MUTCD: Roadway Traffic Control

Course No: C06-012
Credit: 6 PDH

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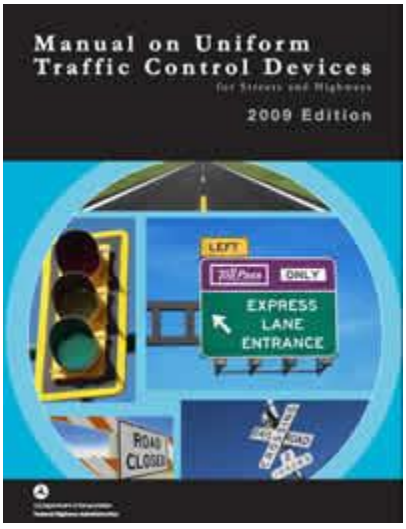
INTRODUCTION

This course discusses how to use the *Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)* to establish roadway traffic control. The contents of this course are intended to serve as guidance and not as an absolute standard or rule. It is intended to help you to use the MUTCD more effectively and not replace it. Should there be any conflicts between the contents of this course and the MUTCD, always follow the MUTCD.

Upon course completion, you should be familiar with the general MUTCD guidelines for traffic control devices. The overall course objective is to give engineers and designers an in-depth look at the principles to be considered when selecting and designing for traffic control.

For this course, the *Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) 2009 Edition* will serve as the text for the fundamental design principles of traffic signs and pavement markings. This document is recognized as the **national standard** for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel. Any traffic control device design or application contained within the MUTCD is considered to be in the public domain and available for use.



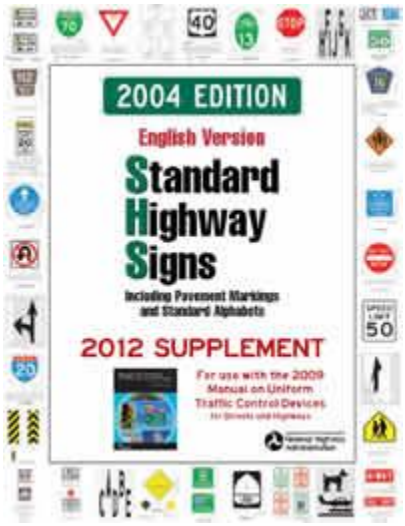
http://mutcd.fhwa.dot.gov/pdfs/2009/mutcd2009edition.pdf

Traffic signs and pavement markings are the primary communication devices used to convey laws and regulations, traffic and roadway conditions, and guidance and other information. These critical tools can provide important information to help users to travel safely on any U.S. roadway system.

However, traffic control devices cannot solve all traffic problems. Drivers process different types of visual and non-visual information differently: speed, roadway conditions, traffic, legal enforcement, noise levels, etc. Also, signs and markings serve as reminders of important information, so road users do not have to memorize everything.

The goal is to provide drivers with relevant information when they need it - resulting in safer, more efficient roadways with reduced liability risks. On the other hand, poor sign management and maintenance can greatly reduce safety, contribute to roadway incidents, and increase liability exposure.

The *Standard Highway Signs and Markings* book contains detailed specifications for all adopted standard signs and pavement markings. All traffic control devices shall be similar to or mirror images of those shown in this manual. Any symbols or colors cannot be modified unless otherwise stated.



http://mutcd.fhwa.dot.gov/SHSe/shs_2004_2012_sup.pdf

MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (MUTCD)

By law (23 CFR 655, Subpart F), the *Manual on Uniform Traffic Control Devices* (MUTCD) is recognized as "the national standard for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel". It is the definitive authority for traffic signs and pavement markings.

The MUTCD is published by the Federal Highway Administration (FHWA) to promote safety and efficiency on our public roads by establishing uniform standards for traffic control devices. It defines the nationwide standards for the installation and maintenance of the devices on all streets and highways. The MUTCD allows us to drive anywhere in the U.S. using the same basic signs. Drivers who see a particular sign should expect it to mean the same thing and be prepared to take the same action regardless of location.

The MUTCD has nine chapters ("Parts"):

General Information **Signs** **Markings** **Highway Traffic Signals**

Low-Volume Roads **Temporary Traffic Control** **School Areas**

Highway-Rail Grade Crossings **Bicycle Facilities**

SHALL, SHOULD, and MAY

The terms "shall," "should," and "may" have specific meanings when used in the MUTCD. These words are defined as follows:

SHALL – Required, mandatory or specifically prohibitive practice. Statements with "shall" conditions are typically used as a STANDARD in the MUTCD. These items cannot be modified or compromised. There is no allowance for discretion and they must be followed.

SHOULD – Advisory or recommended practice in typical situations. Deviation is appropriate if justified by engineering judgment or study. Statements marked as "should" are used for GUIDANCE in the MUTCD.

MAY – Permissive or optional practice without requirement or recommendation. Items marked as "may" are typically used in OPTION statements in the MUTCD and can contain allowable modifications.

SUPPORT statements do not contain the verbs "shall", "should", or "may". These statements are for informational purposes only (without any mandate, recommendation, or enforcement).

BASIC REQUIREMENTS OF TRAFFIC CONTROL DEVICES

In order to be effective, any traffic control device has to be used correctly. The MUTCD lists the following principles to be used when selecting and applying each device:

- **Fulfill a need**

A sign should only be installed if there is a *need* for warning, regulation or guidance information. If a need exists and the sign in question does not meet that need, use something else. Overusing signs can lead to disrespect and loss of emphasis value while underuse can result in persistent but correctable safety problems.

- **Command attention**

Standard signs are designed to be noticed and attract attention. The high-contrast color combinations were chosen due to their ability to stand out and be easily read. Oversized signs, doubled signs, or flashing beacons may also emphasize the sign's message.

- **Command respect**

Warning and regulatory signs that seem unneeded or unreasonable are regularly disobeyed. Good sign management and maintenance is crucial to commanding respect for traffic control devices. Nonstandard or damaged signs are more likely to be disregarded.

- **Have one simple message**

A sign's message needs to be clear and readable. By using standard signs in the MUTCD that have been researched and evaluated by the FHWA, most drivers should understand their meanings.

- **Provide adequate time for proper response**

Traffic control devices should meet or exceed MUTCD standards so drivers have adequate time (Perception-Response Time – PRT) and distance to take appropriate actions before reaching a situation. Otherwise, insufficient response time may result in roadway crashes.

Traffic speed is crucial for determining driver response time. High speeds require longer response time and more reaction distance. This increased distance can be obtained by using larger signs, or by placing signs in advance of the location where the information is needed.

Using the five basic requirements will help make traffic control devices more effective. Design, placement, operation, maintenance, and uniformity should be considered to maximize the ability of a device to meet these principles. However, by disregarding the five requirements, road users may tend to disregard your traffic control devices.

The MUTCD defines a road user as "a vehicle operator, bicyclist, or pedestrian, including persons with disabilities, within the highway or on a private road open to public travel". This group includes drivers of different skill levels and ages, pedestrians, wheelchairs, runners, rollerbladers, bicyclists, truck drivers, and motorcyclists. The ability to empathize with the road user is important skill for engineers in order to meet the needs of everyone using the road. By meeting their needs, you can minimize any problems that the average road user may encounter.

The Americans With Disabilities Act (ADA) of 1990

The regulations of the Americans with Disabilities Act are designed to prevent any discrimination against disabled individuals, including road users. This act requires access needs of the disabled be accommodated through the use of specialized signs, pavement markings, sign placements, etc.

SIGNS

READIBILITY and RETROREFLECTIVITY

Drivers must be able to read a sign from a reasonable distance and have adequate response time to safely travel the roadway. Improving nighttime visibility of signs and pavement markings becomes more important as we get older. As we age, our eyes gradually become less sensitive to light. As the national population gets older, the average driver gets older, and people continue driving at older ages.

Retroreflectivity is the ability of a traffic control device to reflect light from its surface to its original source. Retroflective traffic signs are used to increase nighttime visibility. Maintaining retroreflectivity is crucial to traffic safety since fatal night crashes occur approximately three (3) times as often as daytime traffic fatalities.

To work properly, retroreflectivity needs the following elements: **Light source** (vehicle headlights); **Target** (traffic control device); and **Receptor** (driver's eyes). Technologies involving glass beads or prismatic reflectors are more visible and bright because they reflect more light directly back at the original source.

All signs (regulatory, warning, and guide) and object markers need to be retroreflective or illuminated to display the same shape and color regardless of time and day. New materials or methods can be used as long as the traffic control devices meet the standard color requirements. Sign design should be uniform without any increase in: **visibility, legibility,** or **driver comprehension during day or night conditions.**

Sign Type and Designation

Over the years, traffic signs have been responsible for providing messages of increasing complexity. To accomplish this goal, the MUTCD specifies standard design features to encourage adequate perception-reaction time for the road user. These features (size, shape, and color) are specific to the functional category of each traffic sign.

SIGN CATEGORIES AND USE

CATEGORY	USE
Regulatory	Requires or prohibits actions by the road user
Warning	Warns user of conditions that may require an action to avoid a hazardous situation
Guide & Information	Helps user find their way, informs user of traveler services, etc.
Recreational & Cultural Interest	Guides user to recreation and cultural areas/facilities
Non-Traffic Control	Not meant for highway use, or contains information not related to highway use or traffic control

Sign Color and Shape

A sign's color and shape can be vital in conveying traffic control information. These specific combinations are used to inform drivers of the type of sign. The colors and shapes are meant to command attention and convey a clear simple message. Signs usually have one color for the legend (typically black or white), which includes symbols, text and border. Some signs (such as prohibition signs) have two-color legends containing a red circle and slash over a black symbol. The Federal Highway Administration (FHWA) established the following color code of appropriate colors for traffic control devices.

COLOR CODE FOR TRAFFIC CONTROL DEVICES

COLOR	MEANING
Black	Regulation
Blue	Road user services guidance, tourist information, evacuation route
Brown	Recreational and cultural interest area guidance
Coral	Unassigned
Fluorescent Pink	Incident management
Fluorescent Yellow-Green	Pedestrian warning, bicycle warning, playground warning, school bus and school warning
Green	Indicated movements permitted, direction guidance
Light Blue	Unassigned
Orange	Temporary traffic control
Purple	Lanes restricted to use only by vehicles with registered electronic toll collection (ETC) accounts
Red	Stop or prohibition
White	Regulation
Yellow	Warning

Table 2A-4. Use of Sign Shapes

Shape	Signs
Octagon	Stop*
Equilateral Triangle (1 point down)	Yield*
Circle	Grade Crossing Advance Warning*
Pennant Shape/Isosceles Triangle (longer axis horizontal)	No Passing*
Pentagon (pointed up)	School Advance Warning Sign (squared bottom corners)* County Route Sign (tapered bottom corners)*
Crossbuck (two rectangles in an "X" configuration)	Grade Crossing*
Diamond	Warning Series
Rectangle (including square)	Regulatory Series Guide Series** Warning Series
Trapezoid	Recreational and Cultural Interest Area Series National Forest Route Sign

* This sign shall be exclusively the shape shown.

** Guide series includes general service, specific service, tourist-oriented directional, general information, recreational and cultural interest area, and emergency management signs.

Sign Size

Standard sign sizes should be used unless engineering judgment indicates otherwise. Sign sizes should not be smaller than the minimum sizes contained in the MUTCD. However, larger sizes may be used where deemed appropriate.

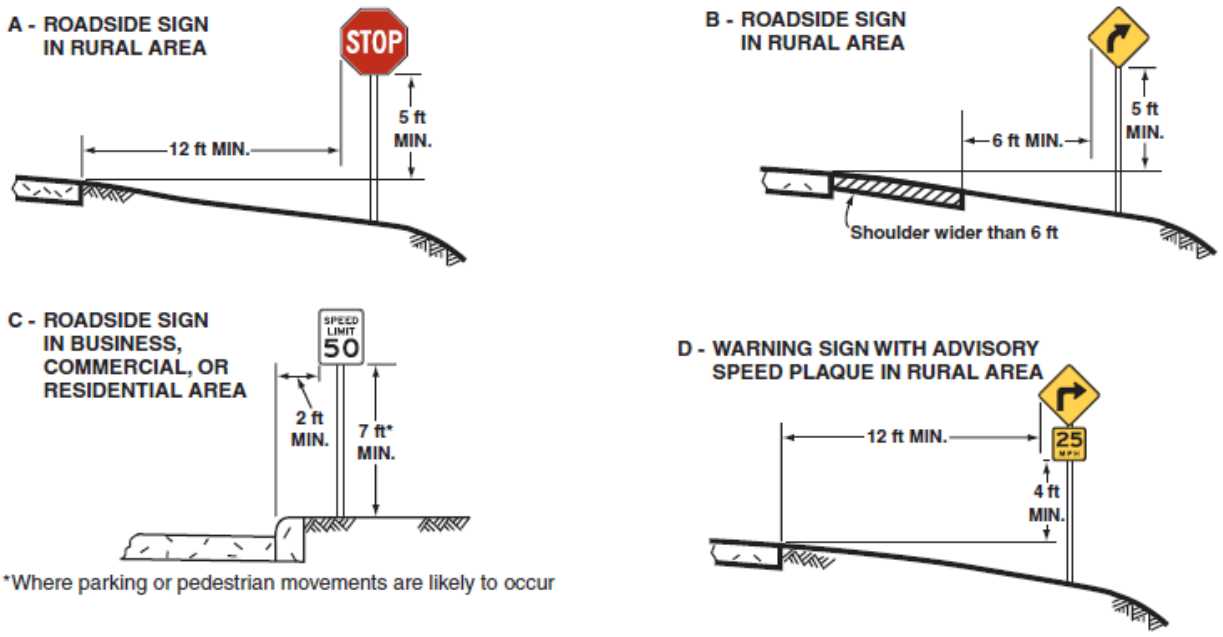
Sign Location

Signs requiring different user decisions need to be spaced sufficiently far apart for the required decisions to be made reasonably safely. Multiple signs should be compatible and provide a logical sequence of communication. The road user needs to have adequate time to adjust speed, avoid any potential hazard, and continue on their desired route. These signs should be placed on the right side of the roadway where they can be easily recognized and understood. Signs in other locations should be considered supplementary to signs in the normal locations.

Potential sign locations should:

Be outside the clear zone unless placed on a breakaway or yielding support
Not be hidden from view
Optimize nighttime visibility
Minimize the effects of mud splatter and debris
Not obscure each other – Avoid clutter

Figure 2A-2. Examples of Heights and Lateral Locations of Sign Installations



Lateral Distance

A sign's proximity to the road directly impacts visibility. Close placement will make it easier to read but will also make it more likely to be damaged by traffic. Signs placed further away from the roadway are less vulnerable to damage but harder to read.

Post-mounted signs should have a *minimum lateral clearance of 12 feet* from the edge of the travel way to the near edge of the sign. For shoulder widths over 6 feet, the *minimum offset should be 6 feet* from the shoulder's edge. Potential sites should be located as far as practical from the edge of shoulder with minimum traffic exposure to the traffic sign supports.

For curbed roadways with parking or pedestrians, the edge of the sign should be a *minimum offset of two feet* from the face of curb which permits an adequate clearance for opening parked vehicle doors. Increasing this lateral offset distance will minimize chances of sign damage by vehicles but caution needs to be exercised to prevent blocking the sidewalk.

Height Above the Roadway

The height of a sign can impact sign visibility, roadway safety, and pedestrian access. The minimum height for signs installed in rural areas is *5 feet* and is measured from the edge of pavement elevation to the bottom of the sign. For urban areas with parking, pedestrian, or

sight distance challenges, the *minimum height requirement is 7 feet*. At curb locations, this distance is measured from the top of curb to the bottom of sign. The minimum height for roadways without curb is measured from the edge of traveled way elevation to the bottom of the sign. For areas with sidewalks, the *minimum height is 7 feet* (measured from the top of sidewalk to the bottom of the sign).

The MUTCD specifies only *minimum heights* for sign assemblies. For hillcrests, it may be useful to place the sign higher than normal for better visibility.

MINIMUM SIGN HEIGHT

5 ft	**Rural**
7 ft	**Parking or pedestrian movements (non-rural)**
7 ft	**Directional signs on expressways and freeways**
8 ft	**Height of sign if secondary sign present**
5 ft	**Secondary sign above the level of the pavement edge**
7 ft	**All route signs, warning signs, and regulatory signs on expressways and freeways**

Sign Priority

For locations requiring more than one sign, priority needs to be established regarding the order of placement. Regulatory signs take precedence over the other signs since they convey legal or regulatory information. Guide, informational, recreational, and cultural interest signs are less crucial due to their location flexibility.

TRAFFIC SIGN PRIORITY

Regulatory → Warning → Guide → Emergency services → Motorist services → Public transportation → Traffic Generators → General Information

REGULATORY SIGNS

Regulatory signs inform motorists of traffic regulations, laws, and applicable legal requirements. They require or prohibit the movement of vehicles, pedestrians, and other road users. Their goal is to encourage the safe and orderly flow of traffic. All signs should clearly communicate its message and provide adequate visibility (retroreflective or illumination).

Unless specifically designated otherwise, all regulatory signs shall be rectangular (exceptions include stop signs, yield signs and railroad crossing signs). The colors used for regulatory signs are white, black, and red.

R1-1

R1-3P

R1-2

R1-2aP

R1-10P

Table 2B-1. Regulatory Sign and Plaque Sizes (Sheet 1 of 4)

Sign or Plaque	Sign Designation	Section	Conventional Road		Expressway	Freeway	Minimum	Oversized
			Single Lane	Multi-Lane				
Stop	R1-1	2B.05	30 x 30*	36 x 36	36 x 36	—	30 x 30*	48 x 48
Yield	R1-2	2B.08	36x36x36*	48x48x48	48x48x48	60x60x60	30x30x30*	—
To Oncoming Traffic (plaque)	R1-2aP	2B.10	24 x 18	24 x 18	36 x 30	48 x 36	24 x 18	—
All Way (plaque)	R1-3P	2B.05	18 x 6	18 x 6	—	—	—	30 x 12
Yield Here to Peds	R1-5	2B.11	—	36 x 36	—	—	—	36 x 36
Yield Here to Pedestrians	R1-5a	2B.11	—	36 x 48	—	—	—	36 x 48
Stop Here for Peds	R1-5b	2B.11	—	36 x 36	—	—	—	36 x 36
Stop Here for Pedestrians	R1-5c	2B.11	—	36 x 48	—	—	—	36 x 48
In-Street Ped Crossing	R1-6,6a	2B.12	12 x 36	12 x 36	—	—	—	—
Overhead Ped Crossing	R1-9,9a	2B.12	90 x 24	90 x 24	—	—	—	—
Except Right Turn (plaque)	R1-10P	2B.05	24 x 18	24 x 18	—	—	—	—
Speed Limit	R2-1	2B.13	24 x 30*	30 x 36	36 x 48	48 x 60	18 x 24*	30 x 36
Truck Speed Limit (plaque)	R2-2P	2B.14	24 x 24	24 x 24	36 x 36	48 x 48	—	36 x 36
Night Speed Limit (plaque)	R2-3P	2B.15	24 x 24	24 x 24	36 x 36	48 x 48	—	36 x 36
Minimum Speed Limit (plaque)	R2-4P	2B.16	24 x 30	24 x 30	36 x 48	48 x 60	—	36 x 48
Combined Speed Limit	R2-4a	2B.16	24 x 48	24 x 48	36 x 72	48 x 96	—	36 x 72
Unless Otherwise Posted (plaque)	R2-5P	2B.13	24 x 18	24 x 18	—	—	—	—
Citywide (plaque)	R2-5aP	2B.13	24 x 6	24 x 6	—	—	—	—
Neighborhood (plaque)	R2-5bP	2B.13	24 x 6	24 x 6	—	—	—	—
Residential (plaque)	R2-5cP	2B.13	24 x 6	24 x 6	—	—	—	—
Fines Higher (plaque)	R2-6P	2B.17	24 x 18	24 x 18	36 x 24	48 x 36	—	36 x 24
Fines Double (plaque)	R2-6aP	2B.17	24 x 18	24 x 18	36 x 24	48 x 36	—	36 x 24
$XX Fine (plaque)	R2-6bP	2B.17	24 x 18	24 x 18	36 x 24	48 x 36	—	36 x 24
Begin Higher Fines Zone	R2-10	2B.17	24 x 30	24 x 30	36 x 48	48 x 60	—	36 x 48
End Higher Fines Zone	R2-11	2B.17	24 x 30	24 x 30	36 x 48	48 x 60	—	36 x 48
Movement Prohibition	R3-1,2,3,4,18,27	2B.18	24 x 24*	36 x 36	36 x 36	—	—	48 x 48
Mandatory Movement Lane Control	R3-5,5a	2B.20	30 x 36	30 x 36	—	—	—	—
Left Lane (plaque)	R3-5bP	2B.20	30 x 12	30 x 12	—	—	—	—
HOV 2+ (plaque)	R3-5cP	2B.20	24 x 12	24 x 12	—	—	—	—
Taxi Lane (plaque)	R3-5dP	2B.20	30 x 12	30 x 12	—	—	—	—

Regulatory signs should be used to fulfill a need. Drivers tend to disregard a regulation that is perceived as unneeded. However, other road users may expect them to obey the sign, and act accordingly which may result in traffic accidents (example: Yield sign). Regulatory signs can be used to remind road users of statutory traffic laws (no parking, one way, etc.). However, some laws may not need signs to be enforceable.

WARNING SIGNS

Warning signs alert road users to unexpected/unapparent conditions on or near the roadway. These signs may require actions by the driver in order to ensure safe traffic operations.

W5-1 W5-2 W5-3 W6-1 W6-2 W12-1

Background colors for warning signs depend on their use. The majority of warning signs are diamond-shaped with a black legend/border and yellow background. Signs regarding pedestrians, bicyclists and playgrounds typically have a black legend/border and yellow or fluorescent yellow-green background. For buses, schools and supplemental plaques, the signs should have a black legend/border with a fluorescent yellow-green background.

School signs
Pentagon-shaped

S1-1

Railroad warning signs
Circular

W10-1

No passing signs
Triangular

W14-3

Properly located warning signs can reduce incidents by improving driver Perception-Response Times (PRT). A standard value for PRT is typically 2.5 seconds, with 2.5 to 3.0 seconds for older drivers, and longer times for unexpected events.

Although some warning signs may be more effective than others, their use should result in a significant reduction in related incidents. But like all traffic signs, improper use usually causes disrespect for all warning signs, and minimizes their effectiveness.

When considering the use of a warning sign:

Determine if the hazard can be removed.
If it will take time to remove the hazard, use a temporary sign to warn traffic.
If the hazard is impossible or too expensive to remove, install a warning sign.
Any temporary signage should be removed as soon as it is no longer needed.

Table 2C-1. Categories of Warning Signs and Plaques

Category	Group	Section	Signs or Plaques	Sign Designations
Roadway Related	Changes in Horizontal Alignment	2C.07	Turn, Curve, Reverse Turn, Reverse Curve, Winding Road, Hairpin Curve, 270-Degree Curve	W1-1,2,3,4,5,11,15
		2C.08	Advisory Speed	W13-1P
		2C.09	Chevron Alignment	W1-8
		2C.10	Combination Horizontal Alignment/Advisory Speed	W1-1a,2a
		2C.11	Combination Horizontal Alignment/Intersection	W1-10,10a,10b,10c,10d
		2C.12	Large Arrow (one direction)	W1-6
		2C.13	Truck Rollover	W1-13
		2C.14	Advisory Exit or Ramp Speed	W13-2,3
		2C.15	Combination Horizontal Alignment/Advisory Exit or Ramp Speed	W13-6,7
	Vertical Alignment	2C.16	Hill	W7-1,1a,2P,2bP,3P,3aP,3bP
		2C.17	Truck Escape Ramp	W7-4,4b,4c,4dP,4eP,4fP
		2C.18	Hill Blocks View	W7-6
	Cross Section	2C.19	Road Narrows	W5-1
		2C.20,21	Narrow Bridge, One Lane Bridge	W5-2,3
		2C.22,23,25	Divided Highway, Divided Highway Ends, Double Arrow	W6-1,2; W12-1
		2C.24	Freeway or Expressway Ends, All Traffic Must Exit	W19-1,2,3,4,5
		2C.26	Dead End, No Outlet	W14-1,1a,2,2a
		2C.27	Low Clearance	W12-2,2a
	Roadway Surface Condition	2C.28,29	Bump, Dip, Speed Hump	W8-1,2; W17-1
		2C.30	Pavement Ends	W8-3
		2C.31	Shoulder, Uneven Lanes	W8-4,9,11,17,17P,23,25
		2C.32	Slippery When Wet, Loose Gravel, Rough Road, Bridge Ices Before Road, Fallen Rocks	W8-5,7,8,13,14
		2C.33	Grooved Pavement, Metal Bridge Deck	W8-15,15P,16
		2C.34	No Center Line	W8-12
	Weather	2C.35	Road May Flood, Flood Gauge, Gusty Winds Area, Fog Area	W8-18,19,21,22
Traffic Related	Advance Traffic Control	2C.36-39	Stop Ahead, Yield Ahead, Signal Ahead, Be Prepared To Stop, Speed Reduction, Drawbridge Ahead, Ramp Meter Ahead	W3-1,2,3,4,5,5a,6,7,8
	Traffic Flow	2C.40-45	Merge, No Merge Area, Lane Ends, Added Lane, Two-Way Traffic, Right Lane Exit Only Ahead, No Passing Zone	W4-1,2,3,5,5P,6; W6-3; W9-1,2,7; W14-3
	Intersections	2C.46	Cross Road, Side Road, T, Y, Circular Intersection, Side Roads	W2-1,2,3,4,5,6,7,8; W16-12P,17P
		2C.47	Large Arrow (two directions)	W1-7
		2C.48	Oncoming Extended Green	W25-1,2
	Vehicular Traffic	2C.49	Truck Crossing, Truck (symbol), Emergency Vehicle, Tractor, Bicycle, Golf Cart, Horse-Drawn Vehicle, Trail Crossing	W8-6; W11-1,5,5a,8,10, 11,12P,14,15,15P,15a; W16-13P
	Non-Vehicular	2C.50,51	Pedestrian, Deer, Cattle, Snowmobile, Equestrian, Wheelchair, Large Animals, Playground	W11-2,3,4,6,7,9,16,17,18,19, 20,21,22; W15-1; W16-13P
	New	2C.52	New Traffic Pattern Ahead	W23-2
Other Supplemental Plaques	Location	2C.53	Downward Diagonal Arrow, Ahead	W16-7P,9P
	HOV	2C.53	High-Occupancy Vehicle	W16-11P
	Distance	2C.55	XX Feet, XX Miles, Next XX Feet, Next XX Miles	W7-3aP; W16-2P,2aP,3P,3aP,4P
	Arrow	2C.56	Advance Arrow, Directional Arrow	W16-5P,6P
	Street Name Plaque	2C.58	Advance Street Name	W16-8P,8aP
	Intersection	2C.59	Cross Traffic Does Not Stop	W4-4P,4aP,4bP
	Share The Road	2C.60	Share The Road	W16-1P
	Photo Enforced	2C.61	Photo Enforced	W16-10P,10aP
	New	2C.62	New	W16-15P

The minimum size for all diamond-shaped signs is 36 x 36 inches for multilane roadways with a posted speed greater than 35 mph.

GUIDE AND INFORMATION SIGNS

Guide and information signs provide information to guide users to their destination in the most simple, direct manner possible. These signs direct drivers using streets and highways by informing them of intersections, directing them to various destinations, or identifying nearby rivers, streams, parks and historical sites.

D1-2 D4-1 D4-2 M5-5

Typical guide signs on streets or highways are rectangular with white text and border on green, blue, or brown backgrounds. Work zone or detour signs are black with an orange background. All guide and information signs (message, border, legend and background) should be retroreflective or illuminated.

As a general rule, guide signs should be limited to a *maximum of 3 lines* to provide adequate time for user comprehension. Long messages (regardless of letter size) take longer for the reader to comprehend. It may be helpful to provide a distance message or action information on guide signs in addition to destinations. Providing accurate and timely navigation information is crucial to traffic safety. Guide and information signs can help prevent erratic maneuvers, and minimize potential crashes.

Freeways

Freeway and expressway signing should be a planned system of installations. An engineering study can be useful for solving the problems of multiple locations within the context of an entire route. Consistent signing should take into account the geographical, geometric, and operating factors that create significant differences between urban and rural conditions.

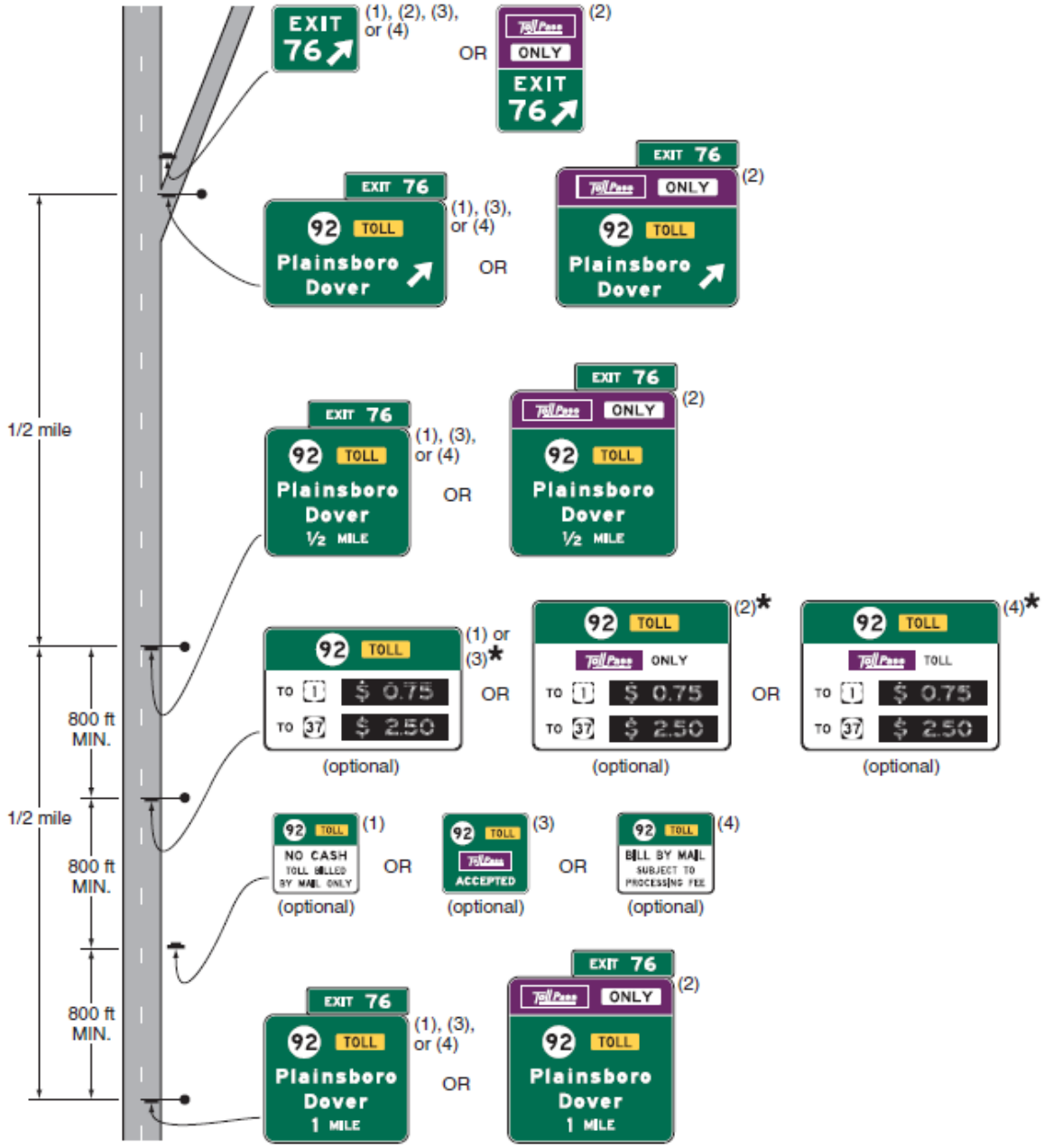
Functions of Guide Signs on Freeways and Expressways

- Provide directions to destinations, roadways, intersections or interchanges;
- Advance notice of the approaches to intersections or interchanges;
- Direct road users in advance of diverging or merging movements;
- Identify routes and provide directions;
- Show distances to destinations;
- Indicate access points to motorist services, rest, scenic, and recreational areas;
- Provide other informational value.

TOLL ROAD SIGNS

Toll highways are typically limited-access freeways or expressways with portions being a toll road, bridge, tunnel, or other crossing point. General signing requirements for toll roads depend on the type of facility and access (freeway, expressway, or conventional road). Toll plazas and collection points require additional modifications to the typical signing.

Figure 2F-6. Examples of Guide Signs for the Entrance to a Toll Highway on which Tolls are Collected Electronically Only



PREFERENTIAL AND MANAGED LANE SIGNS

Preferential lanes are designated for special traffic uses (high-occupancy vehicles (HOVs), light rail, buses, taxis, bicycles, etc.). Lane treatments range from restricting a turning lane to a certain class of vehicles during peak periods to providing a separate roadway system within a highway corridor for certain vehicles.

Types of Preferential Lanes

Barrier-separated: a separate alignment or physically separated from the other travel lanes by a barrier or median

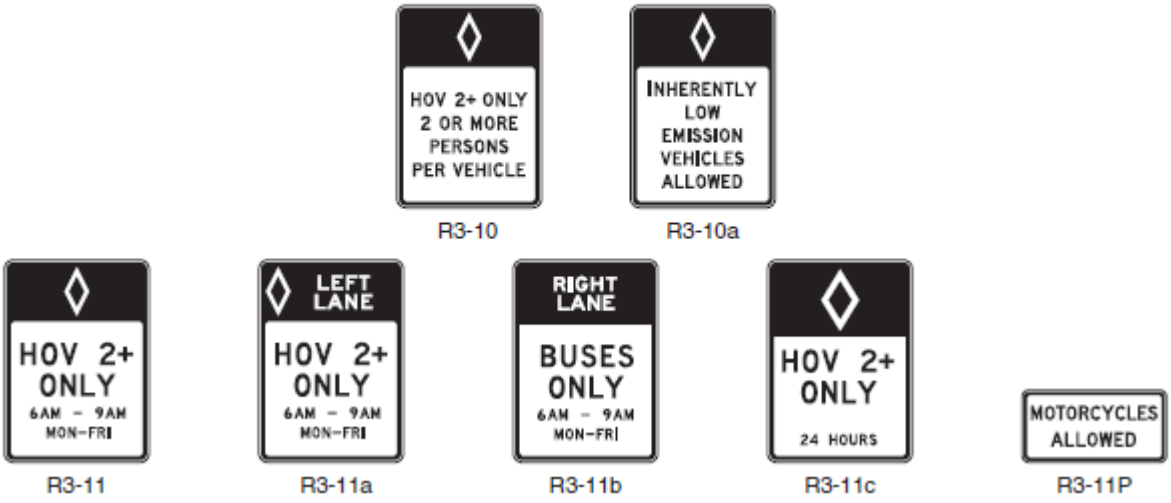
Buffer-separated: separated from the adjacent traffic lanes by a narrow buffer area with longitudinal pavement markings

Contiguous: separated from the adjacent lanes by a lane line

Preferential lanes might allow access with the adjacent traffic lanes or restrict access to designated locations. They can also be operated in a constant direction or as reversible lanes. For a divided highway, reversible preferential lanes can be operated counter-flow to the direction of traffic on the adjacent general-purpose lanes.

Figure 2G-1. Preferential Lane Regulatory Signs and Plaques (Sheet 1 of 2)

POST-MOUNTED PREFERENTIAL LANE SIGNS



GENERAL INFORMATION SIGNS

General Information signs convey various types of information that may be of interest to the traveler - landmarks, geographical interest, State lines, city limits, other political boundaries, time zones, stream names, elevations, safety and transportation-related messages. General information signs contain simple dignified designs without advertising and are commonly used in combination with recreational and cultural interest signs.

Figure 2H-1. General Information and Miscellaneous Information Signs

CHANGEABLE MESSAGE SIGNS

A changeable message sign (CMS) is capable of displaying one or more alternative messages. Some of these signs have a blank mode when no message is displayed, with others displaying multiple messages - one message displayed at a time.

Typical Changeable Message Sign Applications

- Warning situations
- Traffic regulations
- Speed control
- Destination guidance
- Incident management and route diversion
- Warning of adverse weather conditions
- Special event applications
- Crossing situations control
- Lane, ramp, and roadway control
- Lane management
- Travel times

Government agencies typically use changeable message signs to display information regarding safety, transportation, emergencies, homeland security, and America's Missing: Broadcast Emergency Response (AMBER) alerts.

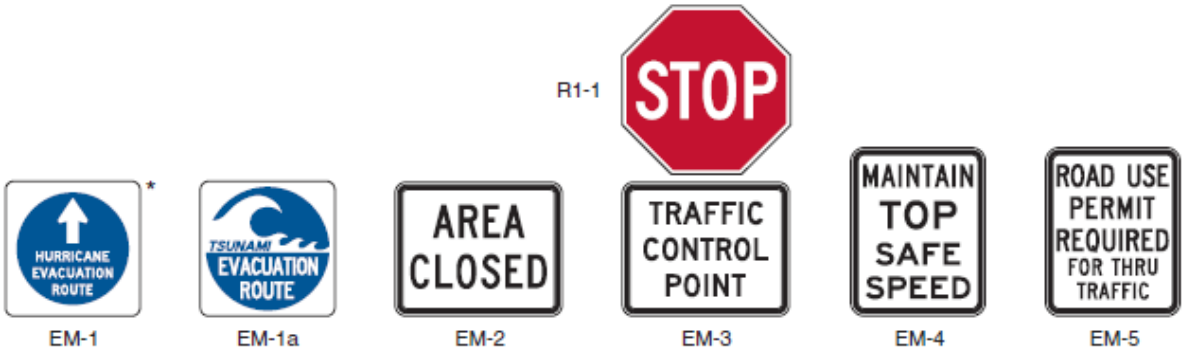
EMERGENCY MANAGEMENT SIGNING

Contingency planning for an emergency evacuation should be considered by all State and local jurisdictions for all applicable roadways. In the event of a disaster with road closures, a contingency plan should address the following elements:

- Controlled operation of certain designated highways,
- Establishment of traffic operations for expediting essential traffic,
- Provision of emergency centers for civilian aid.

Emergency Management signs should guide and control highway traffic in the event of an emergency. These signs should not permanently displace any of the standard signs that are normally applicable.

Figure 2N-1. Emergency Management Signs



State and local authorities are responsible for any advance planning addressing transportation operations' emergencies. The Federal Government provides guidance to the States due to changing circumstances.

RECREATIONAL AND CULTURAL INTEREST SIGNS

Recreational and cultural interest areas are open to the general public for the purpose of relaxation, play, or amusement. Recreational and cultural interest signs guide road users to general areas first and then to specific facilities.

Recreational areas include:

Parks Campgrounds Gaming facilities Ski areas

Cultural attractions include:

Museums Art galleries Historical buildings or sites

Recreational or cultural interest signs are rectangular with white symbols and borders on either a green, brown, or black background. The signs on highways outside of recreational interest areas will have white symbols/borders on brown backgrounds. Exceptions include:

- Ferry, Post Office, Airport, Bus Stop, and Helicopter signs - white symbols with green backgrounds.
- Camping Tent and Trailer, Gas, Handicapped, Lodging, Picnic area, Rest Area, Telephone, Rest Room, Trailer Sanitary Station, Group Camping, Group Picnicking, Parking - white symbols with blue backgrounds.

MARKINGS

PAVEMENT MARKINGS

Pavement marking is more than just roadway striping. It relays regulatory and vehicle-path information to the user without requiring them to divert their attention from the road. Their purpose is to encourage safe, orderly traffic flow while optimizing roadway capacity. Pavement markings need to be easily recognized and understood in order to be effective. A standardized system of marking color, shape, and application has been developed to convey the same message each time they are encountered.

All pavement markings should be maintained to ensure adequate daytime and nighttime visibility. Upon installation, it is the municipality's responsibility to maintain the marking. If the municipality decides that the marking is no longer needed, their decision process should be documented. Any markings deemed non-applicable or confusing should be removed as soon as possible.

COLORS

WHITE PAVEMENT MARKING Separates traffic flows in the same direction
Delineates the right edge of the roadway.

YELLOW PAVEMENT MARKING Separates traffic traveling in the opposite directions
Delineates the left edge of the roadways of divided and one-way highways & ramps
Separates two-way left turn lanes and reversible lanes from other lanes.

BLUE PAVEMENT MARKING Supplements white markings for handicap parking

PURPLE PAVEMENT MARKING Supplements toll plaza approach lane lines or edgelines that are restricted for registered electronic toll collection vehicles.

BLACK PAVEMENT MARKING Used in combination with other pavement markings (yellow, white, red, blue, or purple) where a light-colored pavement does not provide sufficient contrast.

MATERIALS

Pavement markings typically include paints and thermoplastics but they may also use other marking materials (colored paving, raised pavement markers, etc.). Highly visible delineators and channelizing devices can also be placed vertically above the roadway.

Paint is the easiest, cheapest, and most commonly used pavement marking material. However, it is also the least durable. To combat poor nighttime visibility, retroreflectivity is improved by adding glass beads into the wet paint.

Thermoplastic pavement markings use a heated temperature-setting plastic material for use on asphalt pavements. Based on temperature-related expansion and contraction differentials between plastic and concrete (which may result in thermoplastic separation) thermoplastic is prohibited from use on concrete.

Marking color, pattern, and orientation provide crucial information to roadway users. Complying with these standards is critical to provide positive guidance and should be maintained throughout the product's life. Materials for minimizing tripping or loss of traction for users (pedestrians, bicyclists, motorcycles, etc.) should also be considered when choosing pavement markings.

LONGITUDINAL MARKINGS

White and yellow longitudinal markings (long lines) guide traffic along the roadway by providing visual clues to the travel path. Dashed lines (broken lines) allow vehicles to pass or change lanes. These white or yellow markers are *four to six inches wide* and applied with ten foot painted dashes and thirty foot spacing. The distance from the beginning of one dash to the beginning of the next is 40 feet. These lines provide an excellent way to estimate roadway distances (example: three dashes between two side roads; the estimated distance is 3 x 40 = **120 feet** separating the roadways).

WIDTHS & PATTERNS OF LONGITUDINAL PAVEMENT MARKINGS

Normal Line - 4 to 6 inches wide.

Wide Line - at least twice the width of a normal line. The width of the line indicates the degree of emphasis.

Double Line - two parallel lines separated by a discernible space.

Broken Line - normal line segments (10 feet) separated by (30 feet) gaps.

Dotted Line for Extensions - noticeably shorter line segments (typically 2 feet) separated by shorter gaps (typically 2 to 6 feet). The width of a dotted line shall be at least the same as the width of the line it extends.

Dotted Line for Lane Lines - 3 feet line segments with 9 feet gaps.

YELLOW CENTER LINE PAVEMENT MARKINGS AND WARRANTS

Yellow center line pavement markings are used to separate traffic lanes with opposite directions of travel. These can be installed at locations that are not the geometric center of the roadway. Center line pavement markings may be used on short roadway sections to control traffic at specific locations (curves, over hills, grade crossings, bridges, etc.) for roadways without continuous center line pavement markings,

CENTER LINE MARKINGS - TWO-LANE, TWO-WAY ROADWAY OPTIONS

Two-direction passing zone markings - a normal broken yellow line
- passing with care is permitted for traffic traveling in either direction;

One-direction no-passing zone markings - a double yellow line, one of which is a normal broken yellow line and the other is a normal solid yellow line
- passing with care is permitted for traffic traveling adjacent to the broken line, but is prohibited for traffic traveling adjacent to the solid line

Two-direction no-passing zone markings - two normal solid yellow lines
- passing is prohibited for traffic traveling in either direction.

Please note that a single solid yellow line shall never be used for center line marking on two-way roadways.

For undivided two-way roadways with four or more lanes for moving motor vehicle traffic, the centerline markings shall be the two-direction no-passing zone markings (solid double yellow line).

<u>Center line pavement markings are required on:</u>

Paved urban arterials & collectors	Traveled way 20 feet or wider ADT = 6000 vehicles/day or more**
Paved two-way streets or highways	Three or more lanes
Rural arterials & collectors	Traveled way 18 feet or wider ADT = 3000 vehicles/day or more

Where engineering judgment indicates a need

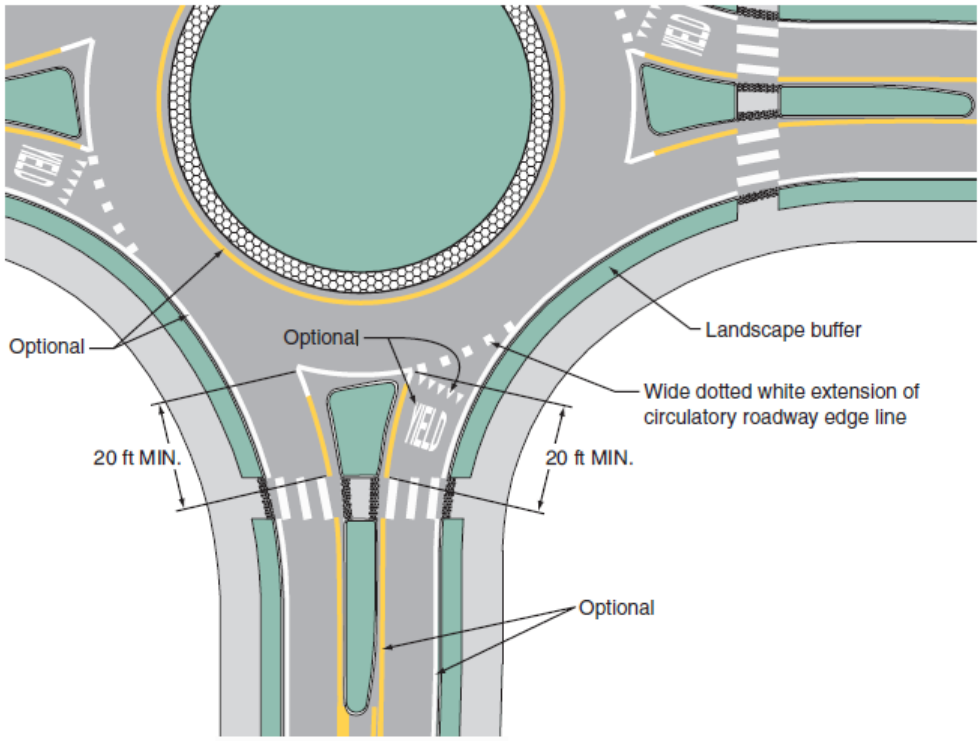
**May be used for a minimum ADT of 4000 vehicles/day

Center line markings may be placed on paved two-way roads with a minimum width of 16 feet.

ROUNDABOUT MARKINGS

A roundabout is a circular intersection designed for safety and speed control with specific traffic control features. Any pavement marking design for a roundabout should be integrated to its location and intended purpose. Any markings on the roundabout's approaches or circular roadway should provide a consistent message to road users. These should promote movement through the facility with minimal lane changes within the circulatory roadway in order to exit the roundabout.

Figure 3C-1. Example of Markings for Approach and Circulatory Roadways at a Roundabout



White Lane Line Pavement Markings

Multi-lane roundabouts need to have lane line markings on the approaches as well as within the circulatory roadway to guide traffic to the appropriate exit. No continuous concentric lane lines should be installed within the roundabout's circulatory roadway.

Edge lines should be located on the outer (right) side of the circulatory roadway with a solid line adjacent to the splitter island with a wide dotted line across the entrance approaches.

For pedestrian facilities, marked crosswalks (placed a minimum of 20 feet from the edge of the circulatory roadway) should indicate where pedestrians should cross roundabout entrances and exits. See Chapter 3C of the MUTCD for further guidance, details, and examples for proper roundabout pavement markings.

TOLL PLAZAS

Toll plaza pavement markings identify the proper lane for the type of toll payment, channelize movements, and delineate roadway obstructions.

When one or more Open Road Tolling (ORT) lanes is restricted to registered Electronic Toll Collection (ETC) vehicles that bypass a mainline toll plaza on a separate alignment, these word markings and longitudinal markings shall be used where the ORT lanes diverge from the lanes designated for the mainline toll plaza.

For ORT lanes that are immediately adjacent to a mainline toll plaza but not separated from adjacent cash payment toll lanes by a curb or barrier, channelizing devices, and/or pavement markings should be used to prevent lane changing. This separation should begin on the approach to the mainline toll plaza where vehicle speeds in the adjacent cash lanes drop below 30 mph during off-peak periods, and should extend downstream to where the departing vehicles in the adjacent cash lanes have accelerated to 30 mph.

For toll approach lanes restricted to registered ETC vehicles, the ETC Account-Only lane word markings and preferential lane longitudinal markings should be used. The solid white lane line or edge line on the right-hand side of the ETC Account-Only lane and the solid white lane line or solid yellow edge line on the left-hand side of the ETC Account-Only lane may be supplemented with purple solid contiguous longitudinal markings installed to the inside edges of the lane lines.

The **purple markings** should be a minimum of *3 inches* wide and a maximum width equal to the width of the line it supplements.

Toll booths and their islands are considered obstructions and should be marked to comply with these conditions. Any longitudinal pavement markings may be omitted alongside toll booth islands between the approach and departure markings.

DELINEATORS

Delineators are useful for roadway locations with long continuous sections or short stretches where the alignment might be confusing or unexpected (lane-reduction transitions, horizontal curves, etc.). These are effective *guidance* devices (rather than warning devices) at night and during adverse weather due to their visibility when the roadway may be wet or snow covered.

Delineator Design

Delineators consist of retroreflective devices (3-inch minimum) that normally retroreflect light from a distance of 1,000 feet when illuminated by standard automobile high beam headlights.

Single delineators: One retroreflective element for a given direction of travel at a specific location. May be installed on the left-hand side where needed

Double delineator: Two identical retroreflective elements mounted together for a direction. An appropriately sized vertically elongated delineator may be substituted for a double delineator.

Delineator Application

A series of single delineators should be located on the right side of freeways and expressways and on one side of interchange ramps, except when either of the following conditions is met:

1) On tangent sections of freeways and expressways when both of the following conditions are met:
   a. Continuous raised pavement markers are used to supplement pavement markings on lane lines throughout all curves and on all tangents,
   b. Roadside delineators are used to direct traffic into all curves.

2) On sections of roadways with continuous lighting between interchanges.

Delineators may also be used on other classes of roadways and their colors should comply with the edge line color.

Delineator Colors

White	Left-hand side of a two-way roadway
Red	Wrong direction of ramp or roadway Truck escape ramp

Appropriate colors can indicate where either an outside or inside traffic lane merges into an adjacent lane. Delineators should be installed adjacent to the lane reduced for the full transition length and show the reduction.

Red delineators may be used on the reverse side of any delineator where it would warn a road user traveling in the wrong direction on that particular ramp or roadway. These delineators should also be used on both sides of truck escape ramps (spaced at 50-foot intervals) to identify the ramp entrance. Spacing beyond the entrance should be adequate for the escape ramp's length and design.

Delineator Placement and Spacing

The mounting height of delineators should be approximately *4 feet* (measured vertically from the bottom of the device to the elevation of the edge of the pavement). They may be mounted at a lower elevation on the face or top of guardrails or other barriers.

Delineators should be installed at a constant distance from the edge of roadway *2 to 8 feet* outside the outer edge of the shoulder; or in line with roadside barriers (maximum distance of 8 feet outside the outer edge of the shoulder). For locations with obstructions between the pavement edge and the line of the delineators, the delineators should be transitioned to the innermost edge of the obstruction. For guardrail or other longitudinal barriers, the delineators should be transitioned just behind, directly above, or on the barrier's innermost edge.

Delineators should be spaced **200 to 530 feet apart** on *mainline tangent sections* and **100 feet apart** on *ramp tangent sections*.

CHANNELIZING DEVICES

Channelization devices (cones, tubular markers, vertical panels, drums, lane separators, raised islands, etc.) are used to emphasize traffic control sites (islands, reversible lane delineation, and channelizing lines).

Colors for channelizing devices are typically orange or the same color as the pavement marking that they supplement/substitute. Channelizing devices should be retroreflective or internally illuminated for nighttime use. *White* retroreflective material should be used for devices that separate traffic in the same direction. If the channelization separates flows in the opposite direction or are located on the left side edge line of a one-way roadway, the sheeting or bands should be *yellow*. These devices should be kept clean and bright to maximize target value.

ISLANDS

Design guidelines for islands are specified in AASHTO's *"A Policy on Geometric Design of Highways and Streets" ("Green Book")*. Traffic islands can be designated by curbs, pavement edges, pavement markings, channelizing devices, or other devices. Typical island markings consist of pavement/curb markings, channelizing devices, and delineators. Pavement markings for approaches to an obstruction may be omitted where determined necessary by engineering judgment.

Islands outlined by curbs or pavement markings should be marked with retroreflective white or yellow material to denote the general alignment of the island's edge along which vehicles travel. The approach ends of islands should be preceded by divergent longitudinal pavement markings on the pavement surface, to guide vehicles along the island edge.

The neutral area between approach-end markings sometimes contains sections of coarse aggregate or other suitable materials (usually less than 1 inch high). Although this area can be traversed at great speeds, these materials create rumble sections that provide higher visibility and warn road users. Bars or buttons (projecting 1 to 3 inches above the pavement surface) can also be used in the neutral area to warn the operator. These raised bars or buttons should be marked with white or yellow retroreflective materials, which are determined by the direction or directions of travel.

However, these channelizing devices, when used in advance of islands having raised curbs, shall not be installed in such a way as to create an unexpected obstacle.

Island delineation should be the same colors as the related edge lines (exception: red wrong-way traffic delineation). Retro reflective or internally illuminated markers of appropriate color may be placed in front of the curb and/or on the top of curbed approaches of raised medians and curbs of islands, to supplement or substitute for retro reflective curb markings. For long islands, curb retro reflection may be discontinued along the entire length of the curb, especially if the island is illuminated, delineated or marked with edge lines.

Pedestrian Islands and Medians

Raised islands or medians in the center area of a roadway can serve as pedestrian refuge island at a midblock or intersection location. These areas allow pedestrians to find an adequate gap in one direction of traffic at a time and wait for an adequate gap in the other direction of traffic before crossing the second half of the road. The *Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)* provides the

minimum widths for accessible refuge islands and for design and placement of detectable warning surfaces.

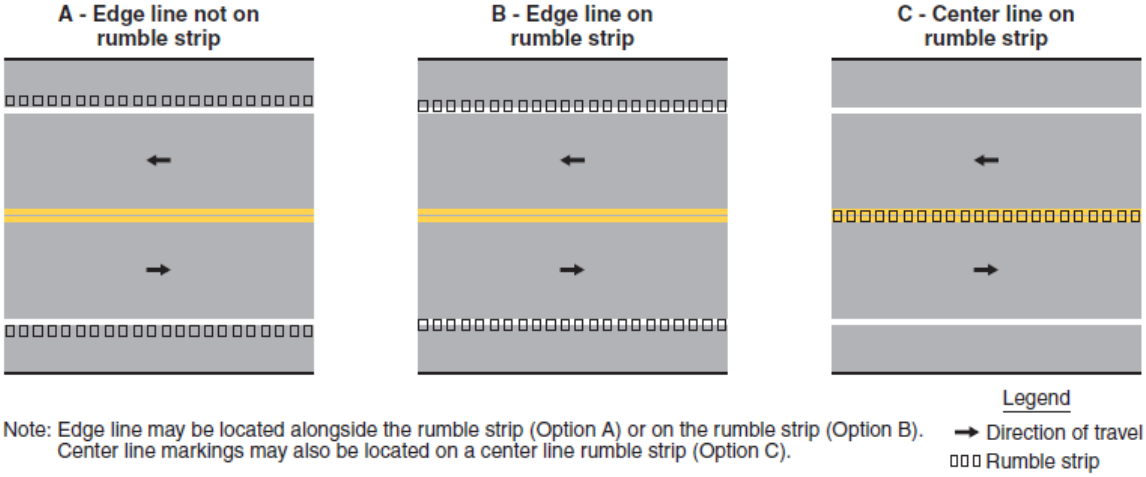
RUMBLE STRIP MARKINGS

Longitudinal rumble strips are either a series of rough-textured, slightly raised, or depressed road surfaces that warn drivers through vibration and sound of the edges of the travel lane.

Possible Longitudinal Rumble Strip Locations

Shoulder	Roadway shoulder near travel lane
Divided Highway	Median side (left) and/or outside shoulder (right)
Two-way Roadways	Along center line

Figure 3J-1. Examples of Longitudinal Rumble Strip Markings



Note: Edge line may be located alongside the rumble strip (Option A) or on the rumble strip (Option B). Center line markings may also be located on a center line rumble strip (Option C).

An edge line or center line may be installed over a longitudinal rumble strip to create a *rumble stripe.* However, edge lines should not be placed in addition to a shoulder rumble stripe.

Transverse rumble strips consist of intermittent narrow, transverse areas of roughly textured, slightly raised, or depressed road surface that extend across the travel lanes. Through noise and vibration, they alert drivers to unusual vehicular traffic conditions, such as unexpected changes in road alignment or conditions that require a stop or speed reduction.

At locations where the color of a transverse rumble strip within a travel lane does not match the color of the pavement, the color of the strip should be either *black or white*.

White transverse rumble strips should not be installed where they may be confused with other transverse markings (stop lines, crosswalks, etc.).

TRAFFIC SIGNALS

Standards for traffic control signals are critical for attracting the attention of different types of road users - older, visually impaired, fatigued, distracted, or unexpecting. Signals are extremely valuable for controlling traffic by assigning right-of-way for various movements, and influencing flow.

Types of Highway Traffic Signals

Traffic control signals	Pedestrian signals	Hybrid beacons
Emergency-vehicle signals	One-lane, two-way signals	
Entrance ramps signals	In-roadway lights	Movable bridges signals
Toll plaza traffic signals	Flashing beacons	Lane-use control signals

ADVANTAGES OF PROPER TRAFFIC CONTROL SIGNALS

- Orderly movement of traffic.
- Increases traffic-handling capacity of intersections
- Reduces frequency and severity of certain types of crashes
- Continuous or nearly continuous movement of traffic at a definite speed
- Interrupts heavy traffic at intervals to permit other traffic to cross.

Although traffic control signals are often considered the solution to all intersection traffic problems, they can still be ill-designed, ineffectively located, improperly operated, or poorly maintained.

DISADVANTAGES OF IMPROPER/UNJUSTIFIED TRAFFIC CONTROL SIGNALS

- Excessive delays,
- Excessive disobedience of the signal indications,
- Increased use of less adequate routes to avoid traffic control signals
- Increased frequency of collisions

TRAFFIC SIGNAL WARRANTS

In order to determine if a traffic control signal is justified, an engineering study (containing traffic conditions, pedestrian characteristics, and physical characteristics of the location) should be performed. This study needs to analyze the existing operation and safety factors,

and the potential for improving these conditions, plus any applicable factors in the following traffic signal warrants:

Warrant 1 - Eight-Hour Vehicular Volume
The Minimum Vehicular Volume (Condition A) is meant for locations with large volumes of intersecting traffic. The Interruption of Continuous Traffic (Condition B) is intended for sites where Condition A is not satisfied and the traffic volume on a major street affects traffic on a minor intersecting street.

Warrant 1 should be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied. Any further analysis of the combination of Conditions A and B is not needed.

Warrant 2 - Four-Hour Vehicular Volume → For locations where the intersecting traffic volume is the main reason for consideration.

Warrant 3 - Peak Hour → Meant for locations where the minor-street traffic suffers undue delay (a minimum of 1 hour of an average day) when entering or crossing the major street. This warrant is used only for unusual cases: office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities, etc.

Warrant 4 - Pedestrian Volume → Intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Warrant 5 - School Crossing → For locations where schoolchildren crossing a major street is the principal reason to consider a traffic control signal.

Warrant 6 - Coordinated Signal System → Meant for locations with progressive traffic movement in a signal system for maintaining proper vehicle platooning. This signal warrant should not be used where the resultant signal spacing is less than 1,000 feet.

Warrant 7 - Crash Experience → For locations where severe and frequent crashes are the main reasons to consider installing a traffic control signal.

Warrant 8 - Roadway Network → Intended for some intersections to encourage concentration and organization of traffic flow in a roadway network.

Warrant 9 - Intersection Near a Grade Crossing → Can be used where none of the conditions described in the other eight traffic signal warrants are met. The proximity to the intersection of a grade crossing on an approach controlled by a STOP or YIELD sign is the principal reason for consideration.

Satisfying a traffic signal warrant/warrants should not in itself require the installation of a signal. Please consult Chapter 4C for further details addressing these warrants.

SIGNAL FEATURES

For road users, the most important features of traffic control signals are location, design, and meaning of the signal indications. Uniform design features are especially important for the safety and efficiency of operations.

MODES OF TRAFFIC CONTROL SIGNALS

Pre-timed	Fixed time schedule Does not change in response to changes in traffic flow
Semi-actuated	Timing affected by detected vehicles on some intersection approaches Used on high-volume (major) road intersections with low-volume (minor) roads
Full-actuated	Timing completely affected by detected traffic on all approaches Used at major street intersections with varying traffic volumes

Typical temporary traffic control signal installation methods minimize costs of installation, relocation, and/or removal. Temporary traffic control signals with specific purposes include: one-lane, two-way facilities in temporary traffic control zones; haul-road intersections; or future access to a location that will have a permanent access point developed at another site.

Traffic signal signs are sometimes used at signal locations for pedestrians, bicyclists, or motorists.

Typical Signalized Location Signs

Movement Prohibition	Lane Control	Pedestrian Crossing
Pedestrian Actuation	Traffic Signal	Signal Ahead Warning
Street Name	Advance Street Name	

Proper intersection pavement markings play an important role in the effective operation of traffic control signals by designating the number of lanes, lane use, the length of additional

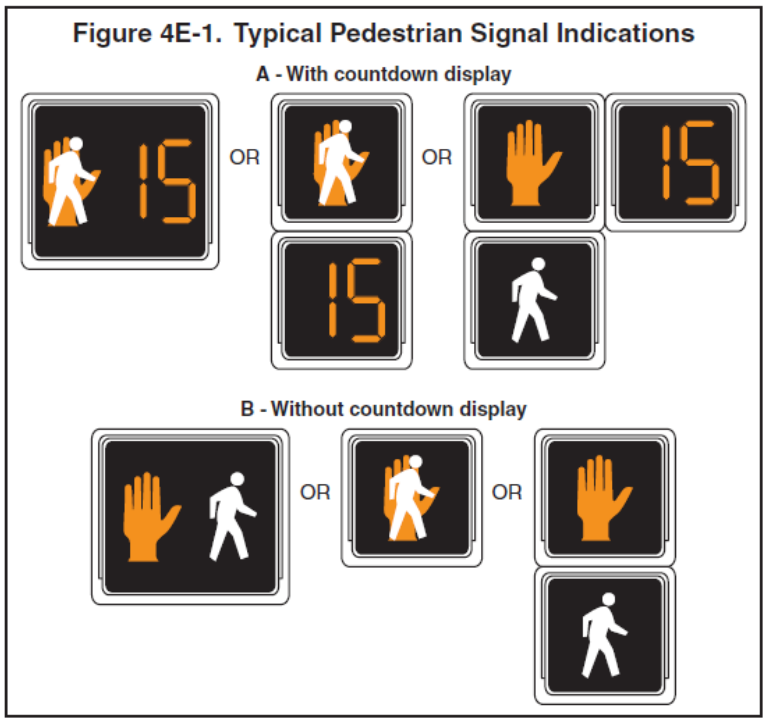
approaches, and stopping points. Signal phasing and timing can then be used to best match the goals of the intersection's operational plan.

PEDESTRIAN CONSIDERATIONS

Pedestrian signal heads provide special traffic signals exclusively used for controlling pedestrian traffic. Engineering judgment should always be used to determine if separate pedestrian signal heads and accessible pedestrian signals are needed.
Pedestrian detectors may contain pushbuttons or passive detection devices.

Passive detection devices register the presence of pedestrians available to cross the roadway. Some passive detection devices can also track the progress of pedestrians crossing the roadway in order to adjust pedestrian timing intervals.

Pedestrian pushbuttons are conspicuous and placed within reach of pedestrians. Pushbutton poles are also positioned in optimal locations for easy access. The "Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)" provides further information regarding pedestrian devices.



Accessible pedestrian signals and detectors also provide non-visual communication (audible tones, speech messages, and/or vibrating surfaces, etc.). A common method that visually-impaired pedestrians use at signalized intersections is to start crossing when they hear the traffic in front of them stop and the traffic alongside them begin to move ("green

interval"). At many signalized locations, insufficient information is provided for pedestrians with visual disabilities needing to cross.

Pedestrian hybrid beacons may be used to warn and control traffic at unsignalized locations to assist pedestrians crossing marked crosswalks. These beacons may be appropriate for crossing locations not meeting signal warrants, or for locations meeting traffic signal warrants without a traffic control signal.

DIFFERENT TYPES OF SIGNALS

Emergency-vehicle traffic control signal - assigns vehicle right-of-way to authorized emergency vehicles. Its location may not meet other traffic signal warrants.

Traffic control signal at a narrow bridge, tunnel, or roadway section - assigns the right-of-way for traffic passing over a bridge or through a tunnel or roadway section with insufficient width for two opposing vehicles to pass.

Temporary traffic control signals - most common application of one-lane, two-way facilities.

Ramp control signals (ramp metering) **-** controls traffic flow entering a freeway facility.

Freeway entrance ramp control signals - used to control traffic entering freeways to reduce the total expected delay to traffic (including freeway ramps and local streets).

Traffic control signals for movable bridges - notify road users of a road closure rather than giving alternate right-of-way to conflicting traffic movements. These signals are coordinated with the operation of the movable bridge, movable bridge warning and resistance gates, or other devices to control traffic. Movable bridge warning gates decrease the likelihood of road users entering a potentially hazardous area. A movable bridge resistance gate is sometimes used downstream of the movable bridge warning gate to physically deter road users. For further information, bridge gates are contained in *AASHTO's "Standard Specifications for Movable Highway Bridges".*

Flashing Beacon - one or more signal sections that operates in a flashing mode. This device can be used as an intersection control beacon or provide other warning applications.

Typical Locations for Warning Beacons

- Obstructions adjacent to the roadway;
- Emphasis for warning signs;
- Midblock crosswalks;
- Emphasis for regulatory signs;
- In conjunction with regulatory or warning signs.

Lane-use control signals - overhead signals that specify the use of roadway lanes or indicate impending prohibition. These signals are distinguished by special signal face placement over certain roadway lanes and by their distinctive shapes and symbols. Supplementary signs may also be used to explain the signal's meaning and intent. Lane-use control signals are typically used for reversible-lane control; they are also suitable for certain non-reversible lane applications and toll plaza lanes.

In-Roadway Lights - installed in the road surface to warn road users of a condition on or adjacent to the roadway not be readily apparent and require action by the road users (school crosswalks, midblock crosswalks, crosswalks on uncontrolled approaches, roundabout crosswalks, and other pedestrian crossings).

LOW-VOLUME ROADS

Low-Volume Road Characteristics

- Outside of built-up areas of municipalities
- Traffic volume under 400 ADT
- Not classified as freeway, expressway, interchange ramp, State highway system road, or residential street
- Variation of conventional or special purpose road
- Paved or unpaved

Typical low-volume roads include agricultural, recreational, resource management and development (mining, logging, grazing, etc.) and local rural roads. Traffic control devices might be placed where limited, but essential, information regarding regulation, guidance, and warning is needed. It is possible to convey this information with a limited number of traffic control devices by focusing on: warning of unusual conditions; prohibiting unsafe movements; or providing minimal destination guidance.

The needs of unfamiliar users for occasional, recreational, and commercial transportation purposes should also be considered when designing low-volume traffic control.

SIGNS

Minimum sign and plaque sizes shall only be used on low-volume roads with an 85th-percentile speed or posted speed limit less than 35 mph.

Table 5A-1. Sign and Plaque Sizes on Low-Volume Roads (Sheet 1 of 2)

Sign or Plaque	Sign Designation	Section	Sign Sizes		
			Typical	Minimum	Oversized
Stop	R1-1	5B.02	30 x 30	—	36 x 36
Yield	R1-2	5B.02	30 x 30 x 30	—	36 x 36 x 36
Speed Limit (English)	R2-1	5B.03	24 x 30	18 x 24	36 x 48
Do Not Pass	R4-1	5B.04	24 x 30	—	36 x 48
Pass With Care	R4-2	5B.04	24 x 30	18 x 24	36 x 48
Keep Right	R4-7	5B.04	24 x 30	18 x 24	36 x 48
Do Not Enter	R5-1	5B.04	30 x 30	—	36 x 36
No Trucks	R5-2	5B.04	24 x 24	—	30 x 30
One Way	R6-2	5B.04	18 x 24	—	24 x 30

All signs need to be retroreflective or illuminated showing the same shape and color, regardless of time, unless stated otherwise. This type of illumination is not satisfied by street, highway, or strobe lighting.

A minimum lateral offset of *2 feet* from the roadway edge to the roadside edge of a sign may be used where roadside features (terrain, shrubbery, and/or trees, etc.) prevent lateral placement.

The purpose of a **regulatory sign** is to inform roadway users of traffic regulations, laws, and legal requirements. Regulatory sign requirements on low-volume roads are addressed in Part 2B of the MUTCD.

The purpose of a **warning sign** is to alert motorists of unexpected conditions that might not be readily apparent. Provisions for warning signs are contained in MUTCD Chapter 2C.

The purpose of a **guide sign** is to direct road users to their destination in the most simple, direct manner possible by displaying information regarding directions, positions, destinations, and routes. Guide signs for low-volume roads are typically not installed to the

extent as higher classes of roads since they typically benefit road users unfamiliar with a particular low-volume road. These are addressed in Parts 2D through 2N of the MUTCD.

MARKINGS

The purpose of pavement markings is to provide guidance and information for road users without diverting their attention from the roadway. All markings should be retroreflective and visible during nighttime conditions unless other illumination provides adequate visibility. General guidelines for markings and delineators are contained in Part 3 of the MUTCD. However, specific provisions for low-volume markings are exclusively contained in Part 5. Other markings, such as stop lines, crosswalks, pavement legends, channelizing devices, and islands, used on low-volume roads need to meet MUTCD guidelines.

HIGHWAY-RAIL GRADE CROSSING

Traffic control at highway-rail grade crossings is intended to provide safe and efficient operations for both railway and roadway. This type of traffic control is located at highway-rail crossings or along their approaches and may include:

signs signals markings illumination other warning devices.

Part 8 of the MUTCD contains provisions for highway-rail grade crossing traffic control devices.

TEMPORARY TRAFFIC CONTROL

The safety of all road users (pedestrians, bicyclists, work zone personnel, etc.) should be the main priority in all phases of any project (planning, design, maintenance, and construction). See Part 6 of the MUTCD for additional criteria, specific details, and more complex temporary traffic control zone requirements.

PRINCIPLES FOR TEMPORARY TRAFFIC CONTROL ZONES

- Traffic should be disrupted as little as possible.
- Road users should be clearly guided at construction, maintenance, and utility work areas.
- Routine inspection and maintenance should be performed both day and night.
- At least one person should be responsible for effective traffic control operation. Any operational changes need to be brought to the attention of supervisory personnel.

Assumption: Temporary traffic control zones should be designed for road users who will only reduce their speeds (in small increments) if they clearly perceive a need to do so.

Temporary traffic control zones should not create any frequent and/or abrupt changes. Transitions should be well delineated with adequate lengths for accommodating realistic driving conditions.

A low-volume temporary traffic control plan should be used to specify particular traffic control devices, or to reference typical drawings.

Speed reduction countermeasures and enforcement can be effective to reduce traffic speeds through temporary traffic control zones.

Pavement markings should be considered for low-volume traffic control zones with existing pavement markings, detours, or temporary roadway. Unneeded interim pavement markings may be omitted in temporary traffic control zones.

TEMPORARY TRAFFIC CONTROL - Part 6

PARTS OF A TRAFFIC CONTROL ZONE

A traffic control zone is located between the first warning device and the where traffic resumes normal operations. Typical types of traffic control devices used in work zone traffic control include:

Signs **Channelizing Devices** **Lighting Devices** **Pavement Markings**

Most temporary traffic control (TTC) zones are divided into the following four areas:

The **advance warning area** informs road users about an upcoming work zone or incident area and may vary from a single device to a series of advance signs.

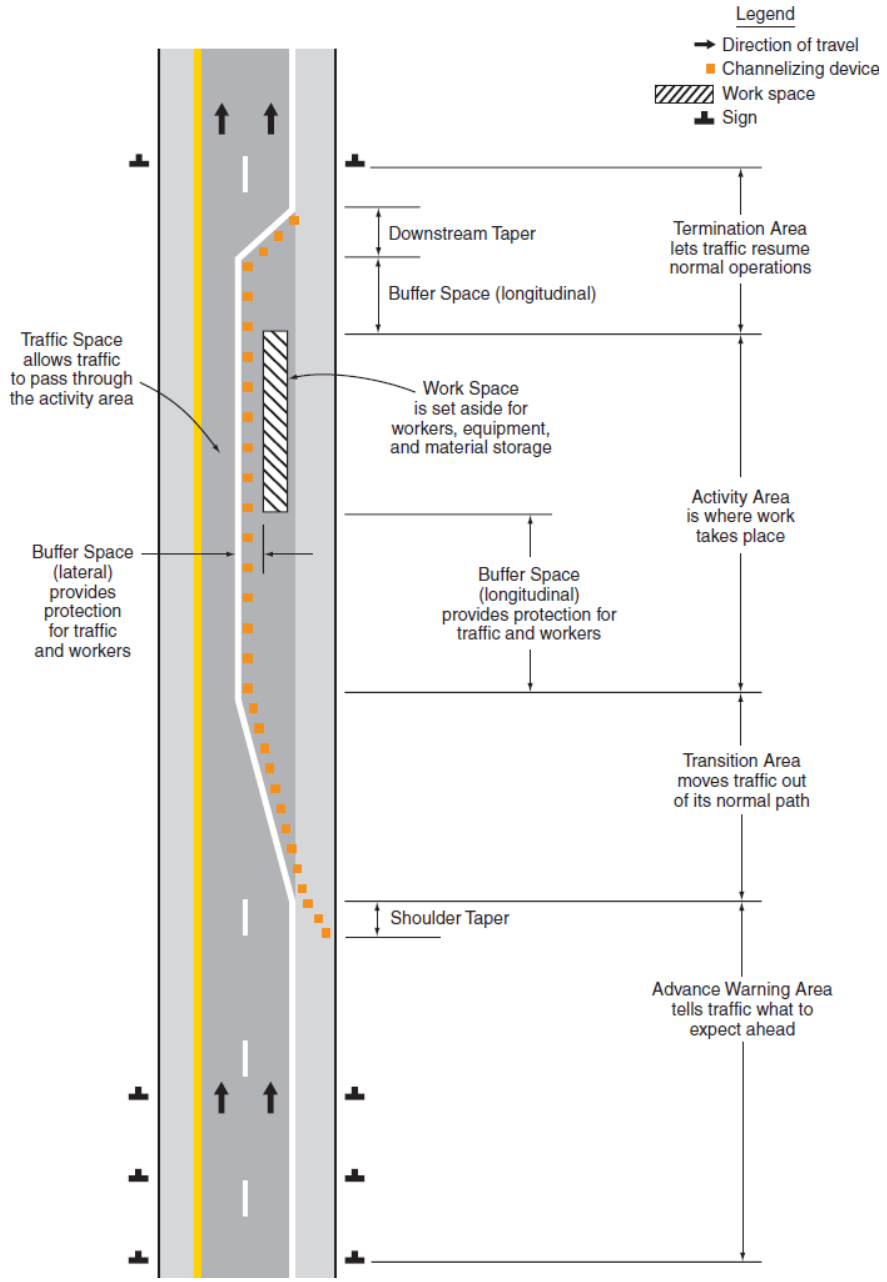
The **transition area** redirects vehicles away from their normal path and through the work area. This route should be conspicuous regardless of time or weather. These areas usually involve the use of tapers.

The **activity area** is where work actually occurs. This site is closed to traffic and set aside for workers, equipment, and construction materials. Activity areas may be broken down into three subareas:

Work Space workers, equipment, and material storage
Traffic Space passing traffic through the activity area
Buffer Space – traffic and worker protection

The **termination area** contains adequate distance for users to clear the work area and return to their normal driving route. This area extends from the downstream end of the work area to the last traffic control device.

Figure 6C-1. Component Parts of a Temporary Traffic Control Zone



FUNDAMENTAL PRINCIPLES OF TEMPORARY TRAFFIC CONTROL

- General plans/guidelines should be developed to provide safety for all users' equipment.
- Road user movement should be obstructed as little as possible.
- Motorists, bicyclists, and pedestrians should be guided in a clear and positive fashion through TTC zones and incident sites.
- Routine day/night inspections should be performed to provide acceptable levels of operations.
- Attention should be given to roadside safety maintenance during the life of the TTC zone.
- Each person (from upper-level management to field workers) whose actions affect TTC zone safety, should receive appropriate training for job decisions each individual is required to make.
- Good public relations should be maintained.

Definitions

The following terms may help determine the appropriate traffic control for the existing street or highway conditions.

Low Speed – roadways with posted speed limits of 40 mile per hour (mph) or less.

High Speed – locations with posted speed limits of 45 mph or greater

Low Volume – sites with the average daily traffic volumes (ADT) less than 400 vehicles per day.

Special attention should be paid to nearby facilities (schools, manufacturing plants, etc.) that impact special traffic generation, and work zone locations subject to peak-hour traffic increases (typically 7-9 a.m. and 4-6 p.m).

Urban Street Conditions – routes with relatively low speeds, pedestrian activity, intersections, business entrances, and/or residential driveways. Work zones do not have to be within a municipality's corporate limits to qualify as an urban condition.

PEDESTRIAN AND WORKER SAFETY

Pedestrian Safety

A wide range of pedestrians (young, elderly, and disabled) can be affected by TTC zones. Pedestrians need protection from any potential injuries and a clearly defined travel path. Pedestrian traffic control (signs, channelizing devices, flags, suitable fencing, etc.) should be used where travel paths are impacted by construction, maintenance, or utility operations. The temporary facilities should be detectable, include accessibility features, and direct pedestrian flow through or around the work zone.

Major Considerations in Planning for Pedestrian Safety

- Avoid pedestrian conflicts with work site vehicles, equipment, or operations
- Avoid any direct conflicts with traffic moving through or around the work area
- Provide a safe, convenient travel path that mimics the most desirable characteristics of sidewalks or footpaths.

Worker Safety

The safety of workers in a work zone is equally as important as the traveling public. TTC zones present challenging conditions which create a high degree of vulnerability for roadway workers. The best protection for all is appropriate work zone traffic control.

Key Elements to Consider for Improving Worker Safety

Training - All workers should be trained to minimize their vulnerability while working adjacent to traffic. All workers with specific traffic control responsibilities should be appropriately trained in TTC techniques, placement, and usage.

Temporary Traffic Barriers - Barriers should be placed along the work space based on lateral clearance of workers from adjacent roadway traffic, vehicle speed, work duration, type of operations, time of day, and traffic volume.

Speed Reduction - Traffic speed may be reduced by regulatory speed zoning, funneling, lane reduction, uniformed law enforcement officers or flaggers.

Activity Area - Internal work activities should be coordinated to minimize backing-up maneuvers of construction vehicles and reduce the exposure to risk.

Worker Safety Planning A worksite basic hazard assessment should be conducted and job classifications should be determined by trained personnel. Protection measures should be determined and implemented by a safety professional.

FLAGGING

Flaggers are used to stop or slow traffic at jobsites to help protect the workers. They should always be clearly visible from an adequate distance to permit proper driver response prior to entering the work site. Since flaggers are responsible for public safety and are constantly in contact with the public, they should have appropriate traffic control and public contact training.

Flagger Requirements

- Receive and communicate specific instructions
- Move and maneuver quickly
- Control signaling devices (such as paddles and flags)
- Understand and apply safe traffic control practices
- Recognize dangerous traffic situations and warn workers in sufficient time

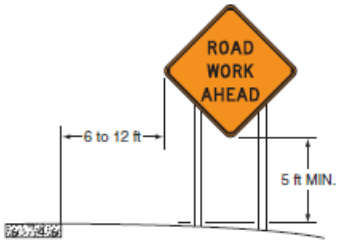
Flaggers should wear appropriate high-visibility safety apparel with fluorescent orange-red and/or fluorescent yellow-green outer material that clearly identifies the wearer as a person. Retroreflective materials should be orange, yellow, white, silver, or yellow-green (minimum visibility of 1,000 feet).

Automated Flagger Assistance Devices

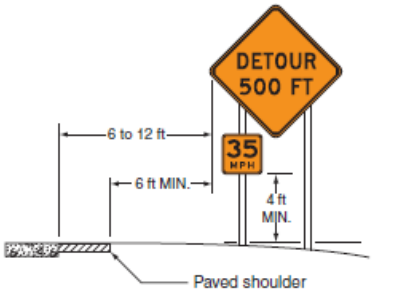
Automated Flagger Assistance Devices (AFADs) are remote-controlled devices operated by a single flagger or by separate flaggers near each site. These help control drivers through TTC zones and allow flaggers further distance away from traffic.

Mounting – Post-mounted signs (in rural areas) need to be installed a minimum height of *5 feet* above the traveled way (measured from the bottom of the sign), and *7 feet* for urban locations. Signs on barricades and other portable supports can be installed at lower heights with the bottom of the sign *a minimum of one foot* above the traveled way. All sign supports and barricades need to meet crashworthy requirements.

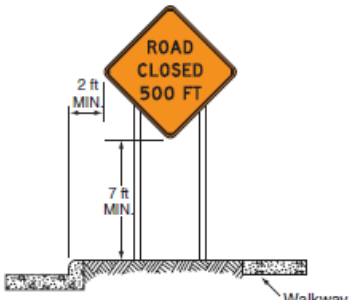
Figure 6F-1. Height and Lateral Location of Signs—Typical Installations



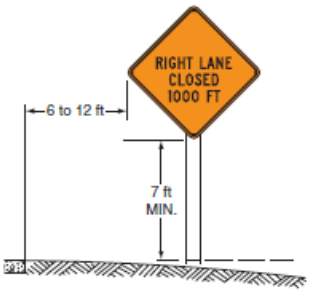
A - RURAL AREA



B - RURAL AREA WITH ADVISORY SPEED PLAQUE

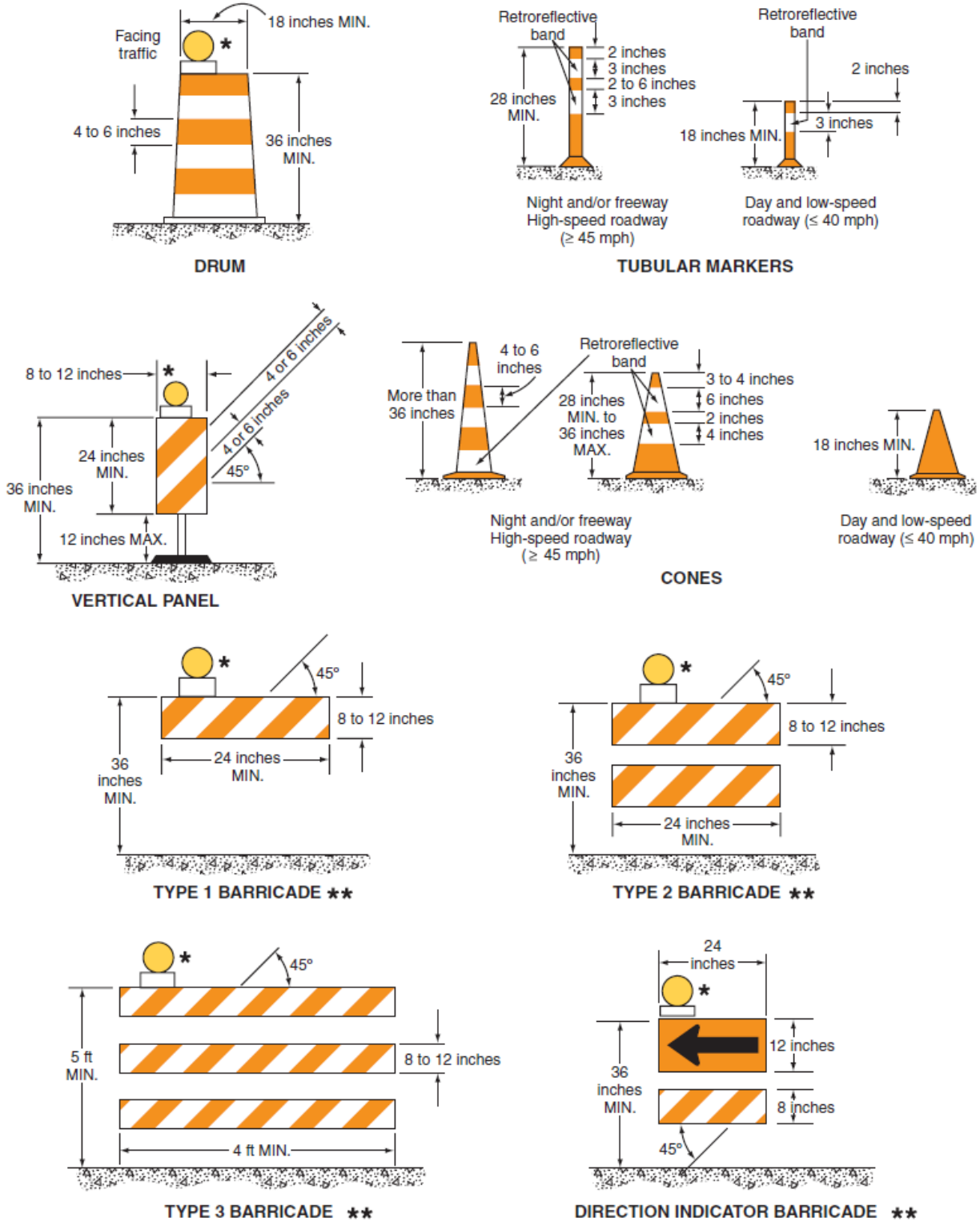


C - BUSINESS, COMMERCIAL, OR RESIDENTIAL AREA



D - BUSINESS, COMMERCIAL, OR RESIDENTIAL AREA (WITHOUT CURB)

Figure 6F-7. Channelizing Devices



* Warning lights (optional)
** Rail stripe widths shall be 6 inches, except that 4-inch wide stripes may be used if rail lengths are less than 36 inches. The sides of barricades facing traffic shall have retroreflective rail faces.

WARNING SIGNS

Warning signs are used extensively in work zones for construction and maintenance activities. These alert road users to unexpected conditions on or near the roadway. Warning signs may require actions by the driver in order to ensure safe traffic operations. They are typically diamond shaped, and are located on the right-hand side of the street or highway.

Background colors for warning signs depend on their use. Signs for pedestrians, bicyclists and playgrounds have a black legend/border and yellow or fluorescent yellow-green background. For buses, schools and supplemental plaques, they have a black legend/border on a fluorescent yellow-green background.

Size – The standard size for advance warning signs in higher-speed work zones is generally 48 inches by 48 inches. For moderately low speeds and traffic volumes, a minimum size of 36 inches by 36 inches may be used. Secondary roads or city streets with very low speeds may use warning signs (having short word messages or symbols) that are smaller than standard sizes with a minimum size of 24 inches by 24 inches.

GUIDE AND INFORMATION SIGNS

Guide signs convey information to move road users through the work zone to their destination in the most simple, direct manner possible. Temporary signs for work zones or detours are black with an orange background. All guide and information signs (message, border, legend and background) shall be retroreflective or illuminated.

G20-1 G20-2 G20-4

Accurate and timely navigation information is crucial for traffic safety. Guide signs can prevent erratic maneuvers, and minimize potential traffic incidents.

Guide Signs Used in TTC Zones

- Standard route markings
- Directional signs and street name signs
- Special guide signs

INCIDENT MANAGEMENT SIGNS

A traffic incident management area is a TTC zone with temporary traffic controls that are authorized by a public authority in response to an incident. The MUTCD defines a traffic incident as "an emergency road user occurrence, a natural disaster, or other unplanned event that affects or impedes the normal flow of traffic". Examples include: vehicles blocking a traffic lane; hazardous material spills; and natural disasters (floods and severe storm damage). Incident management zones extend from the first warning device to the last temporary traffic control device - or to where vehicles clear the incident and return to the original lane alignment.

Traffic incidents can be divided into the following classes of duration:

Major - more than 2 hours
Intermediate - 30 minutes to 2 hours
Minor - under 30 minutes

Incident management signs have a black legend/border with a fluorescent pink background.

W3-4


W4-2

W9-3

E5-2a

The primary functions of TTC at a traffic incident management area is to temporarily guide road users safely past or around the incident, and reduce the likelihood of any secondary traffic incidents.

Benefits of Traffic Incident Management Area TTC

- Protects workers and incident responders
- Aids in moving road users past incident
- Reduces potential secondary crashes
- Prevents unnecessary use of surrounding roadways

Local municipalities should coordinate their incident responses with appropriate local safety, emergency, enforcement, towing and recovery groups to minimize additional risk to other road users.

LIGHTING DEVICES

Lighting devices (warning lights, vehicle rotating or strobe lights, and arrow panels) for short-term work zones are designed to supplement signs and channelizing devices.

Warning lights are portable, powered, yellow, lens-directed, enclosed lights with a maximum spacing equal to those of channelizing devices. *Type A, Type C, and Type D* warning lights should be capable of visibility on a clear night from a distance of 3,000 feet. *Type B* warning lights should be visible on a sunny day without the sun directly on or behind the device from a distance of 1,000 feet. The minimum mounting height for warning lights is 30 inches to the bottom of the lens.

Principal Types of Warning Lights

Low-Intensity Flashing Lights (Type A)

- used at night to warn drivers of a potentially hazardous area
- may be mounted on channelizing devices

High-Intensity Flashing Lights (Type B)

- used during both daylight/nighttime hours to warn motorists of a hazard or to draw attention to advance warning signs
- operates 24 hours per day
- may be mounted on supports or warning signs

Low-Intensity Steady-Burn Lights (Type C & Type D 360° warning lights)

- used at night in a series to delineate the edge of the travel way
- may be placed on the outside of a curve to delineate the curve

DURATION OF WORK

The work duration of a temporary traffic control zone is crucial in determining the number and types of devices to be used. Typically, the number of traffic control devices is directly proportional to the operation's length.

- **Long-Term Stationary** – More than 3 days.
- **Intermediate- Term Stationary** - More than 1 daylight period to 3 days, or night work lasting more than 1 hour.
- **Short-Term Stationary** – Daytime work for more than 1 hour within a single daylight period.
- **Short Duration** – Up to 1 hour.
- **Mobile** – Intermittently or continuously.

LOCATION OF WORK

A TTC zone's location determines the types of traffic control chosen. Usually, the closer the work is to traffic, the more traffic control devices will be required.

Advance warning should convey that work is taking place within the traveled way and should supply information about roadway conditions (exceptions include short-duration and mobile operations). These traffic control devices will indicate how traffic can move through the work zone.

MOBILE OPERATIONS

Mobile operations are typically *intermittent* or *continuously moving* work activities. Safety should never be compromised by using fewer devices than needed due to frequently changing locations. For successful mobile operations, the advance warning area must move with the work area or be periodically repositioned to warn the motorist.

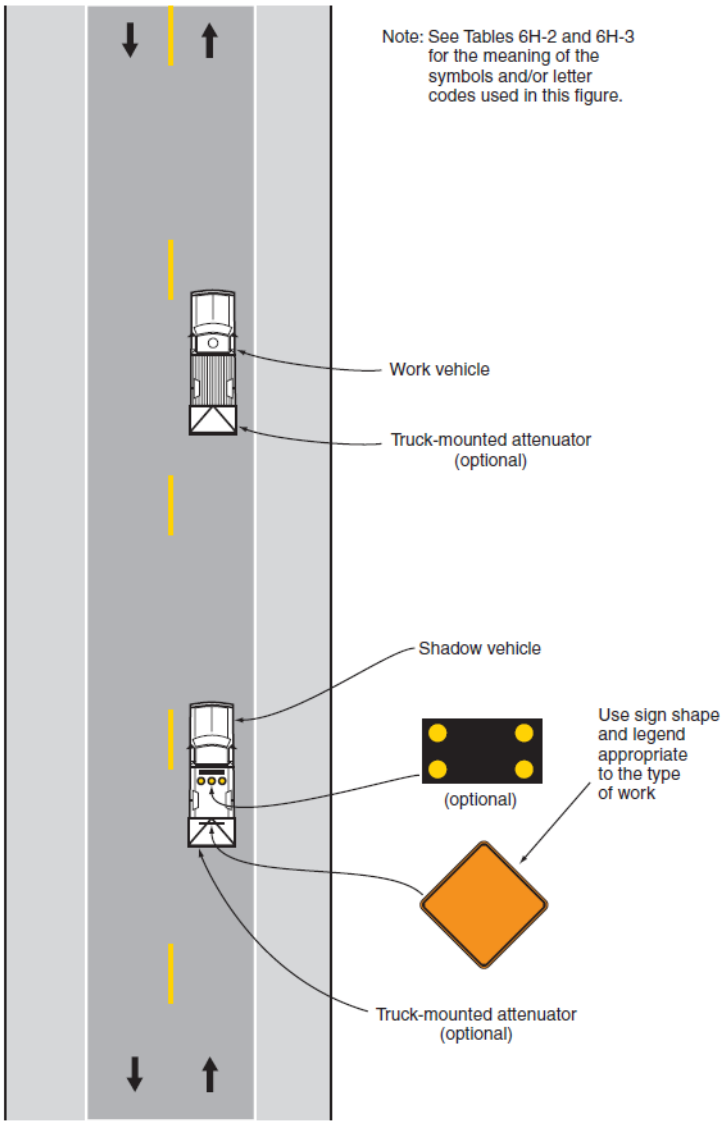
Portable devices should be used whenever possible. Vehicles with appropriate colors, markings, lights, signs, arrow panels, or changeable message signs may be substituted for channelizing devices. Shadow vehicles with truck-mounted attenuators (TMS's) are typically used for these operations.

Intermittent Mobile Operations – These operations (examples include litter cleanup, utility operations, roadway maintenance, etc.) involve frequent short stops but are similar to stationary operations. Slow moving operations (less than 3 mph) may require stationary

signage to be periodically retrieved and repositioned in the advance warning area. If flaggers are used, caution must be used to prevent unnecessary exposure to hazards.

Continuously Mobile Operations – These are mobile work operations where workers and equipment move along at slow speeds without stopping (mowing, pavement striping, street sweeping, or herbicide spraying). For locations with low traffic volumes and good visibility, a well-marked well-signed vehicle may be sufficient. For high traffic volumes and/or speeds, a shadow vehicle should be used to ensure the advance area moves with the work area.

Figure 6H-17. Mobile Operations on a Two-Lane Road (TA-17)



SCHOOL AREAS

The best method to achieve effective traffic control (regardless of location) is by using uniform policies, practices, and standards developed through engineering judgment or studies. Similar traffic situations need to be treated consistently to achieve uniform traffic control. All devices and methods described in this section address specific functions related to specific traffic conditions.

Pedestrian safety depends on public understanding of the need for traffic controls and how they function for their benefit. This concept is crucial for controlling pedestrians, bicycles, and other vehicles near schools.

A school route plan should be prepared for uniformity in school area traffic controls and provide the basis for a school traffic control plan. School, law enforcement, and traffic officials responsible for school pedestrian safety should help develop this plan. It should display streets, the school, existing traffic controls, school walk routes, and school crossings.

SCHOOL TRAFFIC CONTROL PLAN

- Reviews school area traffic control needs
- Coordinates school/pedestrian safety education and engineering measures

Figure 7A-1. Example of School Route Plan Map

Proposed school walk routes should use any existing traffic controls to establish safer routes to and from school. Planning criteria for proposed school walk routes might make it necessary for children to walk an indirect route to an established school crossing with existing traffic control instead of using a direct crossing without existing traffic control. For determining the feasibility of children walking a longer distance to a school crossing with existing traffic control, the following factors should be considered:

- Availability of adequate sidewalks, walkways, etc. with existing control,
- Number of students using the crossing,
- Ages of the students using the crossing,
- Total extra walking distance.

Table 7B-1. School Area Sign and Plaque Sizes

Sign	Sign Designation	Section	Conventional Road	Minimum	Oversized
School	S1-1	7B.08	36 x 36	30 x 30	48 x 48
School Bus Stop Ahead	S3-1	7B.13	36 x 36	30 x 30	48 x 48
School Bus Turn Ahead	S3-2	7B.14	36 x 36	30 x 30	48 x 48
Reduced School Speed Limit Ahead	S4-5, S4-5a	7B.16	36 x 36	30 x 30	48 x 48
School Speed Limit XX When Flashing	S5-1	7B.15	24 x 48	—	36 x 72
End School Zone	S5-2	7B.09	24 x 30	—	36 x 48
End School Speed Limit	S5-3	7B.15	24 x 30	—	36 x 48
In-Street Ped Crossing	R1-6, R1-6a, R1-6b, R1-6c	7B.11, 7B.12	12 x 36	—	—
Speed Limit (School Use)	R2-1	7B.15	24 x 30	—	36 x 48
Begin Higher Fines Zone	R2-10	7B.10	24 x 30	—	36 x 48
End Higher Fines Zone	R2-11	7B.10	24 x 30	—	36 x 48

Plaque	Sign Designation	Section	Conventional Road	Minimum	Oversized
X:XX to X:XX AM X:XX to X:XX PM	S4-1P	7B.15	24 x 10	—	36 x 18
When Children Are Present	S4-2P	7B.15	24 x 10	—	36 x 18
School	S4-3P	7B.09, 7B.15	24 x 8	—	36 x 12
When Flashing	S4-4P	7B.15	24 x 10	—	36 x 18
Mon-Fri	S4-6P	7B.15	24 x 10	—	36 x 18
All Year	S4-7P	7B.09	24 x 12	—	30 x 18
Fines Higher	R2-6P	7B.10	24 x 18	—	36 x 24
XX Feet	W16-2P	7B.08	24 x 18	—	30 x 24
XX Ft	W16-2aP	7B.08	24 x 12	—	30 x 18
Turn Arrow	W16-5P	7B.08, 7B.09, 7B.11	24 x 12	—	30 x 18
Advance Turn Arrow	W16-6P	7B.08, 7B.09, 7B.11	24 x 12	—	30 x 18
Diagonal Arrow	W16-7P	7B.12	24 x 12	—	30 x 18
Diagonal Arrow (optional size)	W16-7P	7B.12	21 x 15	—	—
Ahead	W16-9P	7B.11	24 x 12	—	30 x 18

Note: 1. Larger sizes may be used when appropriate
2. Dimensions are shown in inches and are shown as width x height
3. Minimum sign sizes for multi-lane conventional roads shall be as shown in the Conventional Road column

Conventional Road sign and plaque sizes should be used unless engineering judgment determines that a different sign size would be more appropriate. **Minimum sign sizes** should be used only for low traffic volumes with speeds of *30 mph or lower*, as determined by engineering judgment. **Oversized signs** should be used on expressways.

All school area traffic control signs need to be retroreflectorized or illuminated. School warning signs should have a fluorescent yellow-green background with a black legend and border unless otherwise stated in the MUTCD.

MARKINGS

Pavement markings for school area traffic control have definite and important functions, such as supplementing other devices (traffic signs or signals), or conveying certain regulations, guidance, and warnings that cannot otherwise be understood.

Potential Limitations of Pavement Markings

Limited visibility in inclement weather
Less durability in heavy traffic areas

Despite these potential limitations, markings are advantageous for conveying information to road users without diverting attention from the road.

Pedestrian crosswalks should be marked at all established school route intersections where:

substantial conflicts between road users and student exist;
students are encouraged to cross between intersections;
students would not otherwise recognize the proper place to cross; or
where motorists or bicyclists might not expect students crossing.

Lines for crosswalks should never be placed indiscriminately. An engineering study should be conducted before placing a marked crosswalk at locations away from a traffic control signal or approaches controlled by STOP or YIELD signs.

Warning signs should be used for all marked school crosswalks at non-intersection locations since these are typically unexpected to the road user. Parking prohibitions or other appropriate measures should provide adequate visibility to students and motorists.

CROSSING SUPERVISION

The MUTCD lists three types of school crossing supervision:

Adult crossing guards - control of pedestrians and vehicles
Uniformed law enforcement officers - control of pedestrians and vehicles
Student and/or parent patrols - control of only pedestrians

Adult crossing guards are responsible for the safety and the efficient crossing of schoolchildren within school crosswalk areas. These individuals should be subjected to high standards for selection.

MINIMUM ADULT CROSSING GUARD QUALIFICATIONS

- Average intelligence
- Good physical condition
- Ability to control a STOP paddle effectively
- Ability to communicate specific instructions clearly, firmly, and courteously
- Ability to recognize potentially dangerous traffic situations and manage students
- Mental alertness
- Neat appearance
- Good character
- Dependability
- Overall sense of responsibility for student safety

For further information about organizing and operating a school safety patrol program, consult the *"AAA School Safety Patrol Operations Manual".*

RAILROAD & LIGHT RAIL TRANSIT GRADE CROSSINGS

Traffic control for highway-rail and highway-light rail transit (LRT) grade crossings includes all signs, signals, markings, and other warning devices along approaching roadways and at grade crossings open to the public. Their function is to provide safe, effective operation for both rail and highway traffic at grade crossings.

Agencies with jurisdiction and/or statutory authority should jointly determine the traffic control devices at grade crossings.

Light rail transit (LRT) is a mode of metropolitan transportation (light rail vehicles, streetcars, or trolleys) that operate in mixed traffic within semi-exclusive or exclusive rights-of-way. Grade crossings are typically located at intersections or midblock locations (including public and private driveways). Educational campaigns coordinated with ongoing continuing education for new drivers have proven to be beneficial when introducing proposed LRT locations.

TYPES OF LRT ALIGNMENTS

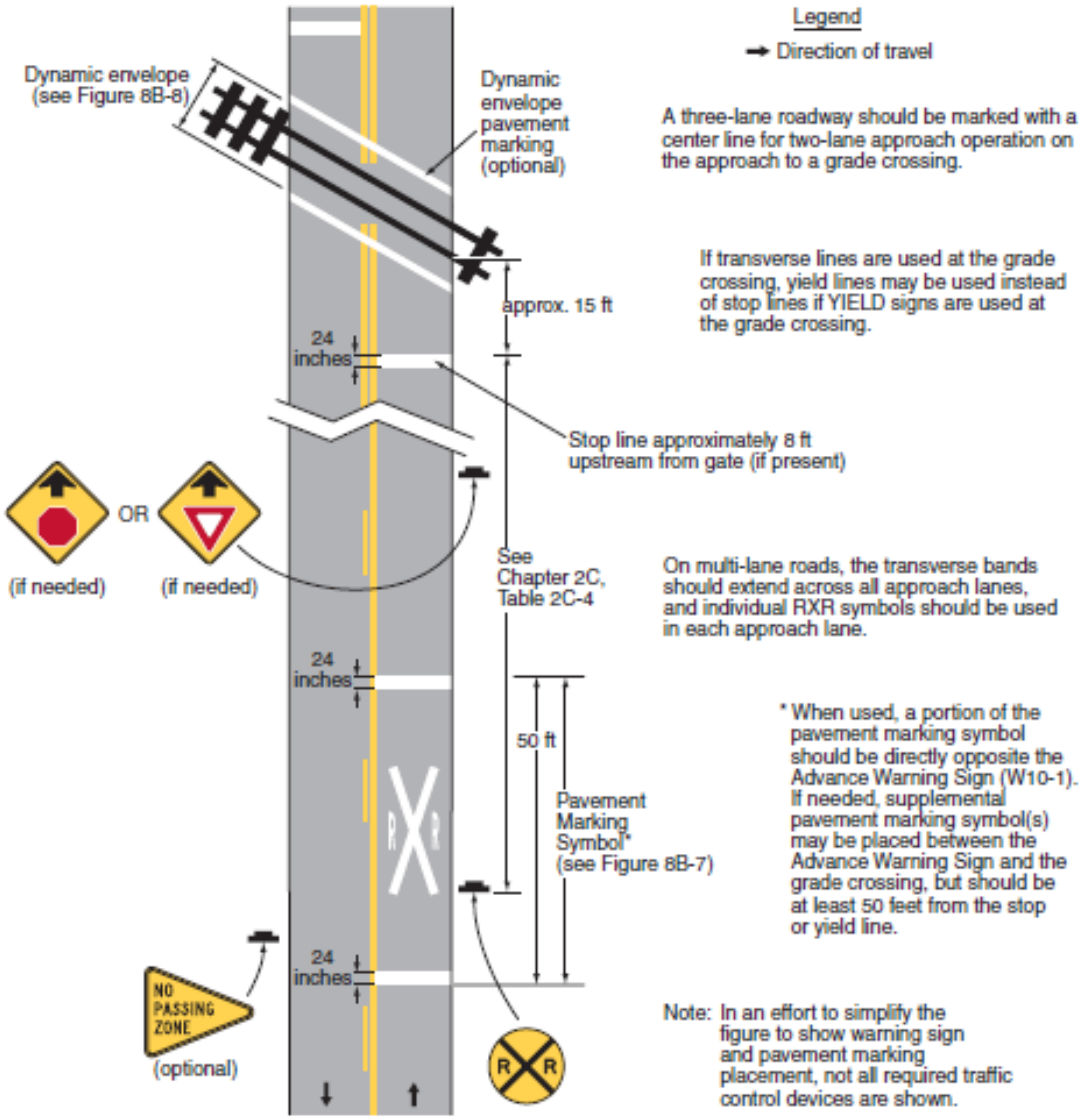
Exclusive	Grade-separated or protected right-of-way Other traffic prohibited No grade crossings
Semi-exclusive	Separate right-of-way or along a street or railroad right-of-way Limited access to other traffic Designated crossings only
Mixed-use	Operates in mixed traffic with all types of road users Shared right-of-way

There is no single standard system of traffic control devices applicable for all grade crossings due to the large number of unique location variables.

Passive traffic control systems (signs and pavement markings only) convey information about a grade crossing and warn road users at the grade crossing to yield to any rail traffic in proximity to the grade crossing. This system regulates, warns, and guides the road users and LRT vehicle operators to take appropriate action when approaching a grade crossing.

All pavement markings for grade crossings should be retroreflectorized white while other markings must meet the provisions in Part 3 of the MUTCD. For paved roadways, advance pavement markings for grade crossings should consist of an X, the letters RR, a no-passing zone marking and certain transverse lines.

Figure 8B-6. Example of Placement of Warning Signs and Pavement Markings at Grade Crossings



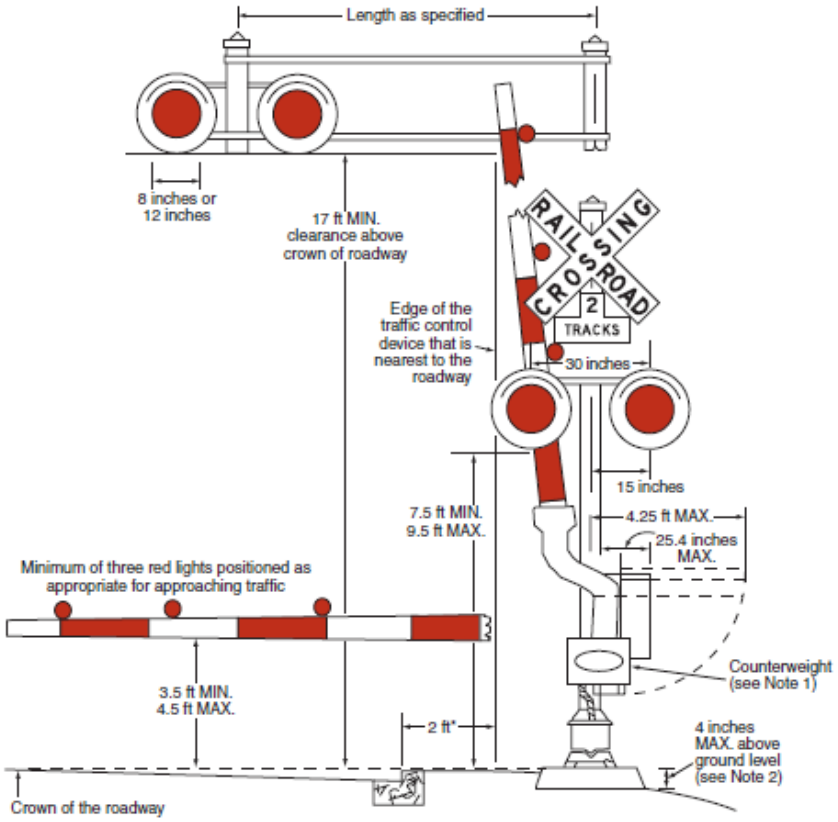
Identical markings shall be placed in each paved grade crossing with signals or automatic gates, and at all other grade crossings with speeds of **40 mph or greater.**

Pavement markings are not required for grade crossings with a posted or statutory speed **less than 40 mph** if an engineering study shows that other devices provide adequate warning and control. Pavement markings are not required at grade crossings in urban areas if other existing traffic control devices are sufficient.

Active traffic control systems warn road users of rail traffic at grade crossings (examples: four-quadrant gate systems; automatic gates; flashing-light signals; traffic control signals; actuated blank-out and variable message signs; and other active traffic control devices).

An engineering study should be used to determine if post-mounted and overhead flashing-light signals may be utilized separately or together. A study can also determine if flashing-light signals may be used without automatic gate assemblies.

Figure 8C-1. Composite Drawing of Active Traffic Control Devices for Grade Crossings Showing Clearances



For locations with curb, a minimum horizontal offset of *2 feet* shall be from the vertical curb face to the closest part of the signal or gate arm in its upright position. Vertical clearance for a cantilevered-arm flashing-light signal should be at least *17 feet* above the crown of the highway to the lowest point of the signal unit.

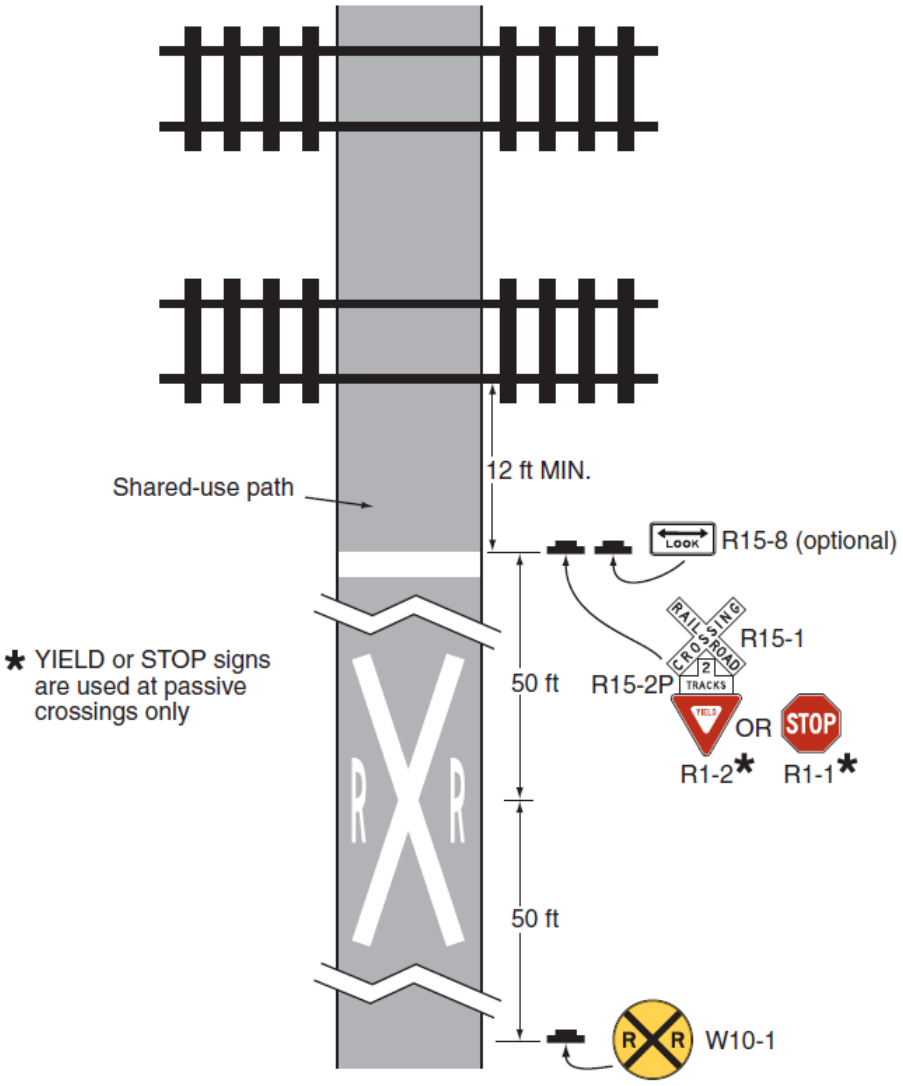
At sites with shoulders (no curb), a minimum horizontal offset of *2 feet* from the edge of shoulder is required, with a minimum offset of *6 feet* from the edge of the traveled way.

The minimum horizontal offset for locations without curb or shoulder should be *6 feet* from the edge of the traveled way.

Unless addressed otherwise in Part 8, sidewalks are considered to be part of a highway-rail or highway-LRT grade crossing instead of a pathway grade crossing. Many of the

provisions contained in this section are applicable to sidewalks adjacent to highway-rail or highway-LRT grade crossings (including detectable warnings, swing gates, and automatic gates). Crosswalks at intersections where pedestrians cross LRT tracks in mixed-use alignments are covered in Part 3.

Figure 8D-1. Example of Signing and Markings for a Pathway Grade Crossing



Pathway Grade Crossings

All signs for pathway grade crossings should be standard shape, legend, and color. These traffic control devices should be mounted at a maximum height of *8 feet* (measured vertically from the bottom edge of the device to the elevation of the pathway surface) and have a minimum lateral offset of *2 feet* (from the near edge of the device to the near edge of the pathway).

Post-mounted pathway signs should be a minimum mounting height of *4 feet*, measured from the bottom edge of the sign to the elevation of the pathway surface.

Pathway grade crossing traffic control devices should be a minimum of *12 feet* from the center of the nearest track.

For overhead traffic control devices on pathways, the clearance from the bottom edge of the device to the pathway surface should be a minimum distance of *8 feet*.

Advance warning signs and pavement markings for a pathway grade crossing should be considered where users include those who travel faster than pedestrians (bicyclists, skaters, etc.).

BICYCLE FACILITIES

Roadways without a marked bicycle lane or any of the other traffic control devices do not necessarily mean that bicyclists are prohibited from using the thoroughfare.

DEFINITIONS

Bike Lane – Part of roadway designated by striping, signing and pavement markings for use by bicyclists

Shared-use Path – Bikeway physically separated from motorized vehicular traffic by an open space or barrier intended for use of bicycles, pedestrians, and other non-motorized users

All traffic control (signs, signals, and markings) including those on bicycle facilities, should be properly maintained by designated responsible parties or agencies to command respect from all road users.

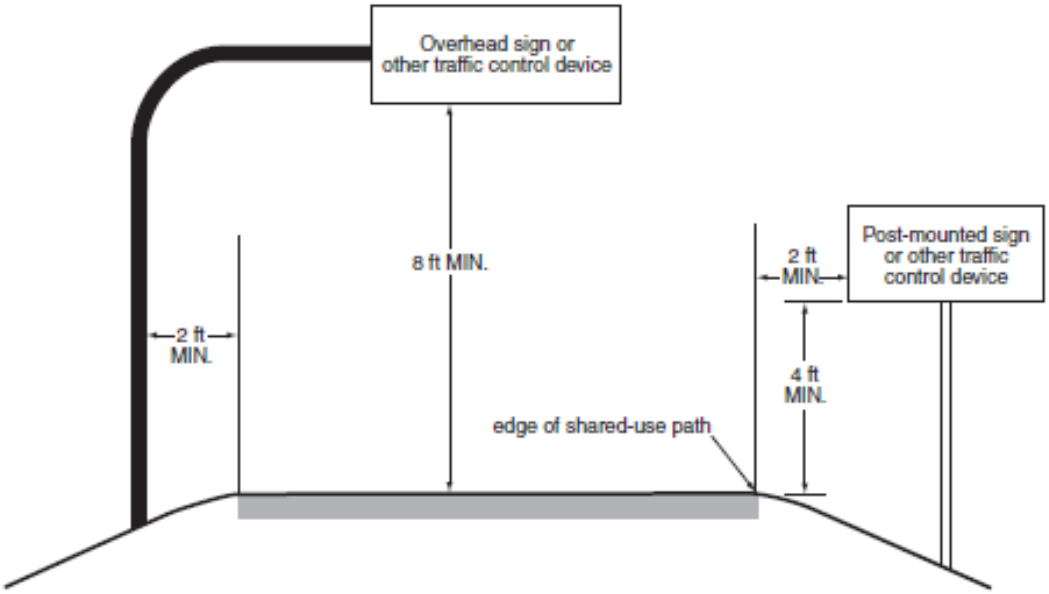
Informational documents used during the development for this section of the MUTCD include:

"Guide for Development of Bicycle Facilities"
"The Uniform Vehicle Code and Model Traffic Ordinance"
State and local government design guides.

SIGNS

All bikeway signs are required to be retroreflectorized for use on shared-use paths and bike lanes. For roadways serving both bicyclists and other users, all height and placement requirements are provided in Part 2 of the MUTCD.

Figure 9B-1. Sign Placement on Shared-Use Paths



For shared-use paths, signs or supports should be installed a minimum lateral distance of *2 feet* from the near edge of the path, or a minimum vertical distance of *8 feet* over the entire path width. The minimum mounting height for post-mounted signs on shared-use paths is *4 feet* (measured vertically from the bottom of the sign to the near edge of the path surface elevation). Overhead sign clearance should be adjusted where necessary to accommodate users requiring more clearance (equestrians, typical maintenance, emergency vehicles, etc.).

Table 9B-1 displays minimum sizes for signs and plaques installed specifically for bicycle traffic applications. These minimum sizes for bicycle facilities shall not be used at locations with any application to other vehicles. Larger size signs and plaques may be used on bicycle facilities when appropriate.

Table 9B-1. Bicycle Facility Sign and Plaque Minimum Sizes (Sheet 1 of 2)

Sign or Plaque	Sign Designation	Section	Shared-Use Path	Roadway
Stop	R1-1	2B.05, 9B.03	18 x 18	30 x 30
Yield	R1-2	2B.08, 9B.03	18 x 18 x 18	30 x 30 x 30
Bike Lane	R3-17	9B.04	—	24 x 18
Bike Lane (plaques)	R3-17aP, R3-17bP	9B.04	—	24 x 8
Movement Restriction	R4-1,2,3,7,16	2B.28,29,30,32; 9B.14	12 x 18	18 x 24
Begin Right Turn Lane Yield to Bikes	R4-4	9B.05	—	36 x 30
Bicycles May Use Full Lane	R4-11	9B.06	—	30 x 30
Bicycle Wrong Way	R5-1b	9B.07	12 x 18	12 x 18
No Motor Vehicles	R5-3	9B.08	24 x 24	24 x 24
No Bicycles	R5-6	9B.09	18 x 18	24 x 24
No Parking Bike Lane	R7-9,9a	9B.10	—	12 x 18
No Pedestrians	R9-3	9B.09	18 x 18	18 x 18
Ride With Traffic (plaque)	R9-3cP	9B.07	12 x 12	12 x 12
Bicycle Regulatory	R9-5,6	9B.11	12 x 18	12 x 18
Shared-Use Path Restriction	R9-7	9B.12	12 x 18	—
No Skaters	R9-13	9B.09	18 x 18	18 x 18

MARKINGS

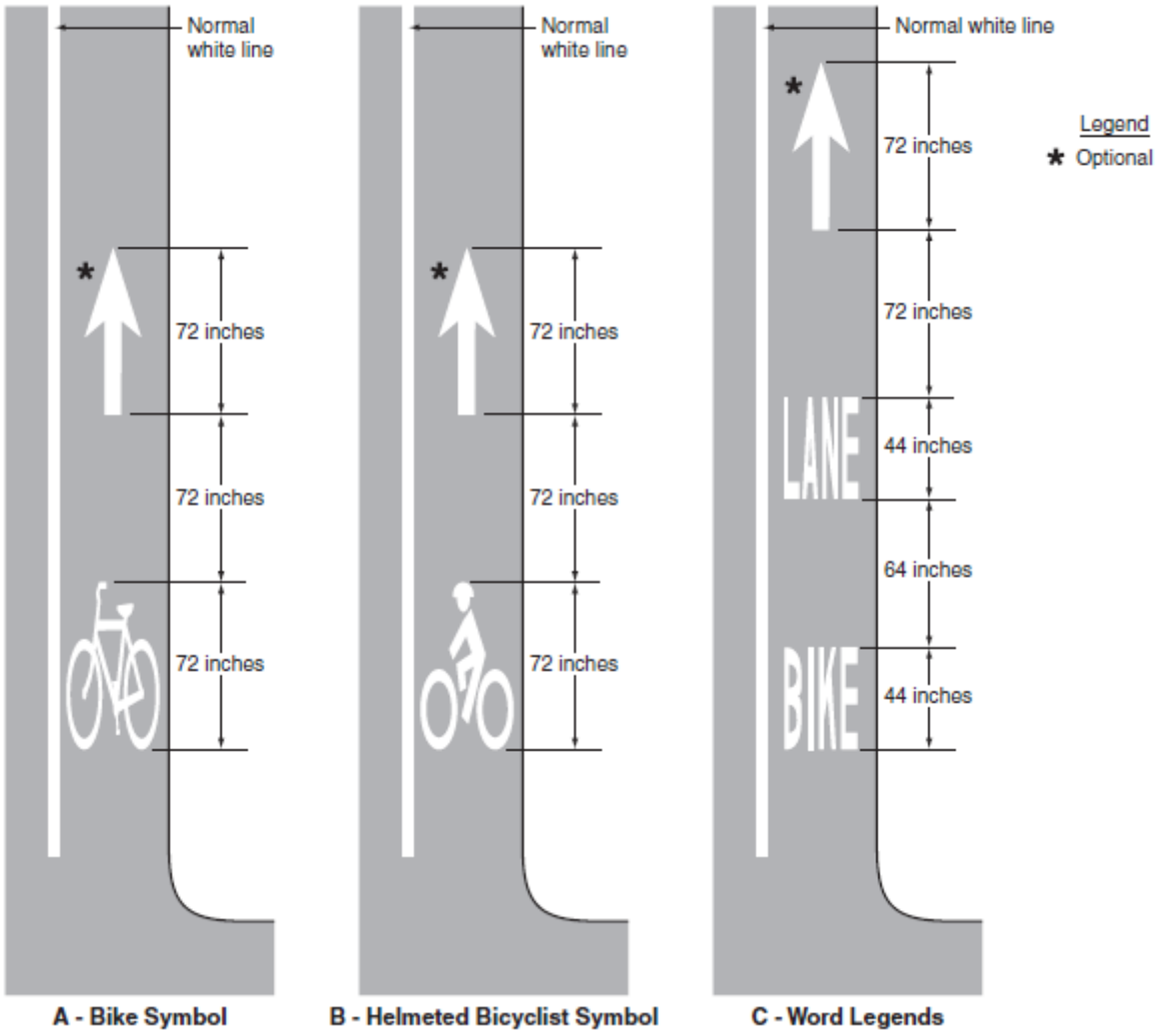
Pavement markings are used to designate space for preferential use by bicyclists and inform road users of the restricted nature of the bicycle lane. These markings separate lanes, assign travel paths, indicate traffic control signal positions, and provide advance information for bicyclists.

Word, symbol, and/or arrow markings should be placed at the beginning of a bicycle lane and at periodic intervals with consideration for selecting marking materials to minimize loss of traction under wet conditions. Smaller size letters and symbols (as well as half-size arrows) may be appropriate for use on shared-use paths.

Longitudinal pavement markings are used to define bicycle lanes. A solid white line (supplemented with the R9-7 sign) may be used to separate different types of traffic on shared-use paths.

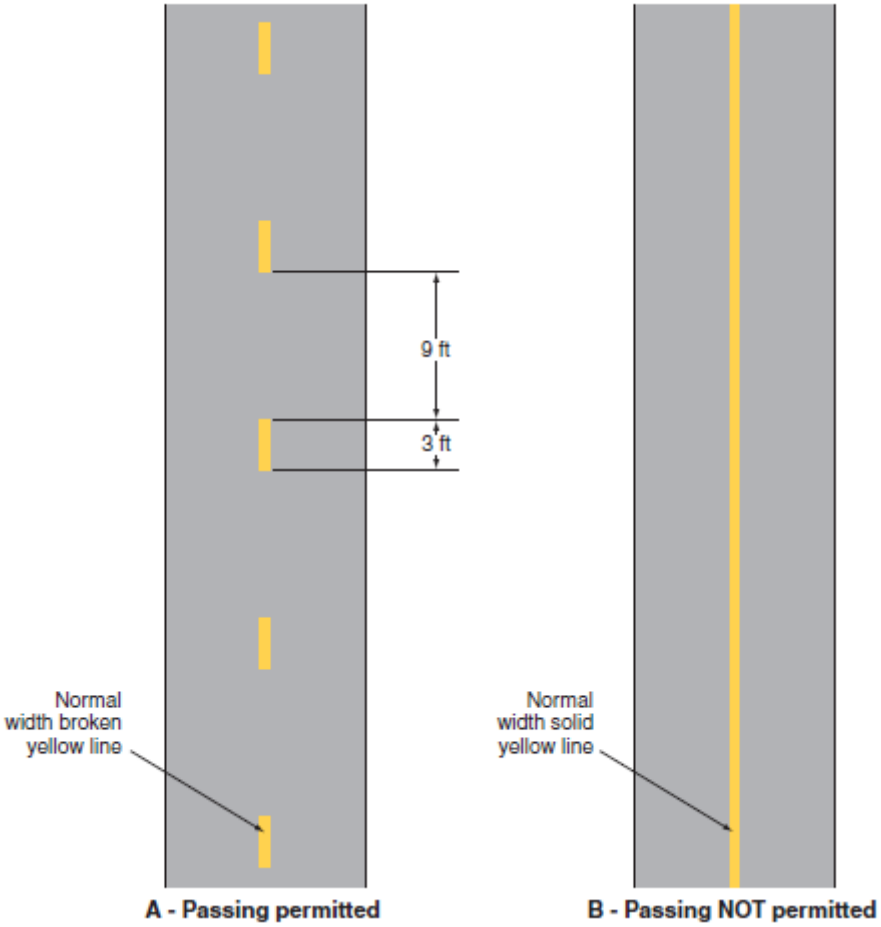
R9-7

Figure 9C-3. Word, Symbol, and Arrow Pavement Markings for Bicycle Lanes



For shared-use paths with two minimum width lanes, a solid yellow line may be used to indicate no passing and no traveling to the left of the line, and a broken yellow line with the usual 1-to-3 segment-to-gap ratio (a nominal 3-foot segment with a 9-foot gap) can be used where passing is permitted.

Figure 9C-2. Examples of Center Line Markings for Shared-Use Paths

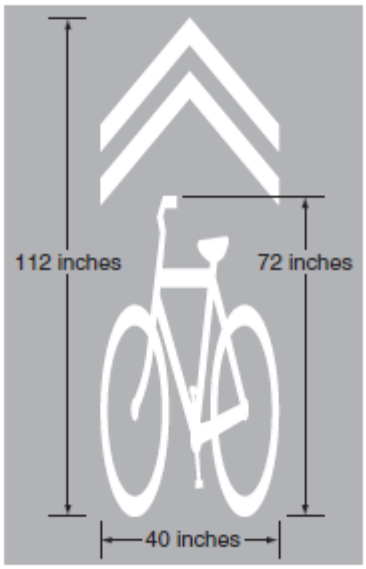


Markings should be used for obstructions (vertical elements to physically prevent unauthorized motor vehicles from entering the path) in the center of the shared-use path.

SHARED LANE MARKING FUNCTIONS

- Assist bicyclists with on-street parallel parking areas in order to reduce the chances of vehicle open door crashes
- Assist bicyclists in lanes too narrow for a motor vehicle and a bicycle to travel side by side
- Alert road users to the likelihood of bicyclists within the traveled way
- Encourage safe passing of bicyclists by motorists
- Reduce the frequency of wrong-way bicycling.

Figure 9C-9. Shared Lane Marking



Shared lane markings should not be used for roadways with a speed limit above 35 mph.

SUMMARY

The overall objective of this course was to give engineers and designers an in-depth look at traffic control selection and design principles. The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) 2009 Edition was used to explain the fundamental design principles of traffic signs and pavement markings. This text is the recognized **national standard** for all traffic control devices installed on any road or bikeway.

Traffic signs and pavement markings are critical tools that convey regulations, traffic, roadway conditions, and other important information. These devices allow users to travel safely on any U.S. roadway. The goal of traffic control is to provide drivers with relevant information when they need it.

The contents of this course were intended to serve as guidance and not as an absolute rule. It was written to help you learn to use the MUTCD more effectively for establishing roadway traffic control.

References

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(Note: All figures, tables, exhibits, etc. contained in this course are from the MUTCD, except where noted otherwise.)