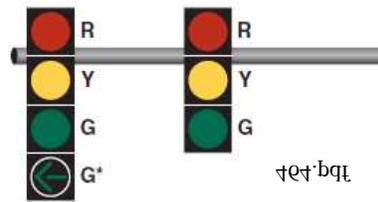
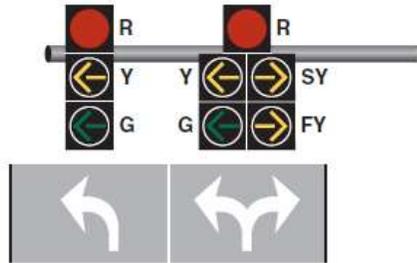
\* Left-turn GREEN ARROW section shall be included if there is an opposing one-way approach and the signal phasing eliminates conflicts.

Notes:

1. A conflict with the right-turn movement is illustrated.
2. Horizontally-aligned signal faces may also be used.
3. Shared signal faces may also be 5 sections in a vertical straight line instead of a cluster.



OR



OR

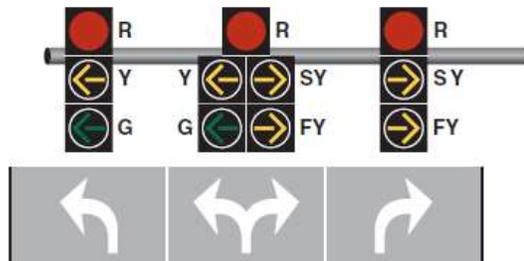
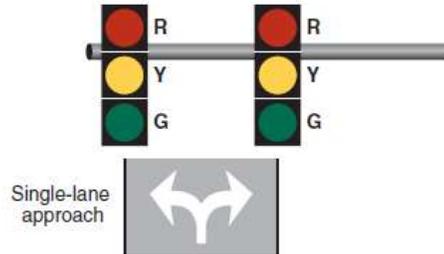


Figure 15. Signal indications with a shared left-turn/right turn lane and no through movement (2)



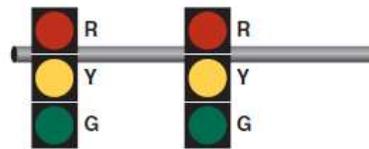
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C - Pedestrian or vehicular conflicts with both turn movements

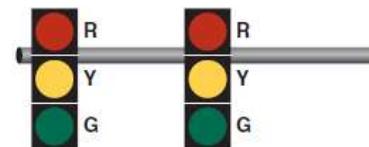
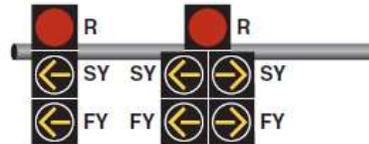


Notes:

1. Horizontally-aligned signal faces may also be used.
2. Shared signal faces may also be 5 sections in a vertical straight line instead of a cluster.



OR



OR

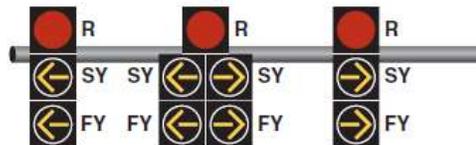


Figure 16. Signal indications with a shared left-turn/right turn lane and no through movement (3)



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Sections 4D.27-4D33 are not covered in this course.

**Section 4D.34 Use of Signs at Signalized Locations**

Traffic signal signs are sometimes used at highway traffic signal locations to instruct or guide pedestrians, bicyclists, or motorists. Among the signs typically used at or on the approaches to signalized locations are movement prohibition signs, lane control signs, pedestrian crossing signs, pedestrian actuation signs, traffic signal signs, Signal Ahead warning signs, Street Name signs, and Advance Street Name signs.

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

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

- A. If the signal indication for an approach is a flashing red at all times, or
- B. If a minor street or driveway is located within or adjacent to the area controlled by the traffic control signal but does not require separate traffic signal control because an extremely low potential for conflict exists.

**Section 4D.35 Use of Pavement Markings at Signalized Locations**

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

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Figure 17. Pavement markings at signalized locations example

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