Signs & Markings

Advancing the Future of Public Safety

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Signs & Markings

The History of Signs & Pavement Markings

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History of Signs & Pavement Markings

Traffic signs have become an essential part of our modern road systems, providing crucial information, guidance, and ensuring safety for motorists and pedestrians alike. Over the years, the development and evolution of traffic signs have been driven by the need to regulate and control traffic flow, minimize accidents, and promote efficient transportation. Let's embark on a journey through time to explore the fascinating history of traffic signs.

The origins of traffic signs can be traced back to ancient civilizations, where rudimentary forms of road signage were used to mark routes and convey warnings. However, it wasn't until the late 19th century that the concept of standardized traffic signs began to take shape. In 1868, the city of London, England, introduced a system of traffic signaling using gas-lit semaphore arms, marking a significant milestone in the history of traffic control.

History of Signs & Pavement Markings

The pivotal moment in the development of modern traffic signs came with the advent of the automobile. As motor vehicles started to populate the roads in the early 20th century, the need for consistent and universal traffic regulations became evident. In 1909, the first comprehensive set of traffic signs was created by the American Automobile Association (AAA) in collaboration with the National Conference on Street and Highway Safety. This initial system featured basic signs with simple pictorial symbols, color-coded to convey different messages.

The first international effort to standardize traffic signs took place in Geneva, Switzerland, in 1949, resulting in the establishment of the Vienna Convention on Road Signs and Signals. This treaty aimed to harmonize road traffic regulations and signs across different countries. It introduced standardized shapes, colors, and symbols for traffic signs, laying the foundation for a globally recognized system.

As technology advanced, the mid-20th century witnessed the integration of new materials and innovations into traffic signs. Reflective materials were introduced, enhancing visibility during nighttime conditions. In the 1960s and 1970s, the United States adopted the concept of the "Standard Highway Signs," which further refined and expanded the range of traffic signs available.

The late 20th century saw an increased focus on enhancing the clarity and legibility of traffic signs. Innovations such as retroreflective sheeting and improved font styles were incorporated to ensure signs were easily visible from a distance and quickly comprehensible to motorists. Additionally, advancements in road infrastructure, such as the introduction of roundabouts and variable message signs, prompted the development of specialized traffic signage to accommodate these changes.

History of Signs & Pavement Markings

In recent years, the evolution of traffic signs has been driven by technological advancements and the growing importance of smart transportation systems. Intelligent transportation systems (ITS) have paved the way for the integration of digital technologies into traffic signs, such as LED displays, dynamic messaging, and real-time information. These innovations offer greater flexibility, allowing signs to adapt to changing traffic conditions and provide up-to-date information to drivers.

Today, traffic signs play a vital role in maintaining order, promoting road safety, and facilitating efficient traffic management. They have evolved from basic pictorial symbols to encompass a vast array of signs, including regulatory signs, warning signs, and informational signs, each serving a specific purpose.

As we continue to navigate the complexities of urban mobility and the rise of autonomous vehicles, it is certain that traffic signs will further evolve to meet the challenges and demands of our ever-changing road systems. By adapting to new technologies and incorporating innovative designs, traffic signs will continue to guide us on our journeys, ensuring safe and efficient transportation for all.

Signs & Pavement Markings Time Line

1.) 1900s: The first traffic signs were simple and primarily used in urban areas. They were typically hand-painted and often featured words or basic symbols, such as arrows and crosses, to indicate directions or warnings.

2.) 1910s: The development of standardized traffic signs began. In 1915, the first stop sign with a white background and red letters was introduced in Detroit, Michigan.

3.) 1920s: The Manual on Uniform Traffic Control Devices (MUTCD) was established in the United States in 1927. This manual provided guidelines for the design, placement, and meaning of traffic signs across the country.

4.) 1930s: Reflective materials were introduced to improve visibility at night. This led to the adoption of retroreflective signs, which reflected light from headlights back towards the driver.

5.) 1940s: During World War II, many traffic sign production materials were redirected for military purposes, causing a temporary halt in sign development.

6.) 1950s: The international road sign system known as the Vienna Convention on Road Signs and Signals was developed in 1950. This convention established standard signs and symbols used in various countries.

Signs & Pavement Markings Time Line

7.) 1960s: The MUTCD continued to evolve in the United States, incorporating new signs and symbols. This included the introduction of yield signs and the familiar yellow diamond-shaped warning signs.

8.) 1970s: The concept of the "traffic light" was refined, and countdown timers were added to signal the time remaining before the light changed.

9.) 1980s: The use of computer-aided design (CAD) technology became more prevalent in the production of traffic signs, allowing for more precise and consistent designs.

10.) 1990s: Variable message signs (VMS) began to be used to display real-time traffic information, such as travel times, accidents, and road closures.

11.) 2000s: Digital and LED technologies were integrated into traffic signs, enabling dynamic displays and improved visibility. This led to the widespread adoption of LED traffic signals and electronic message boards.

12.) 2010s: Smart traffic signs emerged, incorporating sensors and connectivity to provide real-time information and adaptive control based on traffic conditions. These signs could display variable speed limits, lane closures, and weather warnings.

13.) Present Day (2020s): Traffic sign technology continues to advance with the integration of artificial intelligence and machine learning. This includes the development of smart cameras and sensors that can analyze traffic patterns and detect violations automatically.

Signs & Markings

Lesson 1: General

Knowledge Check: Brainstorm

What is the purpose of traffic control devices?

Purposes include:

- Safety and efficiency
- Orderly movement of all road users
- Notify road users of regulations
- Minimize the occurrences of crashes
- Uniformity and easy recognition
- Command attention

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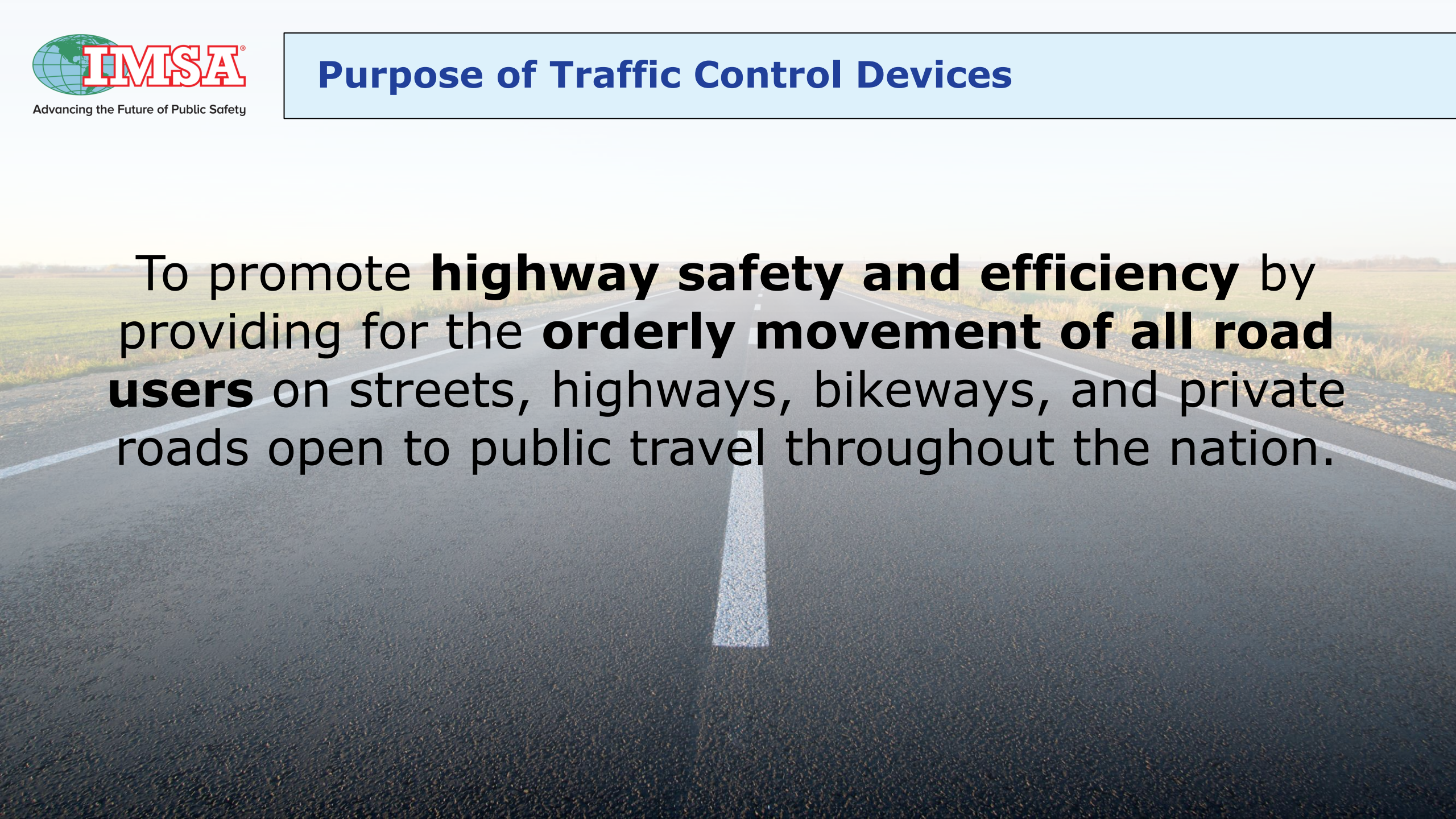
Purpose of Traffic Control Devices



To promote **highway safety and efficiency** by providing for the **orderly movement of all road users** on streets, highways, bikeways, and private roads open to public travel throughout the nation.

Purpose of Traffic Control Devices

Traffic control devices or their supports shall not bear any advertising message or any other message that is not related to traffic control.

Knowledge Check

Which sign meets the MUTCD guideline for a sign?

Principles of Traffic Control Devices

Principles of Traffic Control Devices

To be effective, a traffic control device should meet four basic requirements:

1. Fulfill a need.
2. Command attention & respect from road users.
3. Convey a clear, simple meaning.
4. Give adequate time for proper response.

Principles of Traffic Control Devices

These must be considered to meet those requirements:

- Design
- Placement
- Operation
- Maintenance
- Uniformity

Design

Features that draw attention to the devices:

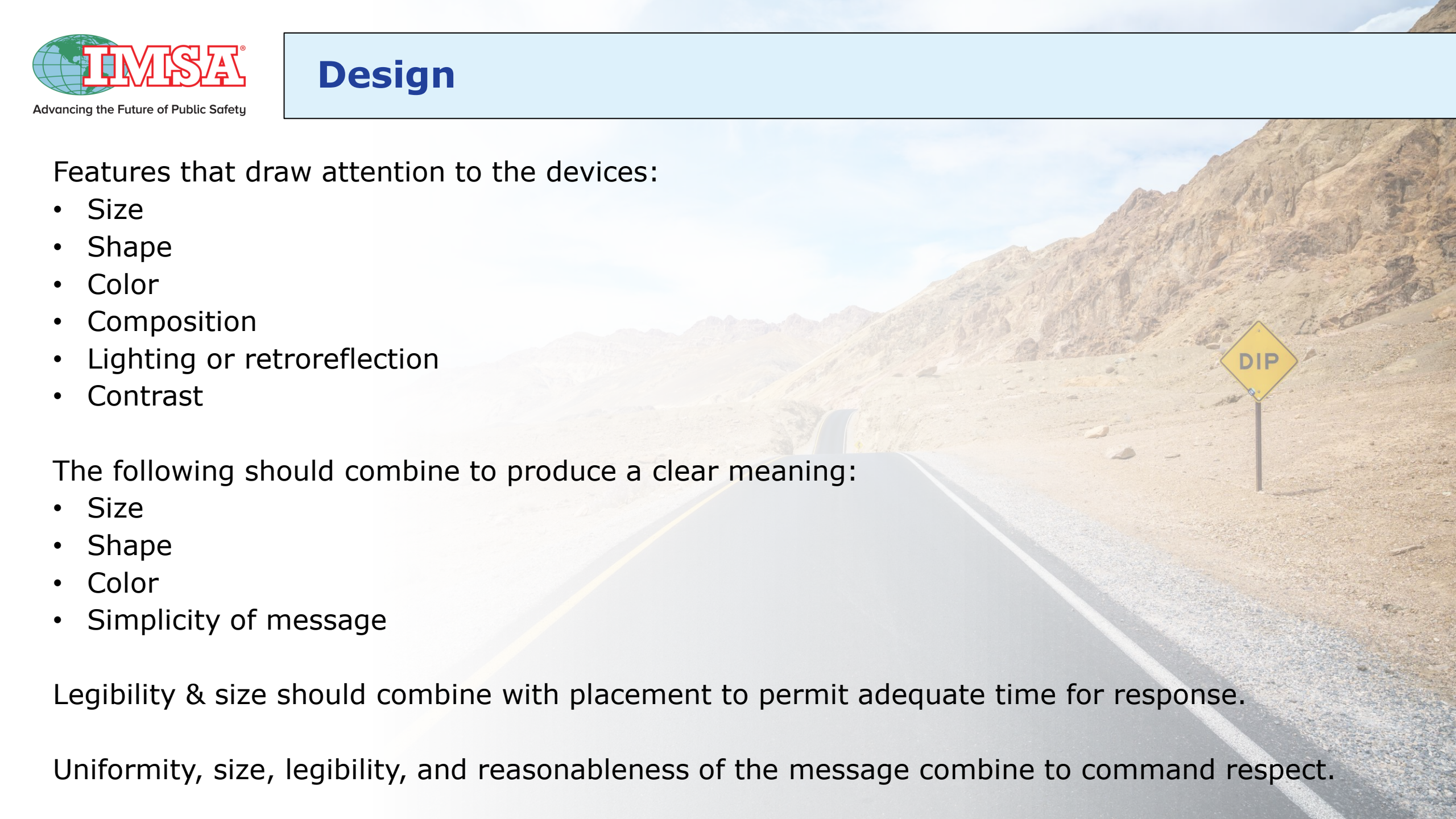
- Size
- Shape
- Color
- Composition
- Lighting or retroreflection
- Contrast

The following should combine to produce a clear meaning:

- Size
- Shape
- Color
- Simplicity of message

Legibility & size should combine with placement to permit adequate time for response.

Uniformity, size, legibility, and reasonableness of the message combine to command respect.



Placement & Operation

Placement must be:

- Within the road user's view.
- Such that a road user has adequate time to make the proper response in both day and night conditions.
- In a uniform and consistent manner.

To aid in conveying the proper meaning, the traffic control device should be appropriately positioned with respect to the:

- Location
- Object
- Situation

Excessive Use of Signs Guidance:

Regulatory and warning signs should be used conservatively because these signs, if used to excess, tend to lose their effectiveness.

If used, route signs and directional guide signs should be used frequently because their use promotes efficient operations by keeping road users informed of their location.

Maintenance

Functional maintenance

- Should be used to determine if certain devices need to be changed to meet current traffic conditions.

Physical maintenance

- Should be performed to retain the legibility and visibility of the device, and to retain the proper functioning of the device.

Uniformity

Purpose

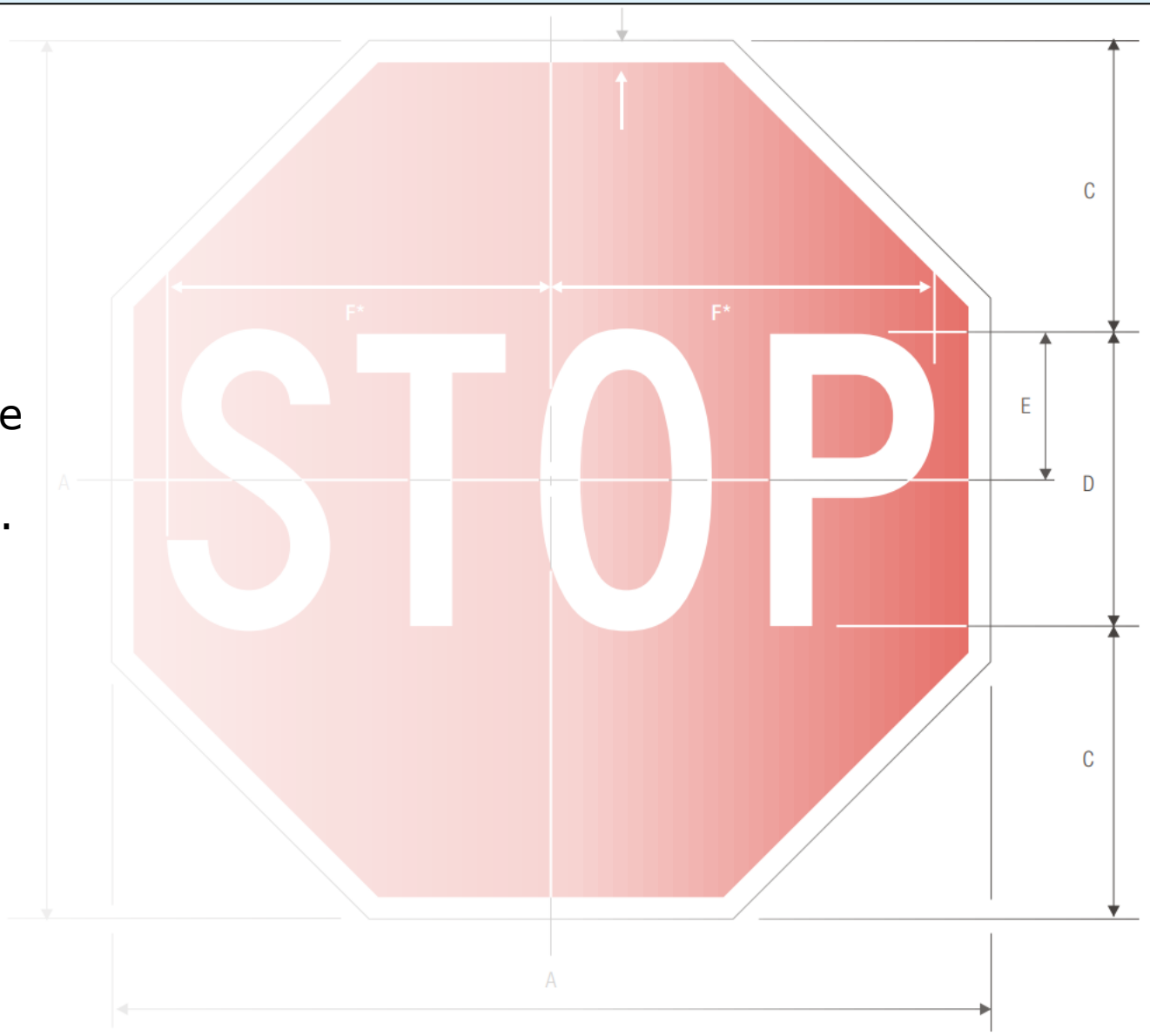
- Uniformity of the meaning of traffic control devices is vital to their effectiveness.

Meaning

- The meanings described to devices in the MUTCD are in general accord with the publications mentioned in Section 1A.11.

Note

- Later in this class we will cover specific signs and how to design them for uniformity.



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Color Codes

The general meaning of the 13 colors shall be as follows:

Black Regulation	**Blue** Road user services guidance, tourist information, and evacuation routes	**Brown** Recreational and cultural interest area guidance	**Coral** Unassigned	**Fluorescent Pink** Incident management	**Fluorescent Yellow-Green** Warnings such as: pedestrian, bicycle, school bus, and school
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	**Yellow** Warning

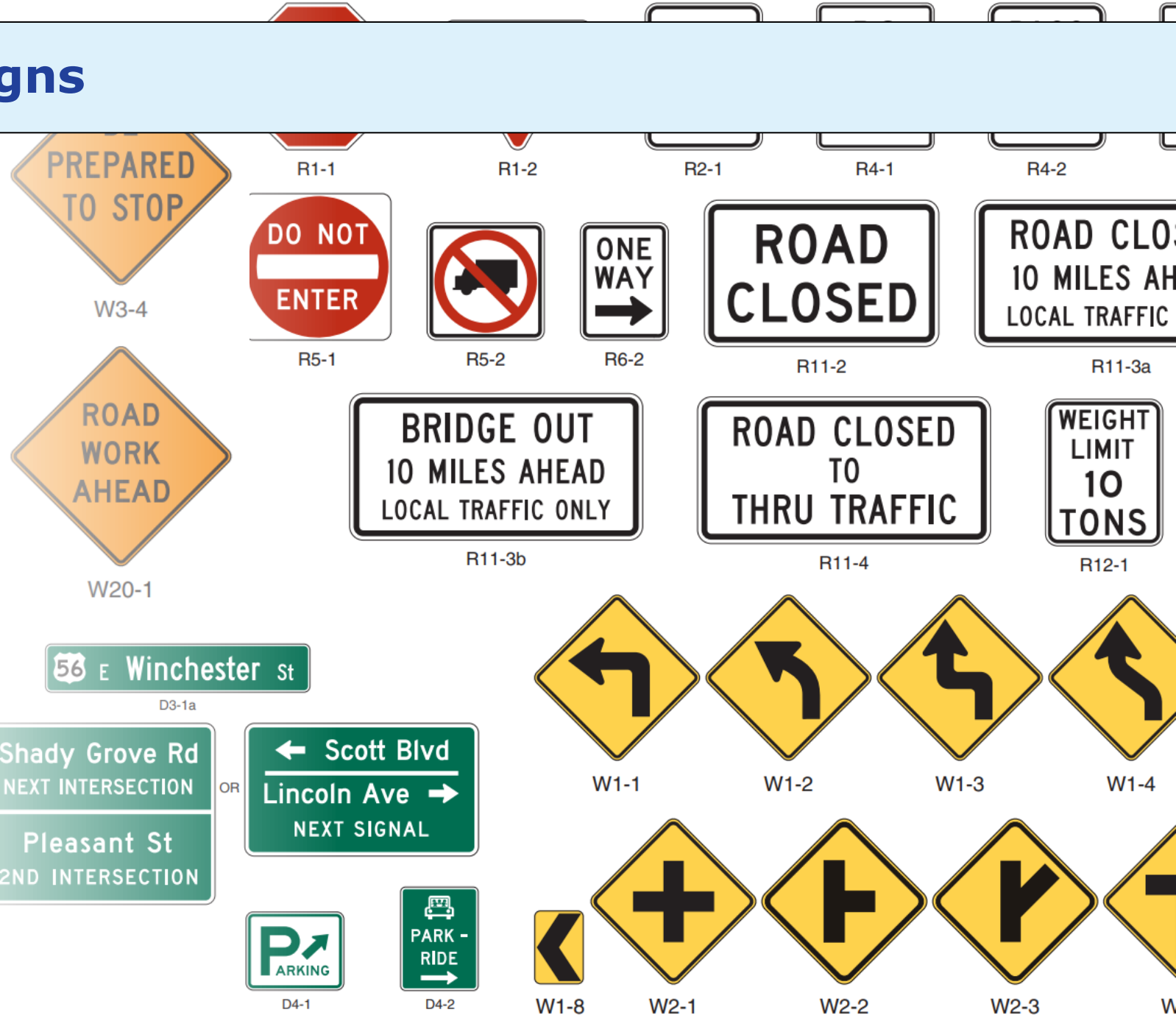
White
Regulation signs

Types of Signs Overview

Types of Signs

Types of signs:

- Regulatory
- Warning signs
- Guide
- Construction
- School



Regulatory Signs

Definition:

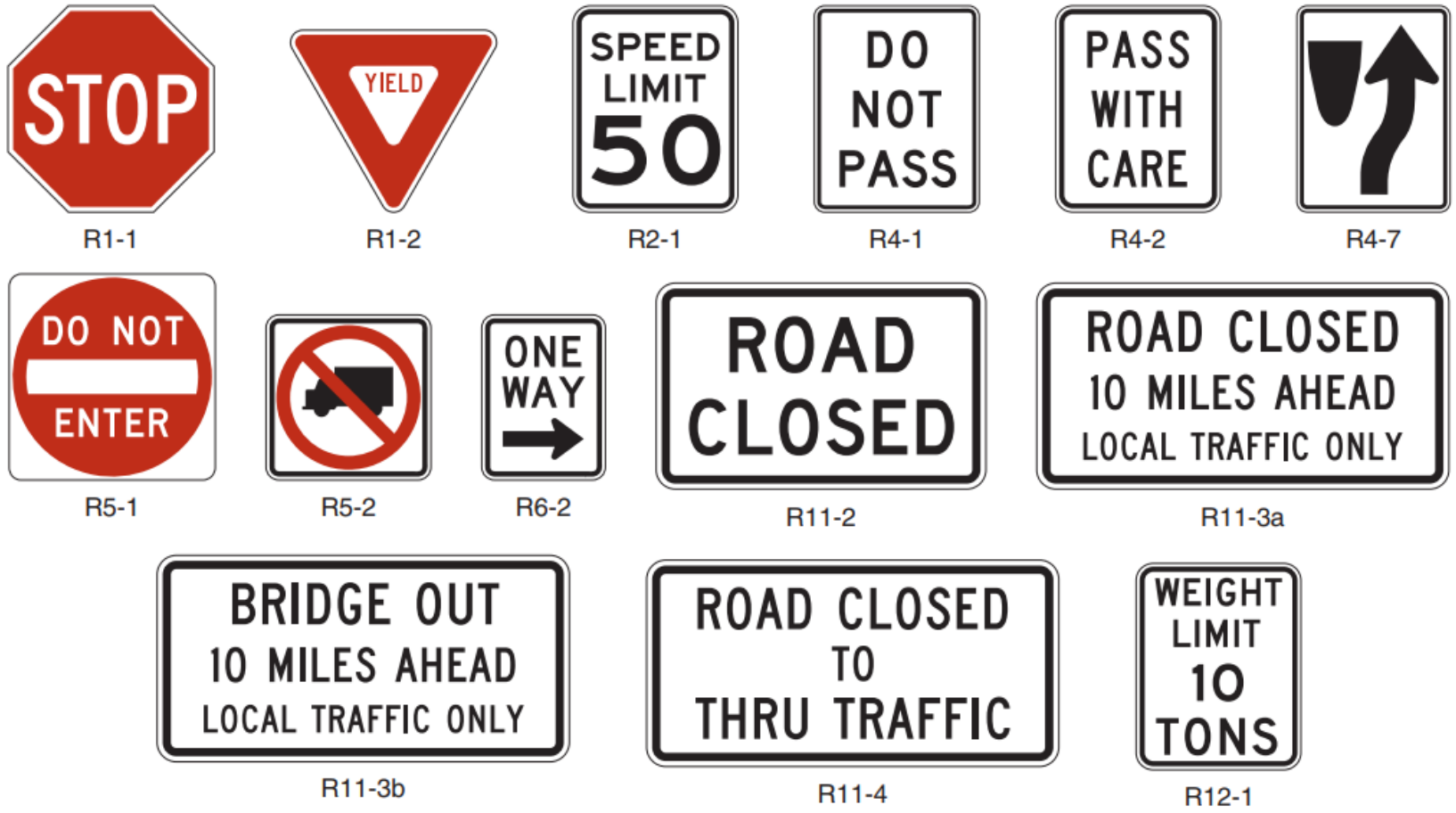
- Regulatory signs give notice of traffic laws or regulations.

Examples:

- Stop, speed limit, yield

Look:

- Black/white, red/white
- Rectangle



Warning Signs

Definition:

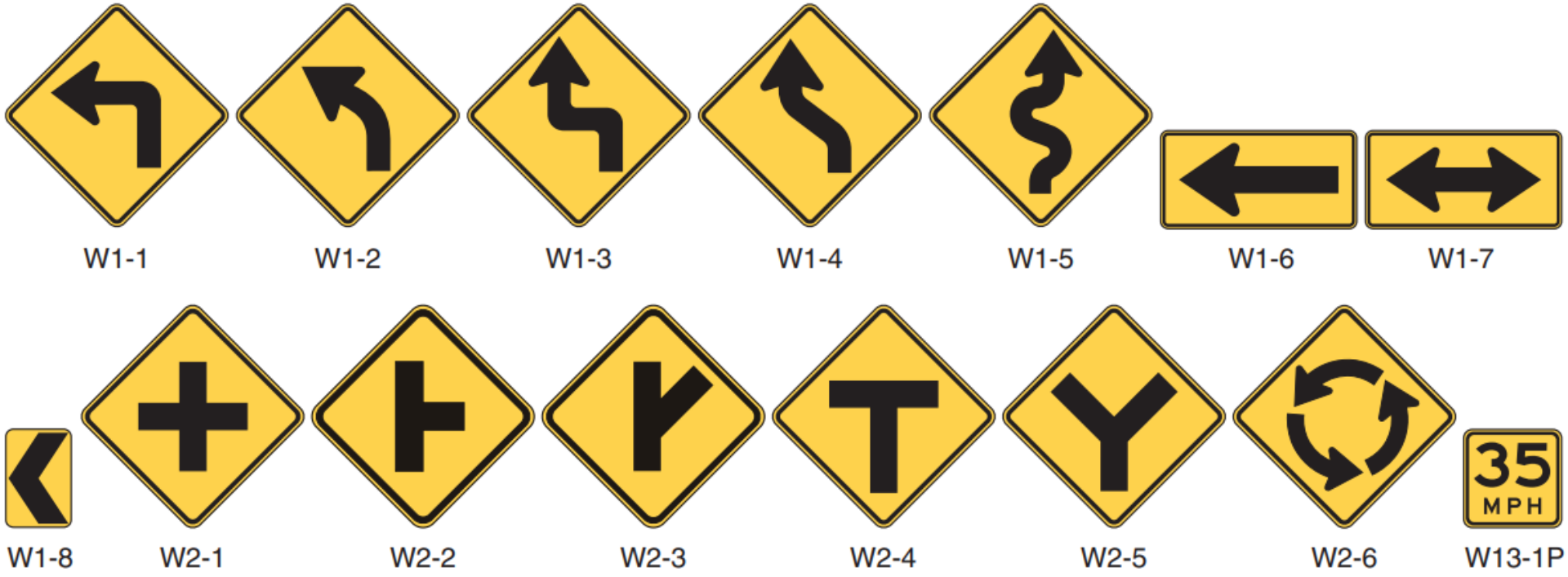
- Warning signs give notice of a situation that might not be readily apparent.

Examples:

- Dip, intersection, deer crossing

Look:

- Yellow/black
- Diamond



Guide Signs

Definition:

- Guide signs direct road users to important destinations, identify nearby rivers and streams, parks, forests, and historical sites, and generally give information that will help users along their way.

Examples:

- Hospital, street name blades, rest stop

Look:

- Green/blue/brown

D3-1

OR

D3-2

Interstate Route Sign
M1-1

Off-Interstate Business Route Sign
M1-2 (Loop), M1-3 (Spur)

U.S. Route Sign
M1-4

State Route Sign
M1-5

County Route Sign
M1-6

Forest Route Sign
M1-7

Construction Signs

Definition:

- Construction signs are used to warn, inform, and provide effective traffic control around work zones.

Examples:

- Road work ahead, flagger

Look:

- Orange/black
- Diamond

Note:

These signs are temporary.

W3-4

W20-1

School Signs

Definition:

- School signs provide effective traffic control around schools in order to prioritize pedestrian safety.

Examples:

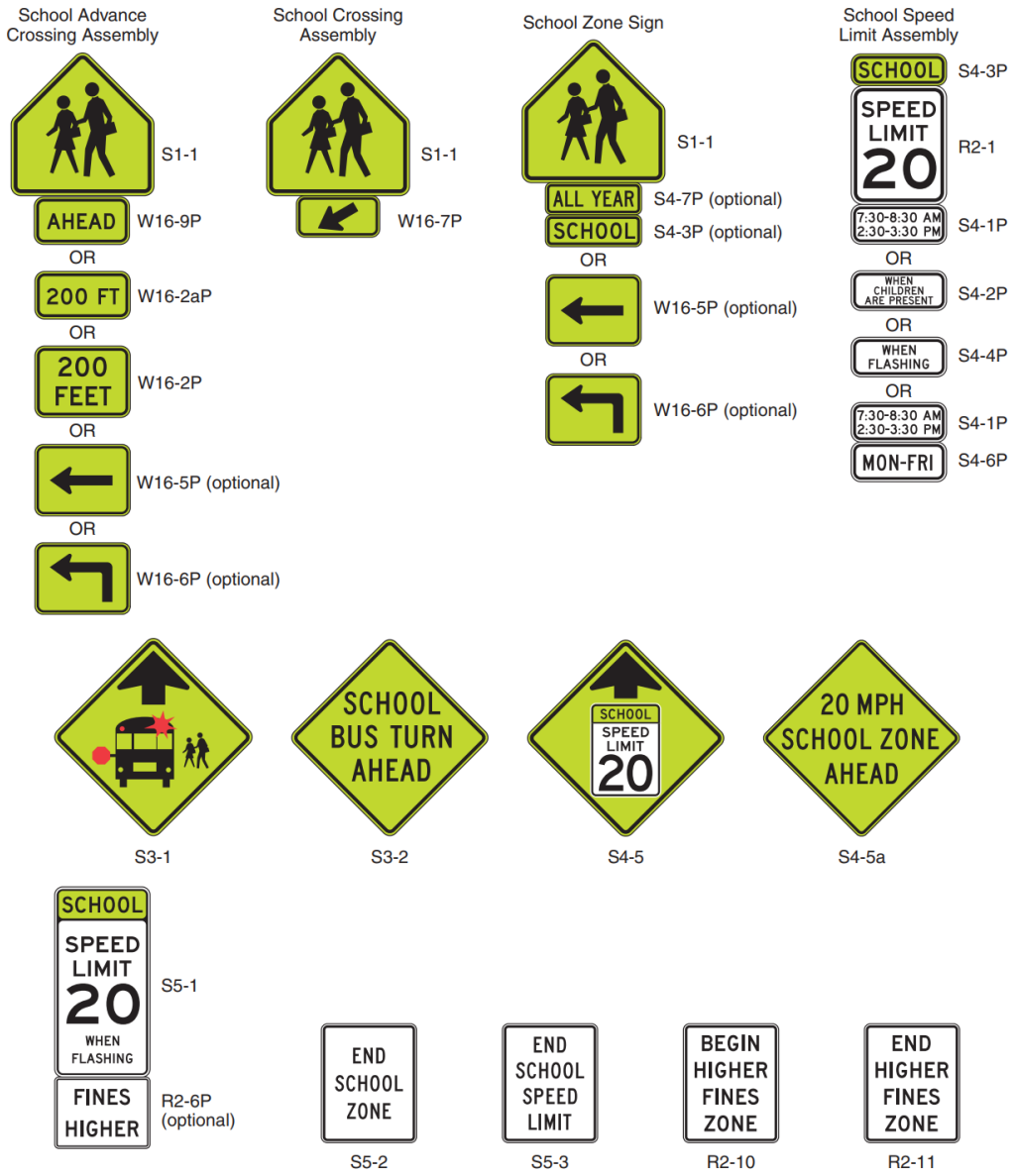
- School crossing assembly, school zone

Look:

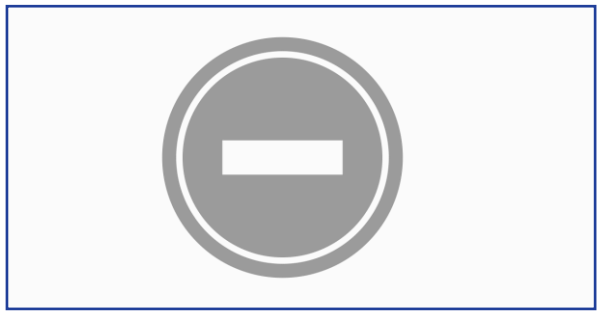
- FYG/black/white
- Diamond/rectangle

Note:

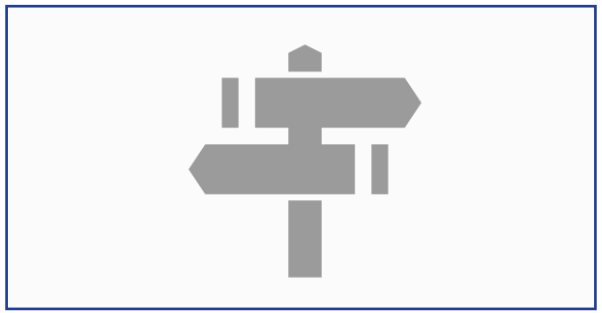
MUTCD Chapter 7 for more information.



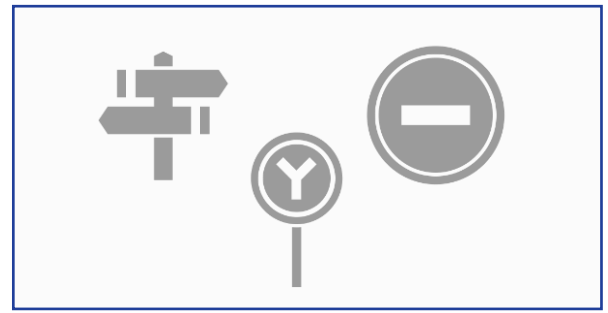
Lesson Summary



Purpose of Traffic Control Devices



Principles of Traffic Control Devices



Types of Signs Overview

Signs & Markings

Lesson 2: Regulatory Signs

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Application of Regulatory Signs

Regulatory Sign Purpose:

- Inform road users of selected traffic laws or regulations.
- Indicate the applicability of the legal requirements.

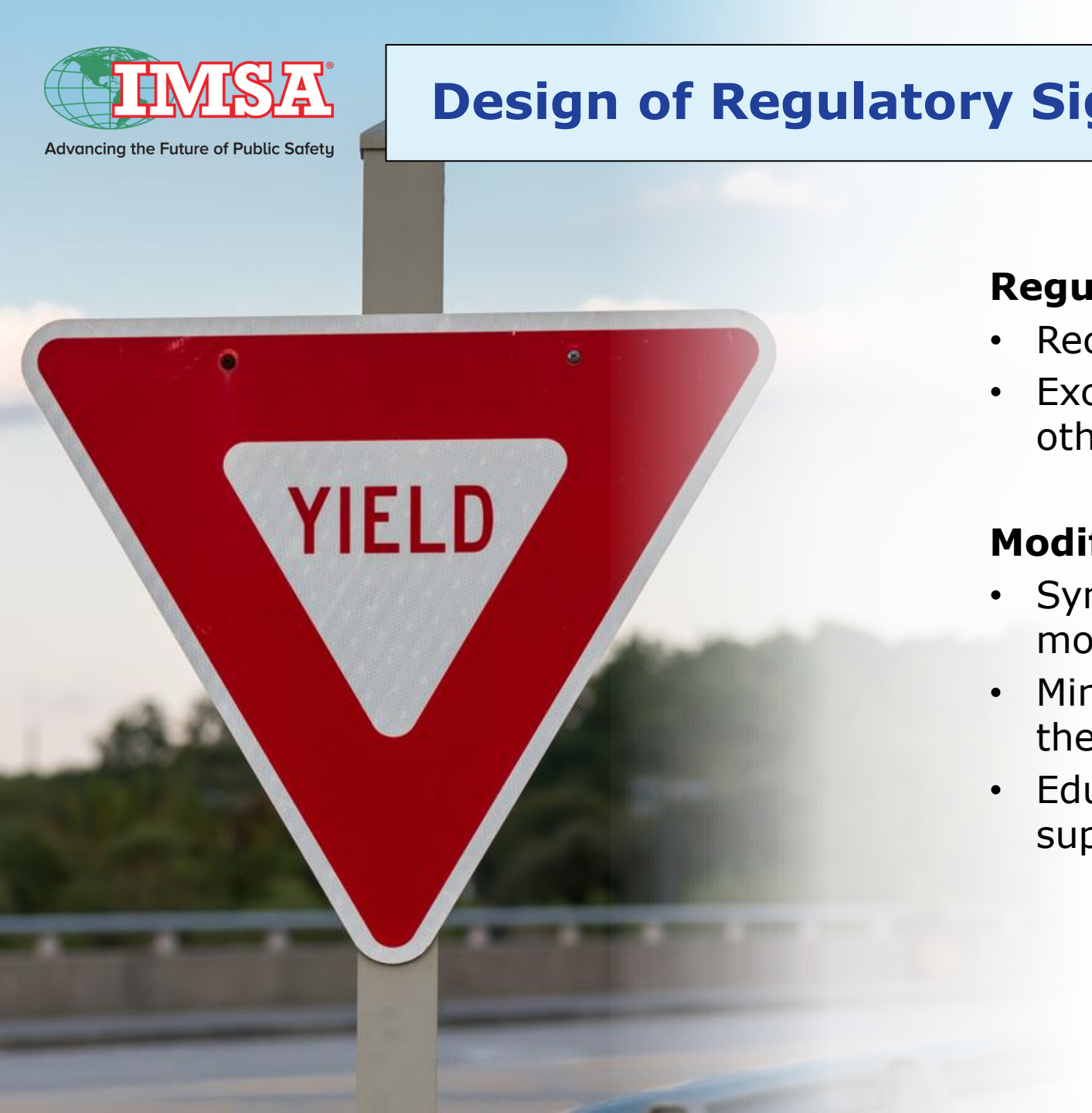
Regulatory Sign Design:

- Clearly indicate the requirements imposed by the regulations.
- Provide adequate visibility and legibility.

Regulatory Sign Placement:

- **Installed at or near where the regulations apply.**
- Retroreflective or illuminated to show the same shape and similar color both day and night.
- Illumination more than street or highway lighting.

Design of Regulatory Signs



Regulatory signs should be:

- Rectangular
- Except for: stop, yield & unless specified otherwise

Modifications:

- Symbols on regulatory signs may NOT be modified.
- Minor wording modifications may be made by the engineer in charge.
- Educational plaques may be used to supplement symbol signs.

Size of Regulatory Signs

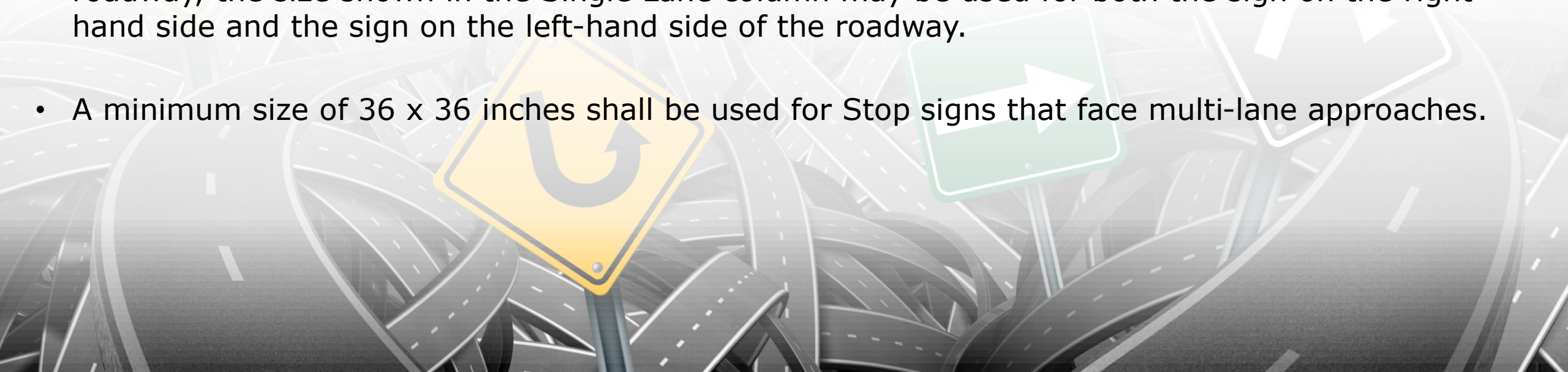
The following slides will cover the sizes for regulatory signs.

But first, a few notes:

- Where the posted speed limit is 35 mph or less on a multi-lane highway or street, other than for a Stop sign, the minimum size shown in the Single Lane column may be used.

- Where a regulatory sign, other than a Stop sign, is placed on the left-hand side of a multi-lane roadway in addition to the installation of the same regulatory sign on the right-hand side or the roadway, the size shown in the Single Lane column may be used for both the sign on the right-hand side and the sign on the left-hand side of the roadway.

- A minimum size of 36 x 36 inches shall be used for Stop signs that face multi-lane approaches.



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Size of Regulatory Signs – MUTCD Standards

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	—	—	—	—

Common Regulatory Signs & Placement

Stop Signs

Use:

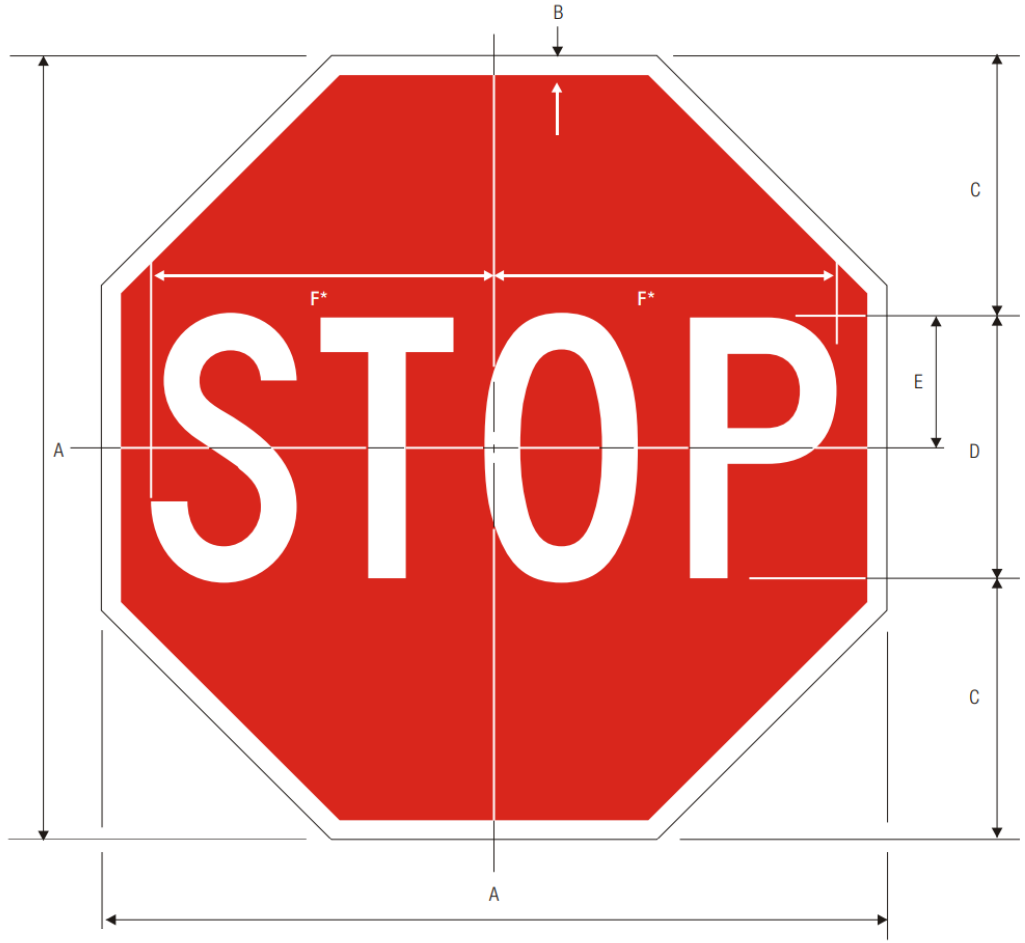
- Used when it is determined that a full stop is always required on an approach to an intersection.

Colors:

- Legend: White (retroreflective)
- Background: Red (retroreflective)

Notes:

- You may need to add the following plaques:
  - All-Way
  - Cross traffic does not stop
  - Oncoming traffic does not stop
  - Except right turn



A	B	C	D	E	F
18	.375	6	6 C	3	7.75
24	.625	8	8 C	4	10
30	.75	10	10 C	5	12.5
36	.875	12	12 C	6	15
48	1.25	16	16 C	8	20

C

R1-1
STOP

*Reduce spacing 40%

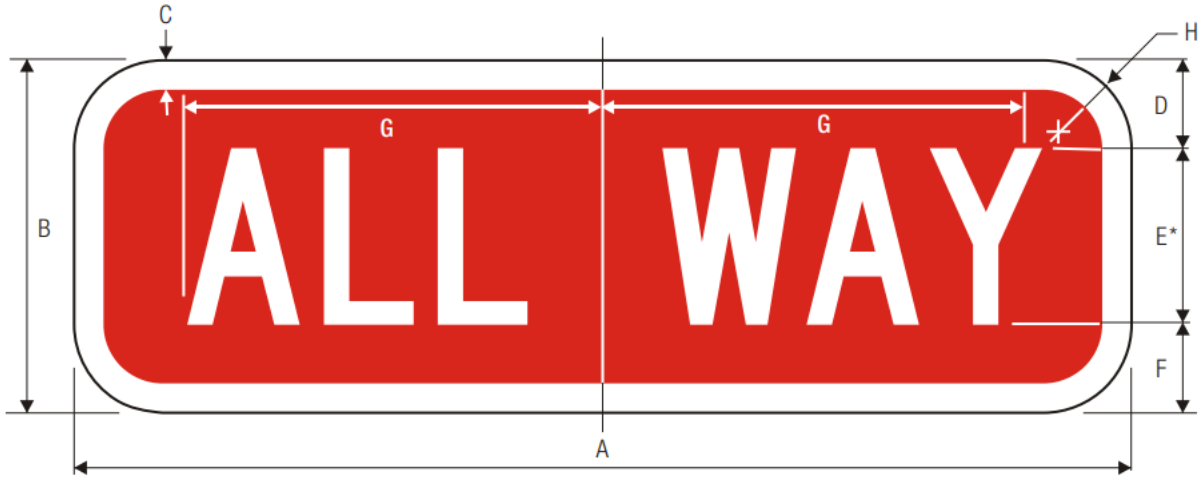
Multi-Way Stop Applications – All Way Plaques

Use

- Use at intersections where all approaches are controlled by Stop signs.

Colors

- Legend: White (retroreflective)
- Background: Red (retroreflective)



R1-4
ALL WAY

*Series 2000 Standard Alphabets.

	A	B	C	D	E	F	G	H
C	18	6	.5	1.5	3 C	1.5	7	1.5
	24	9	.5	2	5 C	2	11	1.5
	30	12	.75	3	6 C	3	13.25	1.875
	36	15	.75	4	7 C	4	15.771	2.25
	48	18	1	4.5	9 C	4.5	20.415	3

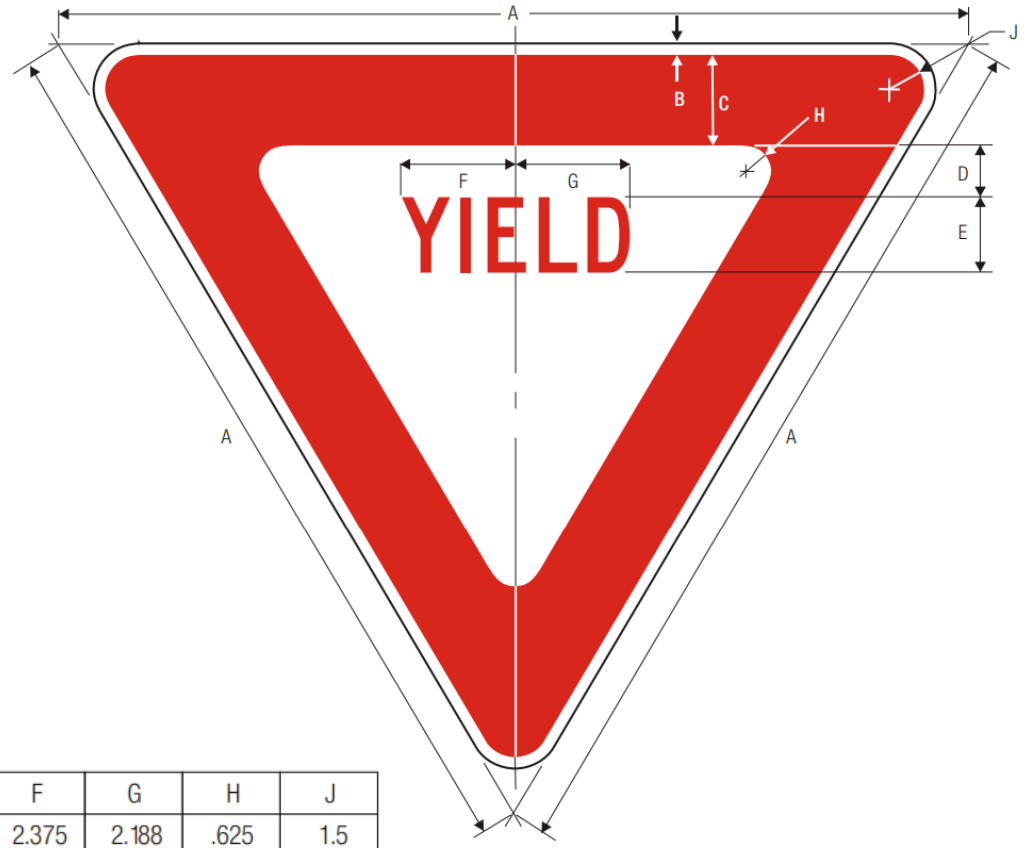
Yield Signs

Use

- Assigns right-of-way to traffic on certain approaches to an intersection. Vehicles controlled by a Yield sign need to slow down to a speed that is reasonable for the existing conditions or stop when necessary to avoid interfering with conflicting traffic.

Colors

- Legend: Red (retroreflective)
- Background: White (retroreflective)



R1-2
YIELD

A	B	C	D	E	F	G	H	J
18	.375	2	1	1.5 C	2.375	2.188	.625	1.5
24	.375	3	1.375	2 C	3.25	3	.875	1.5
30	.625	4	1.75	2.5 C	3.938	3.625	.875	1.5
36	.75	5	2	3 C	4.688	4.375	1.25	2
48	1	6	2.75	4 C	6.25	5.875	2	3
60	1.5	8	3.5	5 C	7.875	7.25	2.5	4

C

Yield Signs

Yield signs may be installed:

- On the approaches to a through street or highway where conditions are such that a full stop is not always required.
- At the second crossroad of a divided highway, where the median width at the intersection is 30 feet or greater.
- For a channelized turn lane that is separated from the adjacent travel lanes by an island.
- At an intersection where a special problem exists.
- Facing the entering roadway for a merge-type intersection.

Check the MUTCD for more information.

Yield Here and Stop Here Signs

Use

- Used if Yield (stop) lines are used in advance of a marked crosswalk that crosses an uncontrolled multi-lane approach.

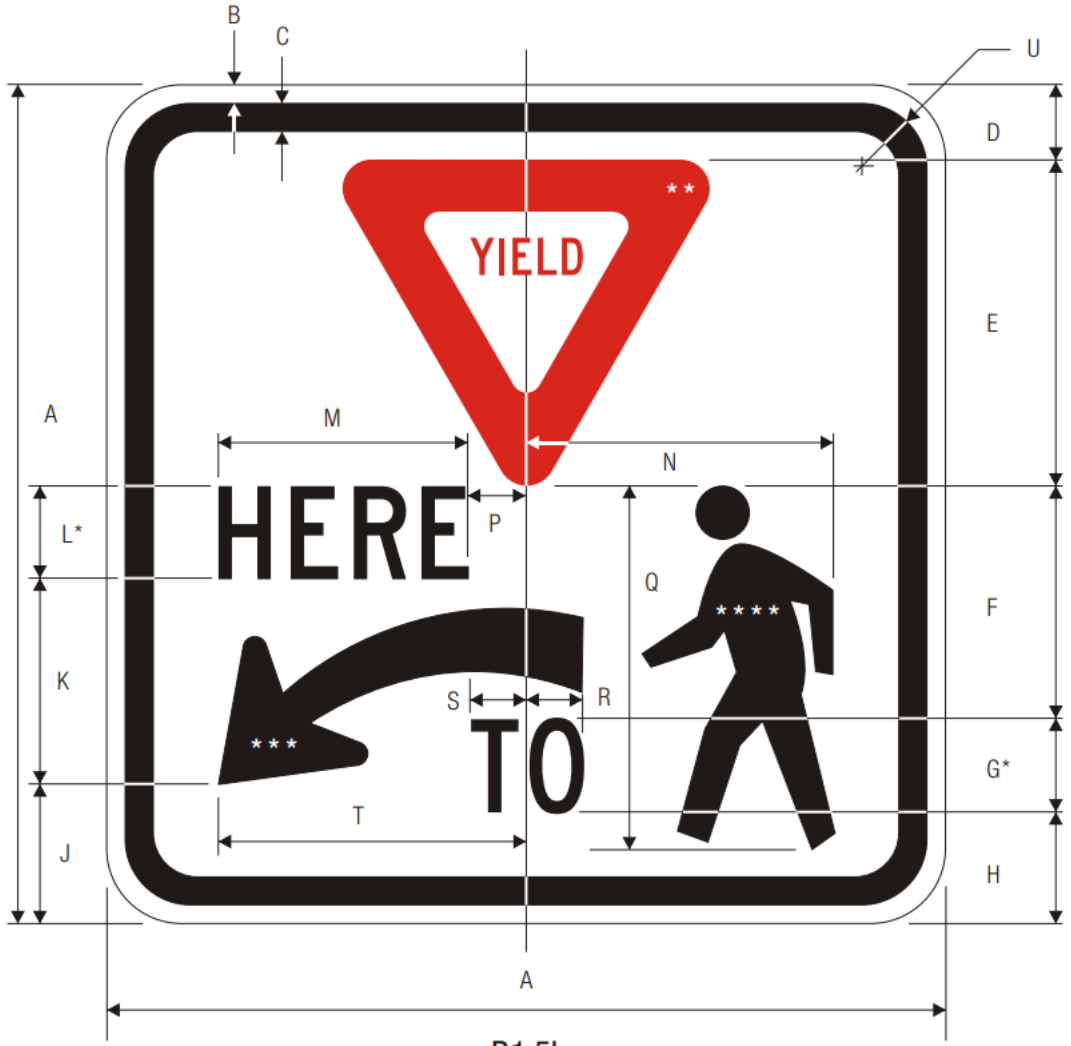
Colors

- Legend & Arrow: Black
- Pedestrian Symbol: Black
- Background: White (retroreflective)
- Yield Symbol: Red (retroreflective)

C	A	B	C	D	E	F	G	H	J	K	L
	18	.375	.625	1.625	7	5	2 C	2.375	3	4.375	2 C
	30	.5	.75	2.75	11.5	8.5	3 C	4.25	5	7.25	3 C
	36	.625	.875	3.25	14	10	4 C	4.75	6	8.75	4 C

M	N	P	Q	R	S	T	U
5.364	6.605	1.240	7.805	1.220	1.220	6.605	1.5
8.061	11	2	13	1.820	1.820	11	1.875
10.728	13.21	2.48	15.61	2.44	2.44	13.21	2.25

*Series 2000 Standard Alphabets.
**Insert R1-2 and size to fit.
***Insert R10-6a Arrow and size to fit.
****See 6-10 for design detail.



R1-5L
YIELD HERE TO PEDESTRIANS

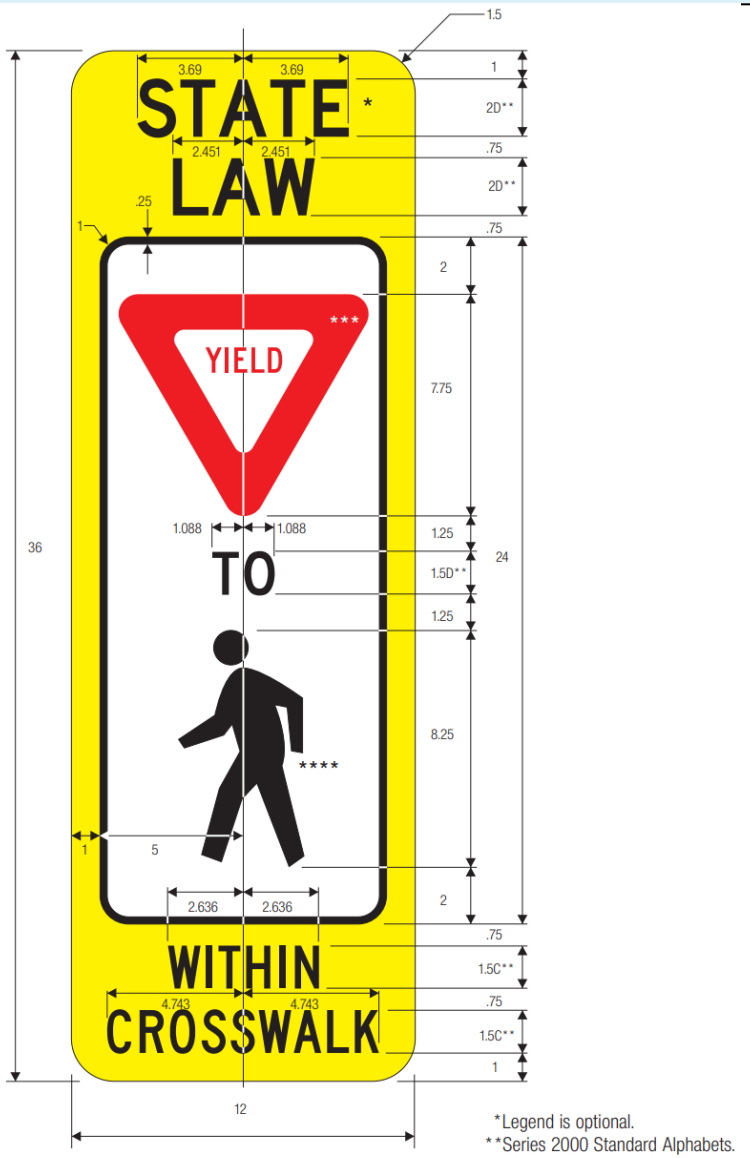
Pedestrian Crossing Signs

Use

- Used to remind road users of laws regarding right-of-way at an unsignalized pedestrian crosswalk.

Colors

- Legend: Black
- Background: FYG (retroreflective)
- Yield Symbol: Red (retroreflective) on white (retroreflective)
- Pedestrian Symbol: Black on white (retroreflective)



R1-6
IN-STREET PEDESTRIAN CROSSING

Speed Limit Signs

Use

- Speed Limit signs shall be located at the points of change from one speed limit to another.
- Speed Limit sign showing the next speed limit shall be installed at the downstream end of the section to which a speed limit applies.
- Additional Speed Limit signs shall be installed where it is necessary to remind road users of the speed limit that is applicable.

Colors

- Legend: Black
- Background: White (retroreflective)

R2-1
SPEED LIMIT (ENGLISH)

C	A	B	C	D	E	F	G	H	J	K	L
	18	24	.375	.625	3	3 E	2	8 E	7.188	5.5	1.5
	24	30	.375	.625	4	4 E	2	10 E	9.563	7.313	1.5
	36	48	.625	.875	6	6 E	5	14 E	14.375	11	2.25
	48	60	.75	1.25	8	8 E	6	16 E	19.125	14.625	3

*Optically space numerals about centerline

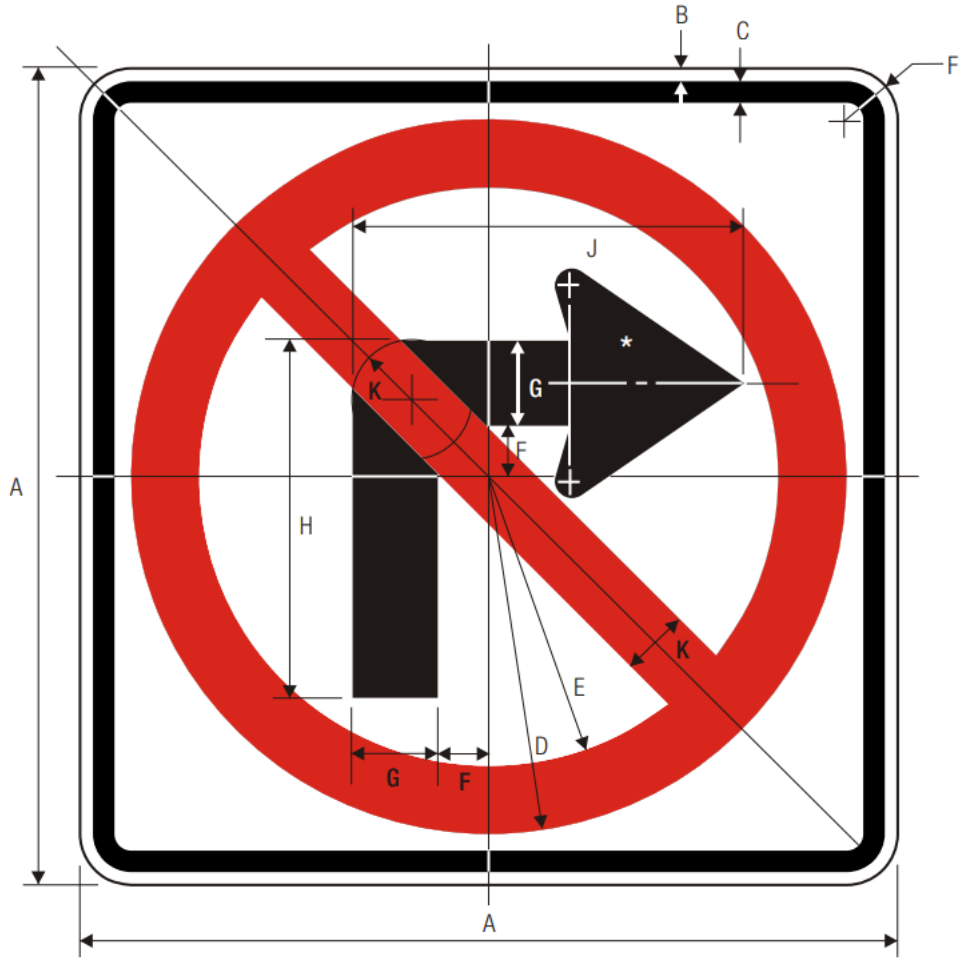
Movement Prohibition Signs

Use

- Used if specific movements are prohibited.

Colors

- Circle & Diagonal: Red (retroreflective)
- Symbol & Border: Black
- Background: White (retroreflective)



R3-1
RIGHT TURN PROHIBITION

	A	B	C	D	E	F	G	H	J	K
C	24	.375	.625	10.5	8.5	1.5	2.5	10.5	11.5	2
	30	.5	.75	13.125	10.625	1.875	3.125	13.125	14.5	2.5
	36	.625	.875	15.75	12.75	2.25	3.75	15.75	17.25	3
	48	.75	1.25	21	17	3	5	21	23	4

Intersection Lane Control Signs

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Use

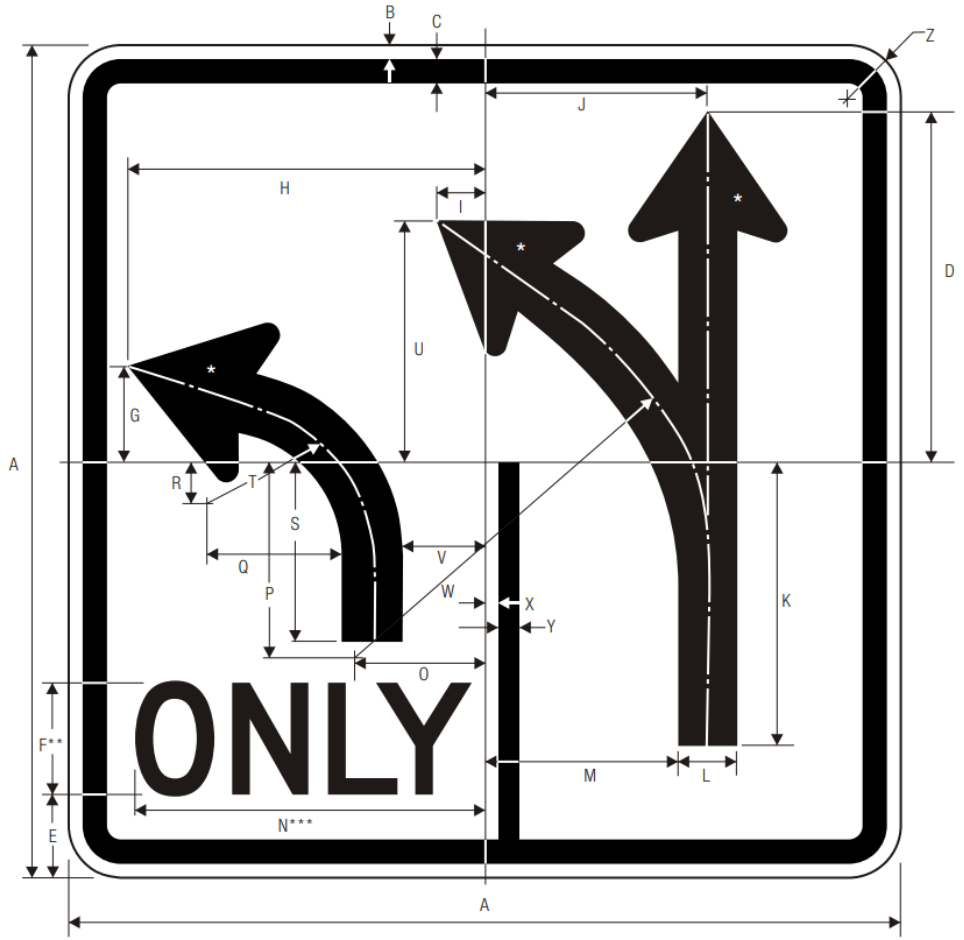
- Used when turns from a lane are allowed where such turns would otherwise not be permitted.
- When a road user is required to stay in the same lane and proceed straight through an intersection.
- To indicate permitted movements from a lane.

Colors

- Legend: Black
- Background: White (retroreflective)

C	A	B	C	D	E	F	G	H	I	J	K	L	M
	30	.5	.75	12.625	3	4 D	5	12.875	1.75	9.75	10.25	2.5	8.5
	36	.625	.875	15	3.6	5 D	6	15.45	2.1	11.7	12.3	3	10.2
	48	.75	1.25	20.2	4.8	6 D	8	20.6	2.8	15.6	16.4	4	13.6

N	O	P	Q	R	S	T	U	V	W	X	Y	Z
12.332	4.75	7.5	4.5	2.625	6.5	5.75	8	2.75	14.5	.5	.75	1.875
15.445	5.7	9	5.4	3.15	7.8	6.9	9.6	3.3	17.4	.6	.9	2.25
19.556	7.6	12	7.2	4.2	10.4	9.2	12.8	4.4	23.2	.8	1.2	3



R3-8

ADVANCE INTERSECTION LANE CONTROL

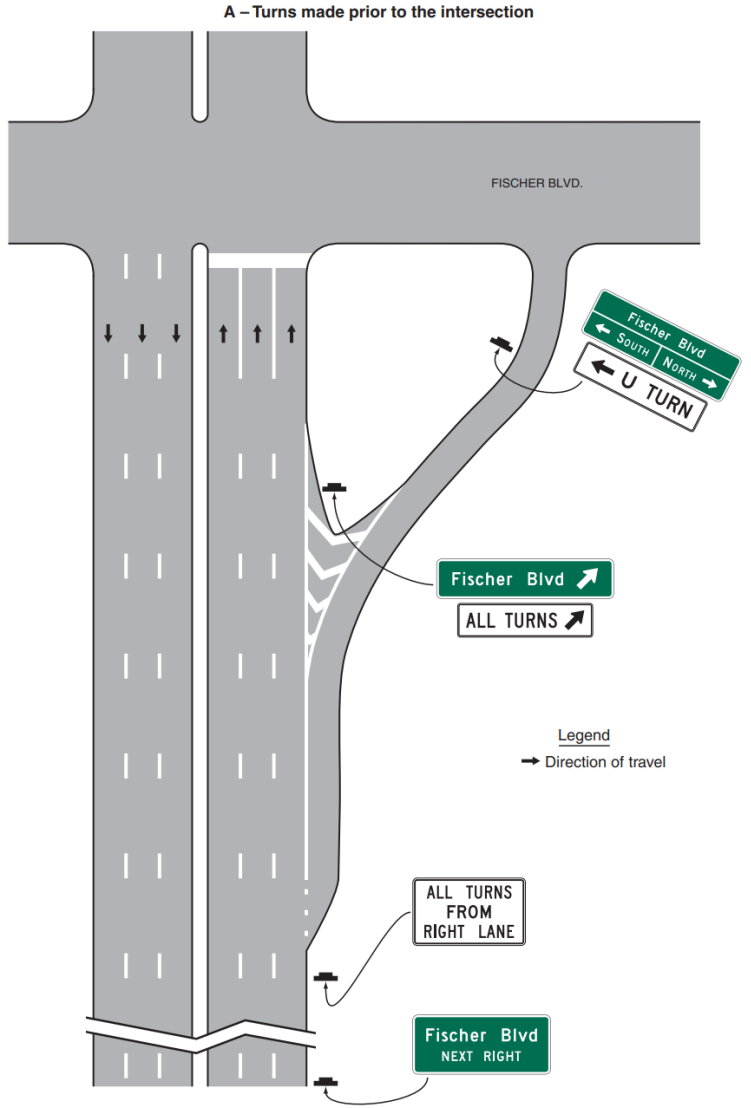
*See page 6-2 for design details.
**Series 2000 Standard Alphabets.
***Reduce spacing to fit.
****OK is optional.

Jughandle Signs

What are they?

- A jughandle turn is a left-turn or U-turn that, because of special geometry, is made by initially making a right turn.
- See diagram in section 2B.27 in the MUTCD for more information.

Figure 2B-9. Examples of Applications of Jughandle Regulatory and Guide Signing
(Sheet 1 of 3)



Passing Signs

Use

- The Do Not Pass sign may be used in addition to pavement markings to emphasize the restriction on passing.

Colors

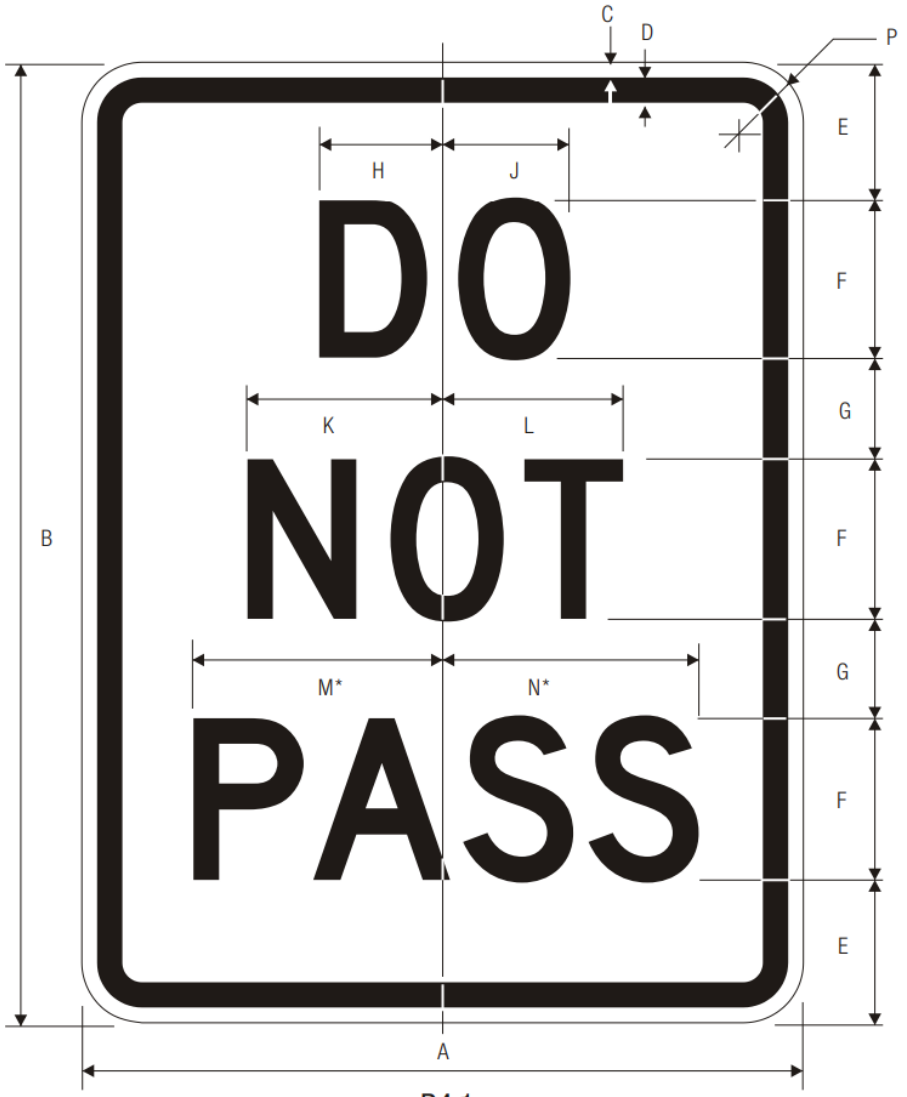
- Legend: Black
- Background: White (retroreflective)

Other passing signs include:

- Pass with care, keep right except to pass, trucks use right lane, keep right/left, stay in lane, etc.

A	B	C	D	E	F	G	H	J	K	L	M	N	P
12	18	.375	.438	2.875	2.75 D	2	2.125	2.188	3.188	3.438	4.188	4.438	1.5
18	24	.375	.625	3.5	4 D	2.5	3.125	3.313	4.75	4.875	6.25	6.5	1.5
24	30	.375	.625	3.5	6 D	2.5	4.688	5	7.125	7.375	9.375	9.75	1.5
36	48	.625	.875	7	8 D	5	6.25	6.625	9.5	9.75	12.5	13	2.25
48	60	.75	1.25	8	10 D	7	7.75	8.313	11.875	12.25	15.625	16.25	3

C



R4-1
DO NOT PASS

*Reduce spacing to fit.

Do Not Enter Signs

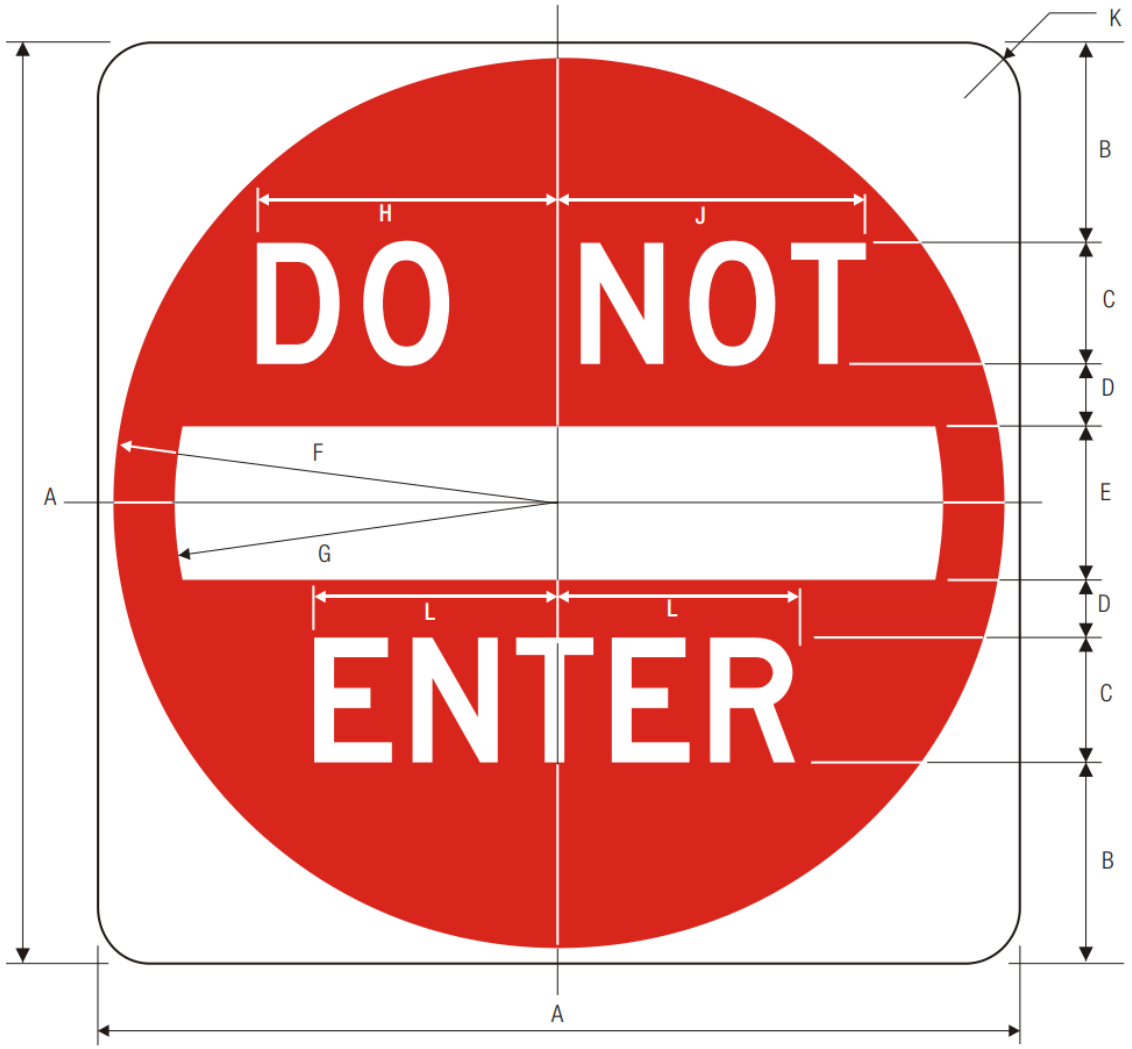
Use

- Used where traffic is prohibited from entering a restricted roadway.

Colors

- Symbol: Red (retroreflective)
- Legend & Background: White (retroreflective)

C	A	B	C	D	E	F	G	H	J	K	L
	30	6.5	4 D	2	5	14.5	12.5	9.75	10	1.875	7.875
	36	7.5	5 D	2.5	6	17.5	15	12	12.375	2.25	9.813
	48	11	6 D	3	8	23.5	20	14.5	15	3	11.75



R5-1
DO NOT ENTER

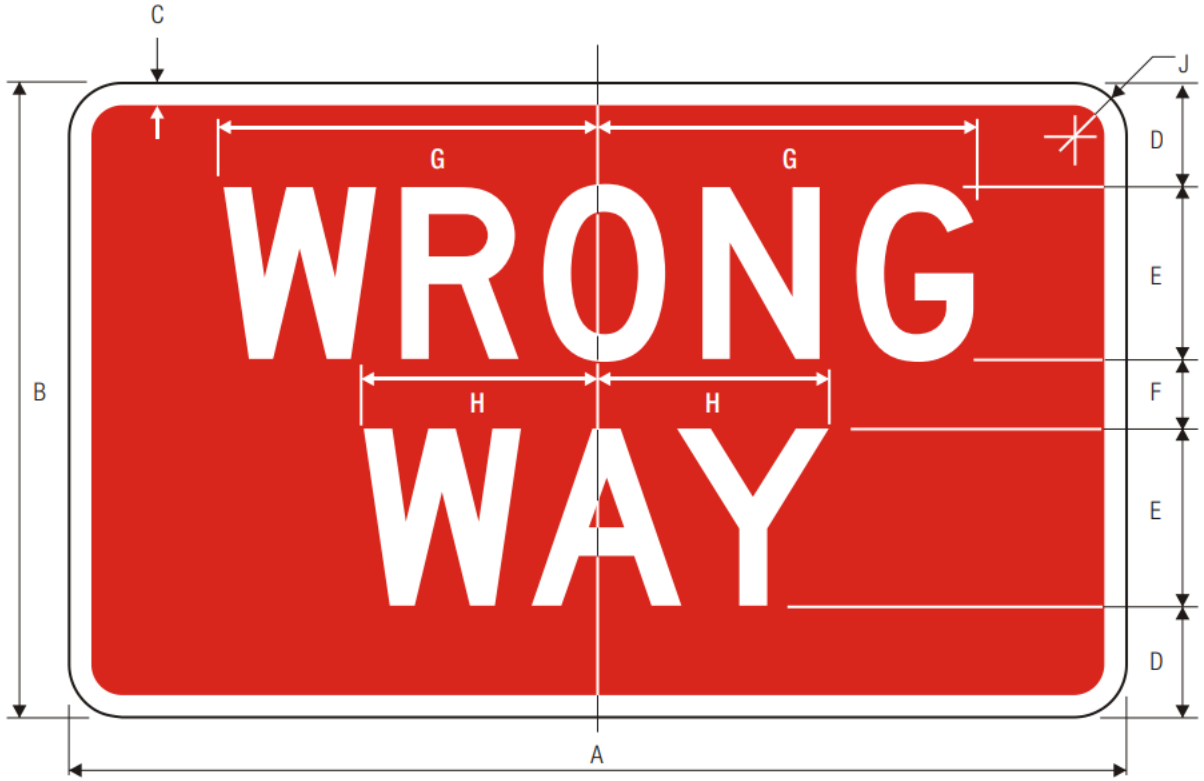
Wrong Way Signs

Use

- Used as a supplement to the Do Not Enter sign where an exit ramp intersects a crossroad, or a crossroad intersects a one-way roadway in a manner that does not physically discourage or prevent wrong-way entry.

Colors

- Legend: White (retroreflective)
- Background: Red (retroreflective)

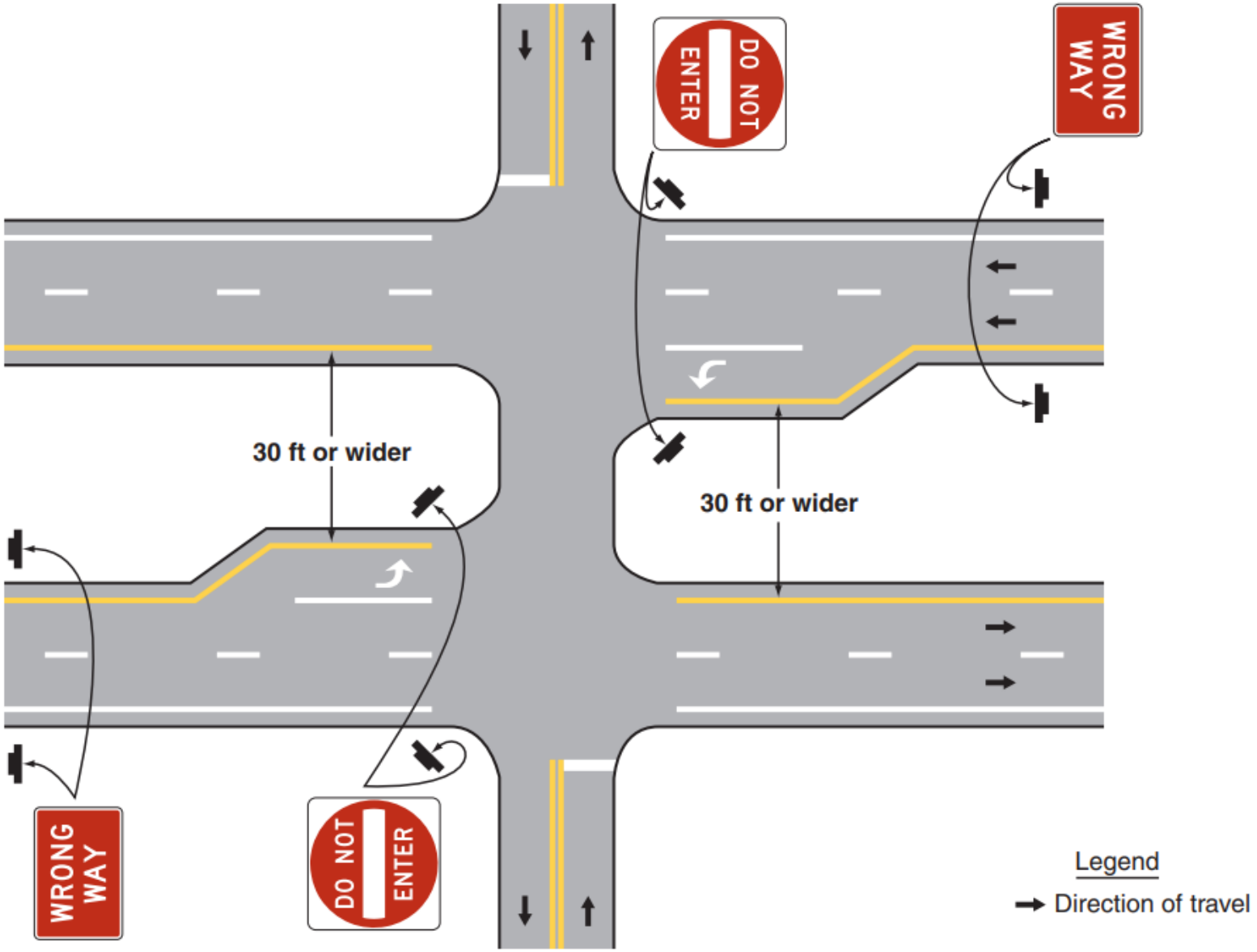


R5-1a

WRONG WAY

	A	B	C	D	E	F	G	H	J
	30	18	.625	3	5 D	2	11.063	6.688	1.5
C	36	24	.75	4.5	6 D	3	13.313	8.063	1.5
	42	30	.875	5	8 D	4	17.75	10.75	1.875

Locations of Wrong Way Signing for Divided Highways with Median Widths of 30 Feet or Wider



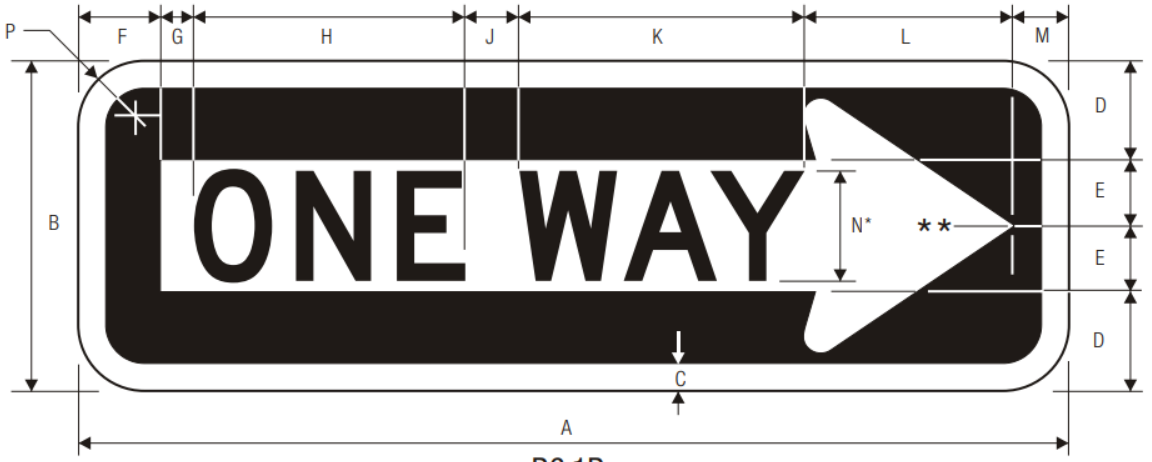
One Way Signs

Use

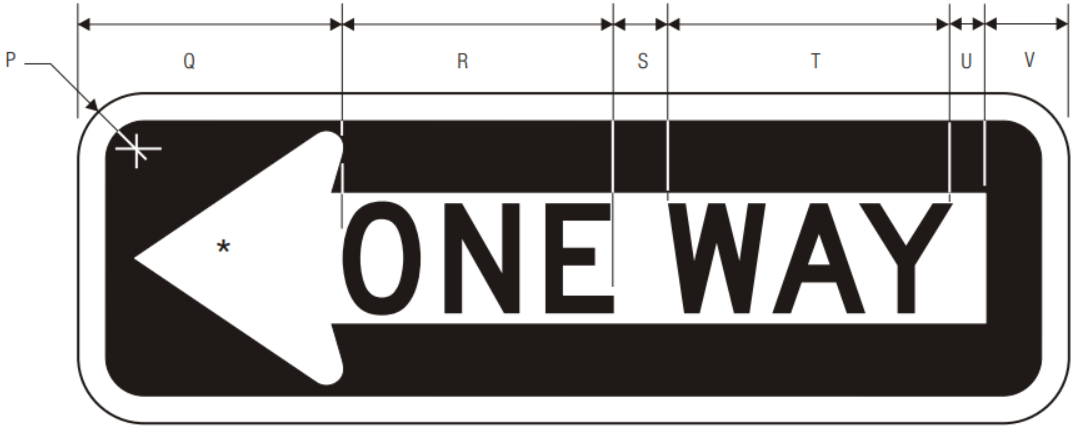
- Used to indicate streets or roadways upon which vehicular traffic is allowed to travel in one direction only.

Colors

- Legend: Black
- Background: Black
- Arrow: White (retroreflective)



R6-1R
ONE WAY



R6-1L
ONE WAY

C	A	B	C	D	E	F	G	H	J	K	L	M
	36	12	.5	3.375	2.625	3	1.25	9.125	2	9.625	9	2
	54	18	1	5.5	3.5	5	4	12.309	2.929	12.762	13	4

N	P	Q	R	S	T	U	V
4 D	1.5	11	9.125	2	9.625	1.25	3
5 D	1.875	17	12.309	2.929	12.762	4	5

*Series 2000 Standard Alphabets.
**See page 6-2 for arrow design.

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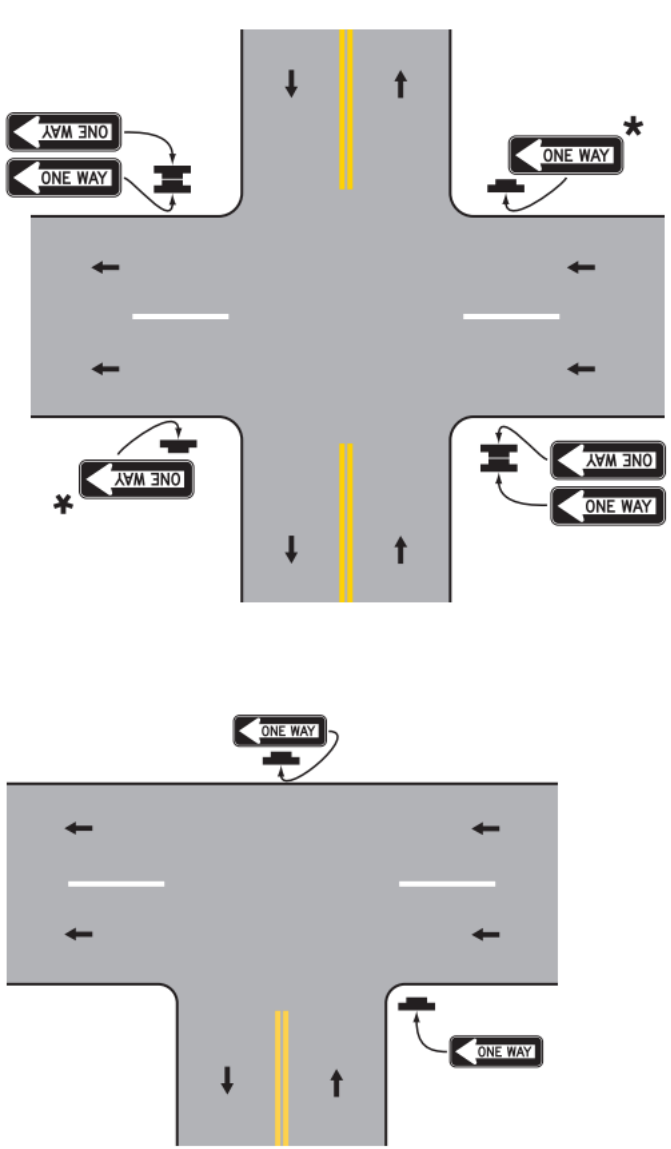
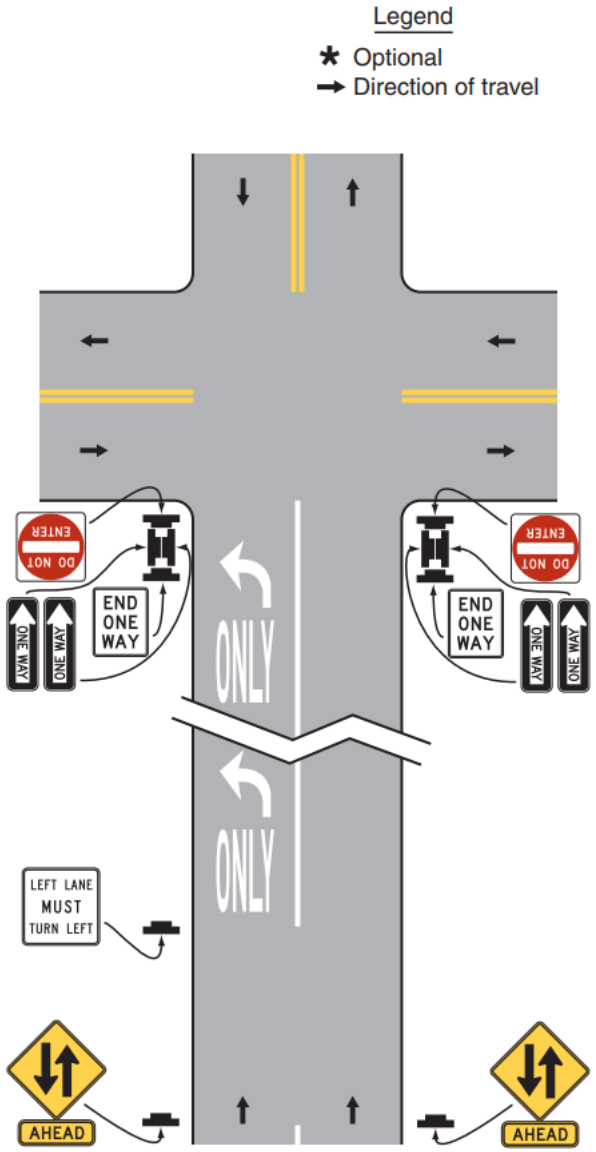
Locations of One Way Signs





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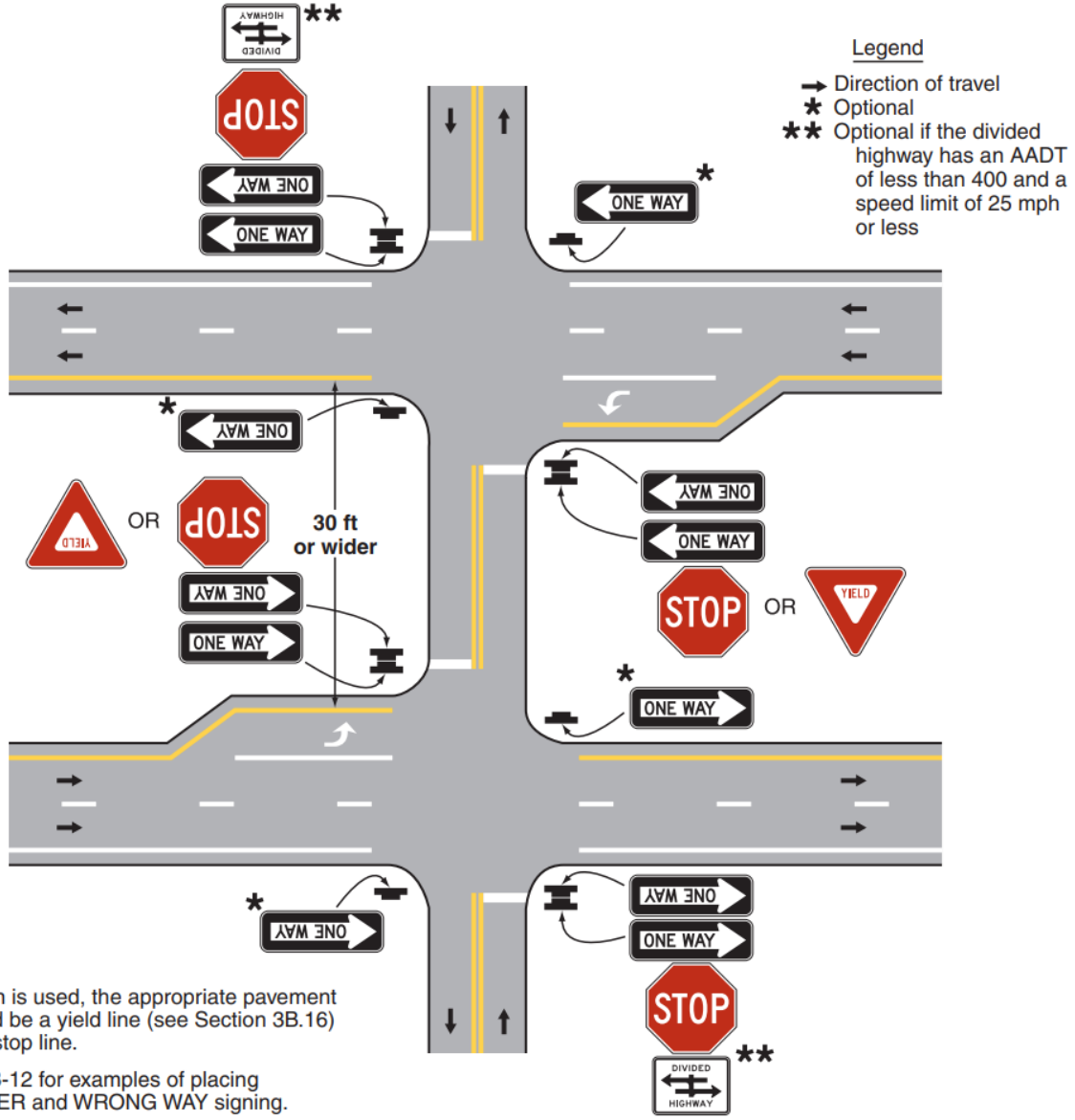
One Way Signing for Divided Highways with Median Widths of 30 Feet or Wider



Notes:

If a YIELD sign is used, the appropriate pavement marking would be a yield line (see Section 3B.16) rather than a stop line.

See Figure 2B-12 for examples of placing DO NOT ENTER and WRONG WAY signing.

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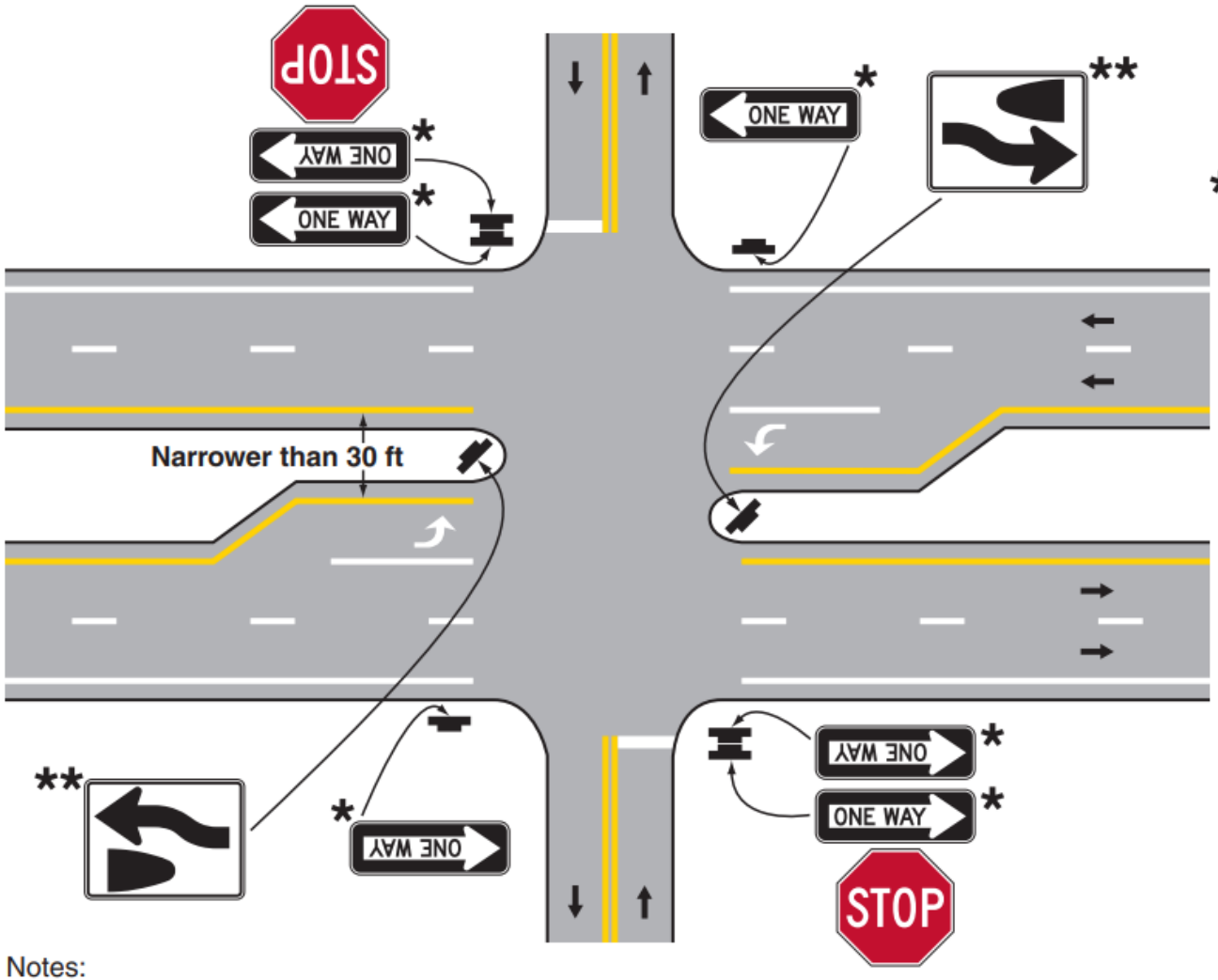
One Way Signing for Divided Highways with Median Widths Narrower Than 30 Feet



Legend

→ Direction of travel

★One Way signs are optional if Keep Right signs are installed

★★Keep Right signs are optional if One Way signs are installed

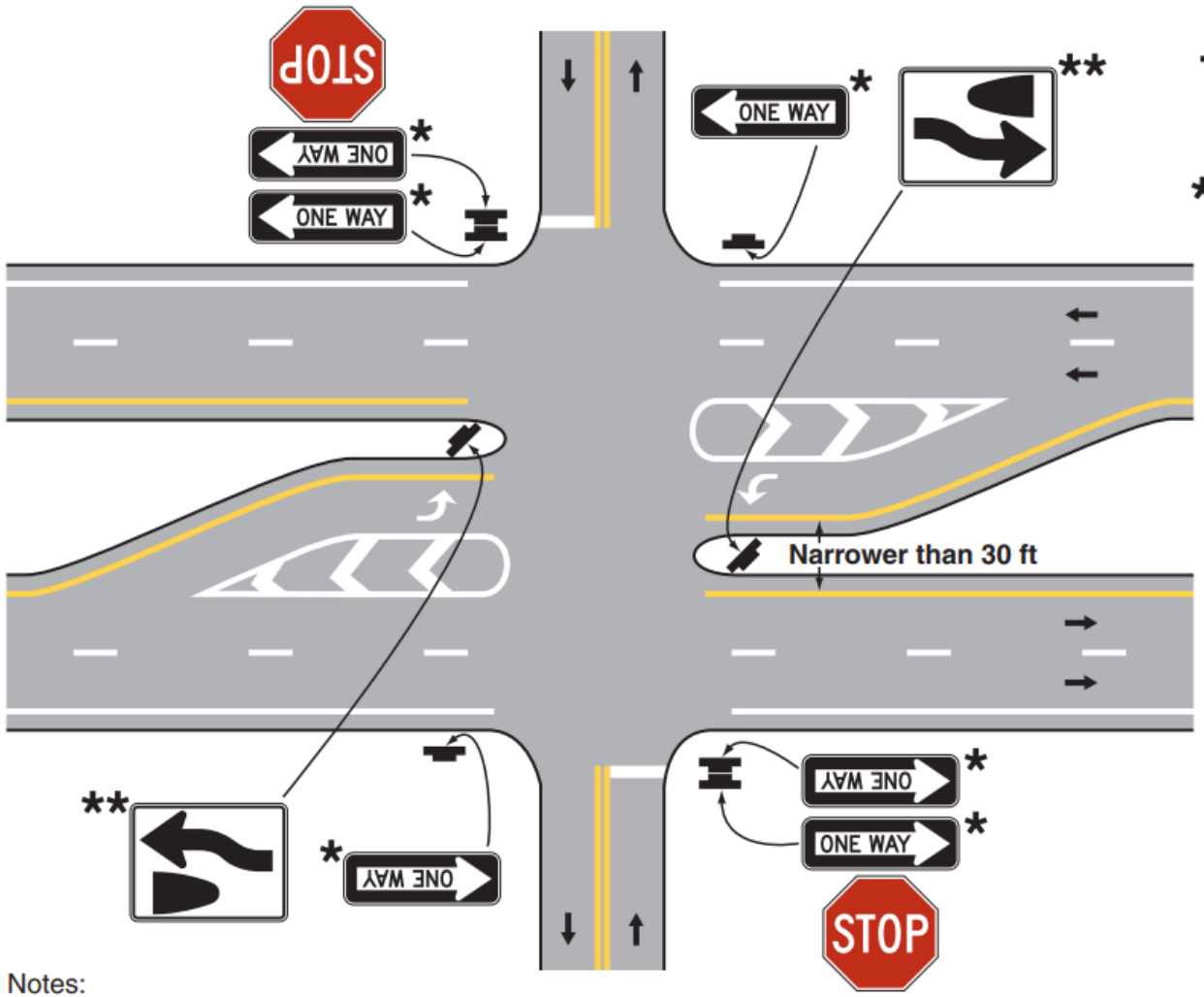
Notes:

See Figure 2B-12 for examples of placing DO NOT ENTER and WRONG WAY signing.

See Figure 2B-15 if median is 30 feet or more in width.

Typical Mounting

One Way Signing for Divided Highways with Median Widths Narrower Than 30 Feet and Separated Left-Turn Lanes



Legend

→ Direction of travel

*One Way signs are optional if Keep Right signs are installed

**Keep Right signs are optional if One Way signs are installed

Notes:

See Figure 2B-12 for examples of placing DO NOT ENTER and WRONG WAY signing.

See Figure 2B-15 if median is 30 feet or more in width.

Typical Mounting

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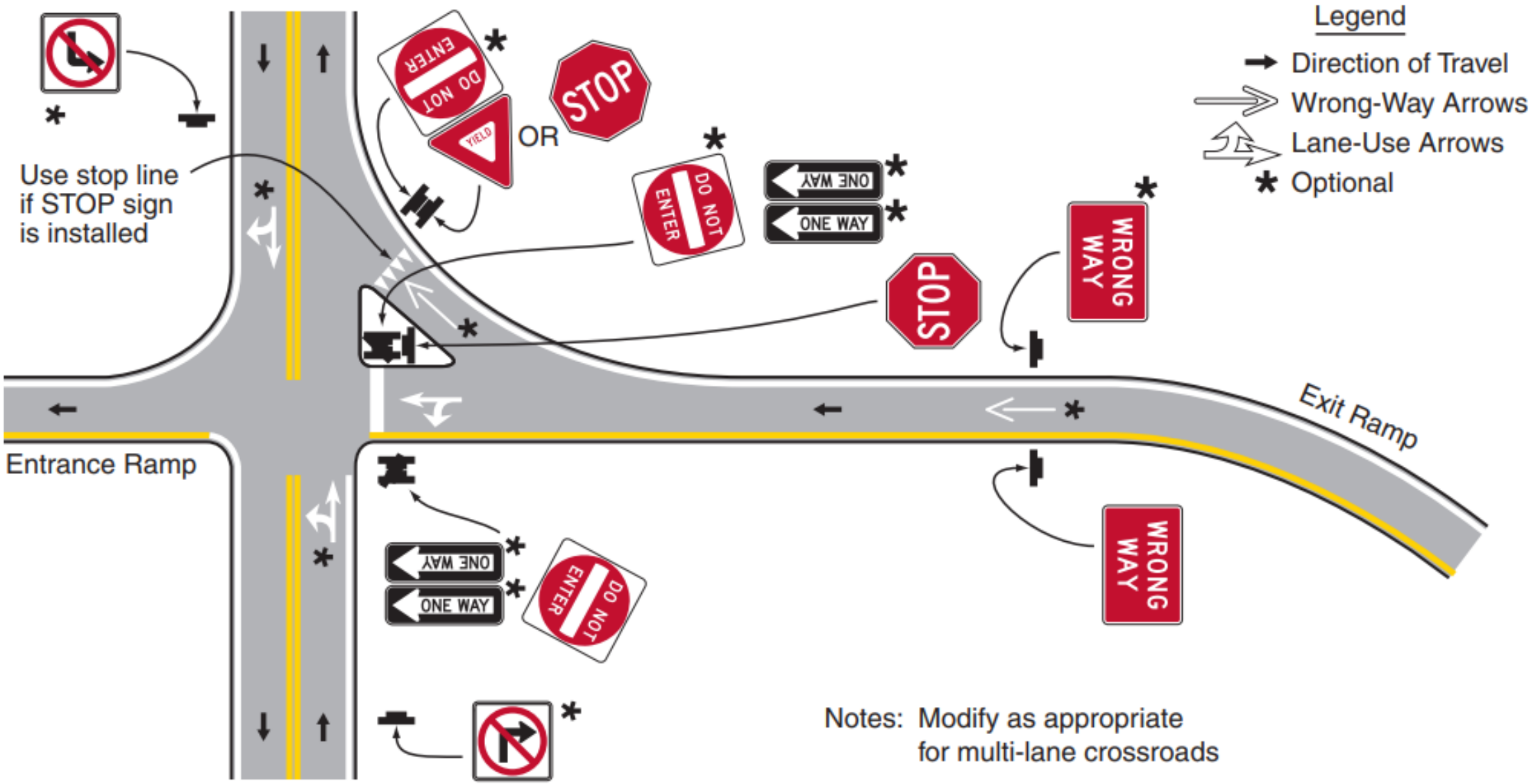
Example of Application of Regulatory Signing and Pavement Markings at an Exit Ramp Termination to Deter Wrong-Way Entry



Notes: Modify as appropriate for multi-lane crossroads

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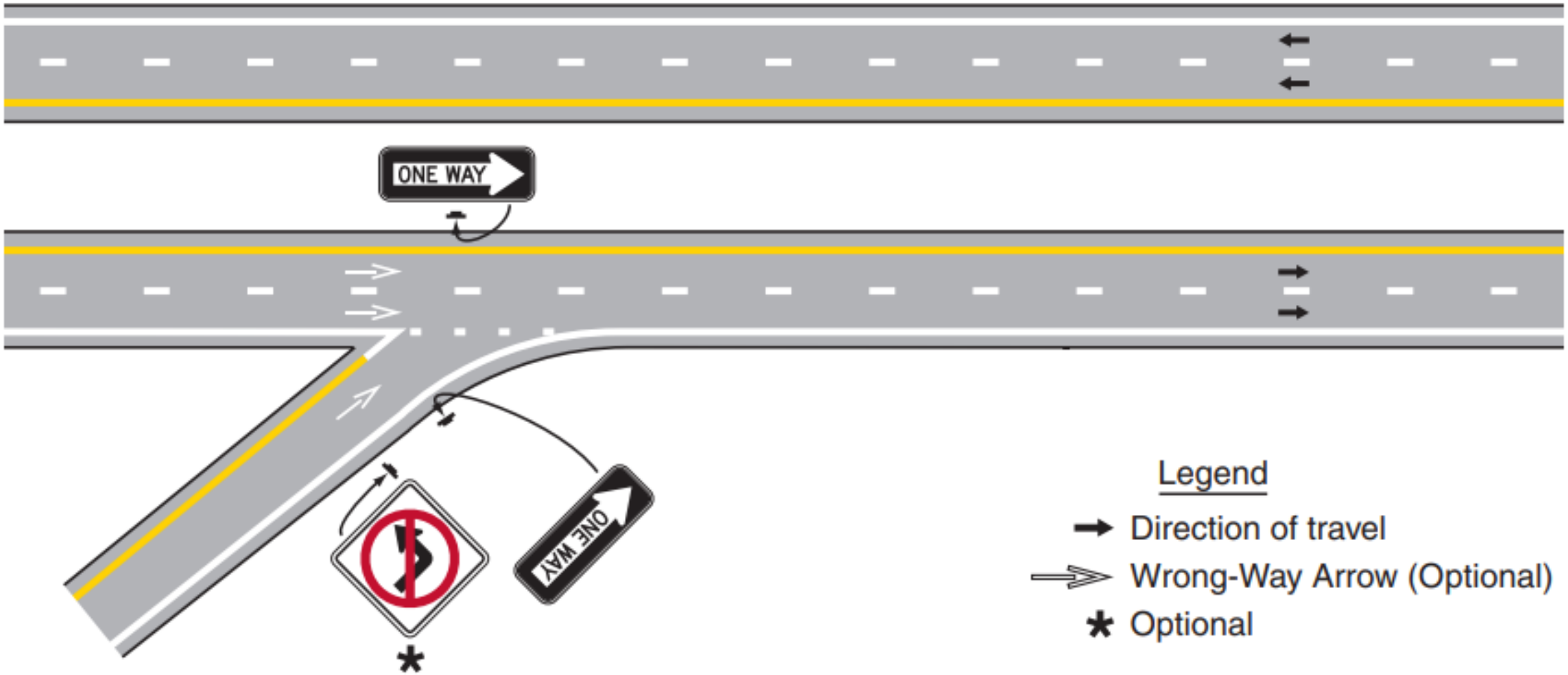
Example of Application of Regulatory Signing and Pavement Markings at an Entrance Ramp Terminal Where the Design Does Not Clearly Indicate the Direction of Flow



Roundabout Signing

Roundabout Directional Arrow (R6-4 series) sign use:

- Used if the central island of a roundabout allows for the installation of signs.
- In the central island to direct traffic counter-clockwise around the central island.

Roundabout Circulation (R6-5P) plaque use:

- Where the central island of a roundabout does not provide a reasonable place to install a sign.
- Should be placed below the Yield signs on each approach.

R6-4

R6-4a

R6-4b

R6-5P

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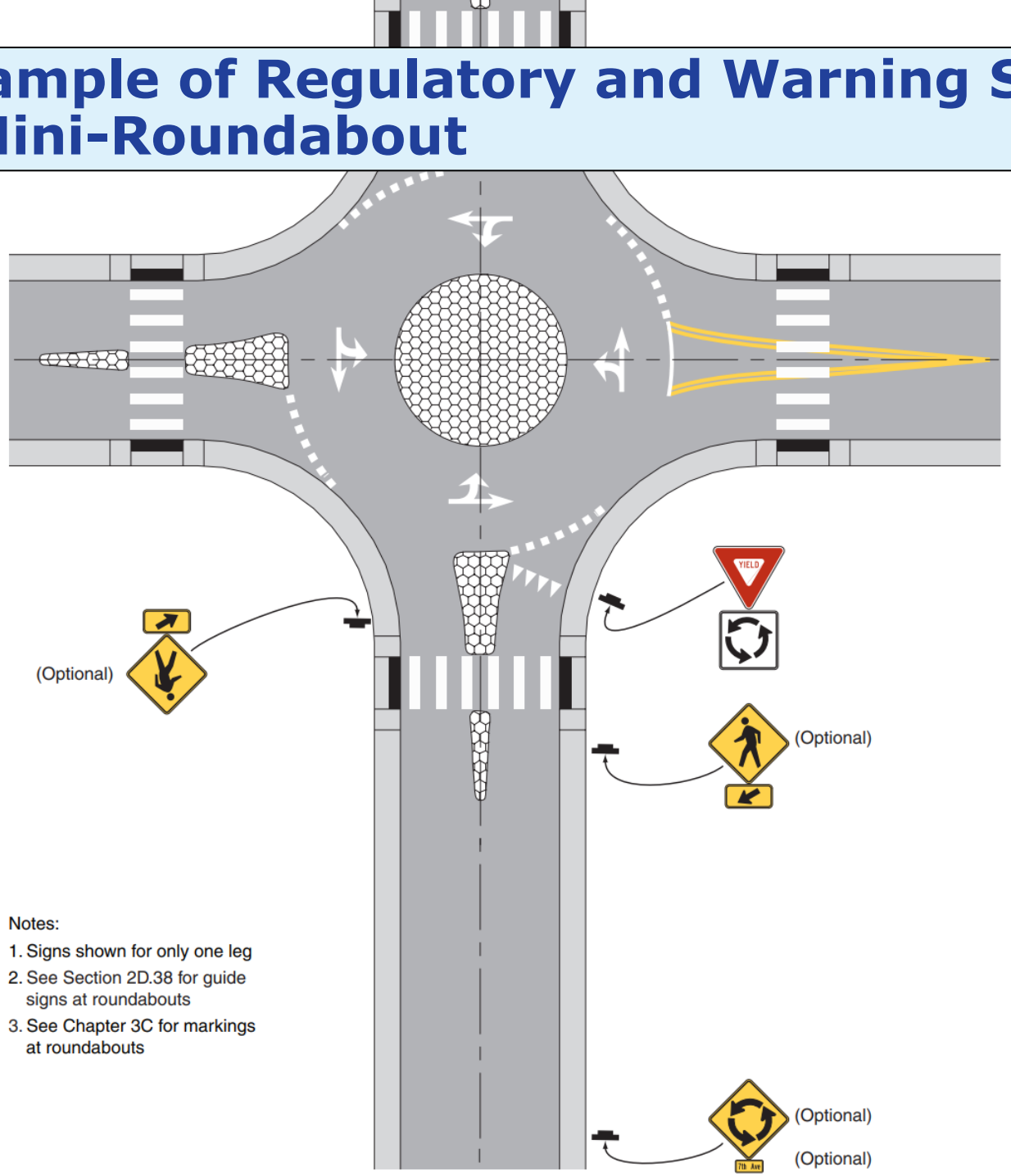
Example of Regulatory and Warning Signs for a Mini-Roundabout



Notes:

1. Signs shown for only one leg
2. See Section 2D.38 for guide signs at roundabouts
3. See Chapter 3C for markings at roundabouts

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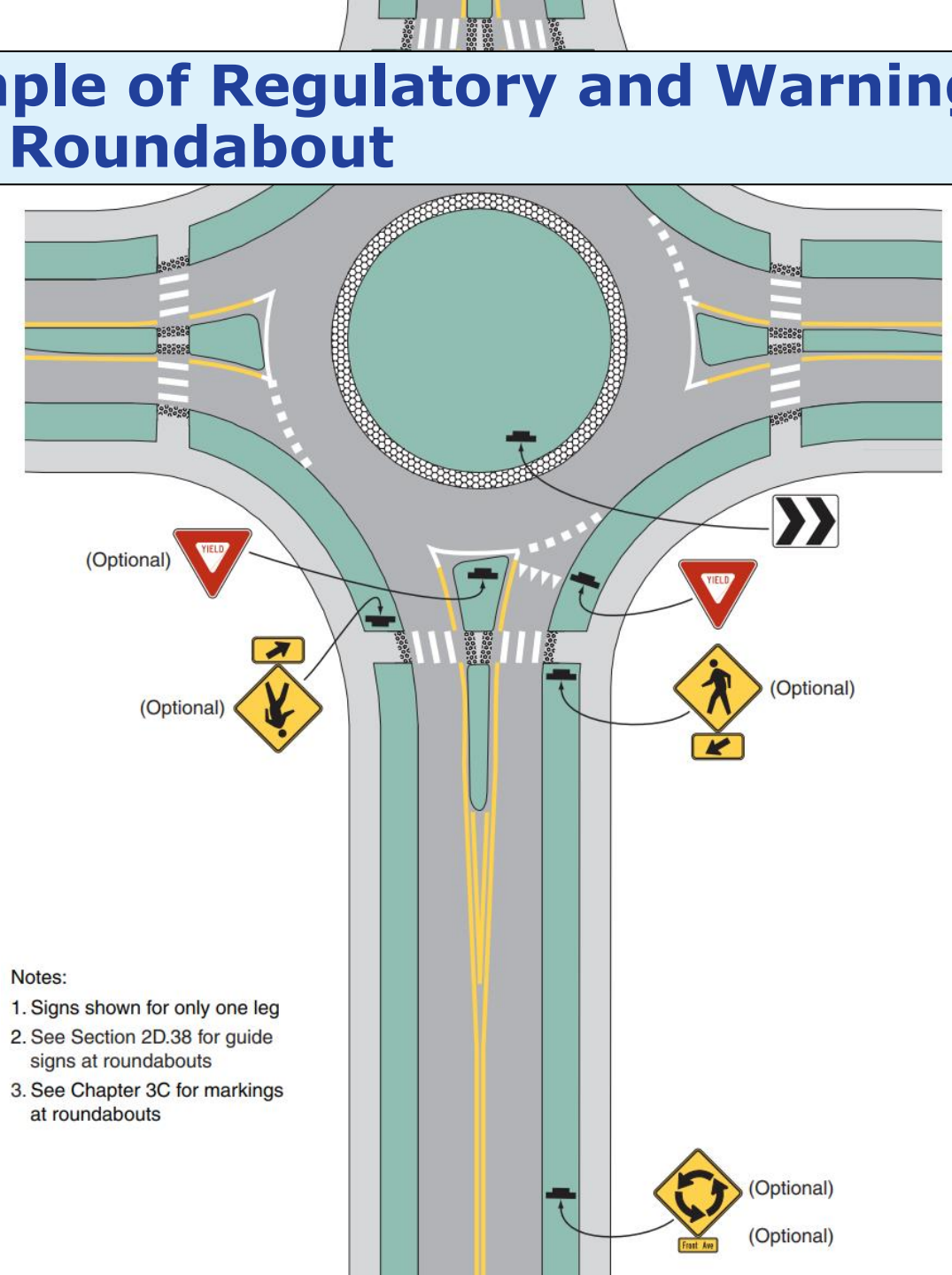
Example of Regulatory and Warning Signs for a One-Lane Roundabout



Notes:

1. Signs shown for only one leg
2. See Section 2D.38 for guide signs at roundabouts
3. See Chapter 3C for markings at roundabouts

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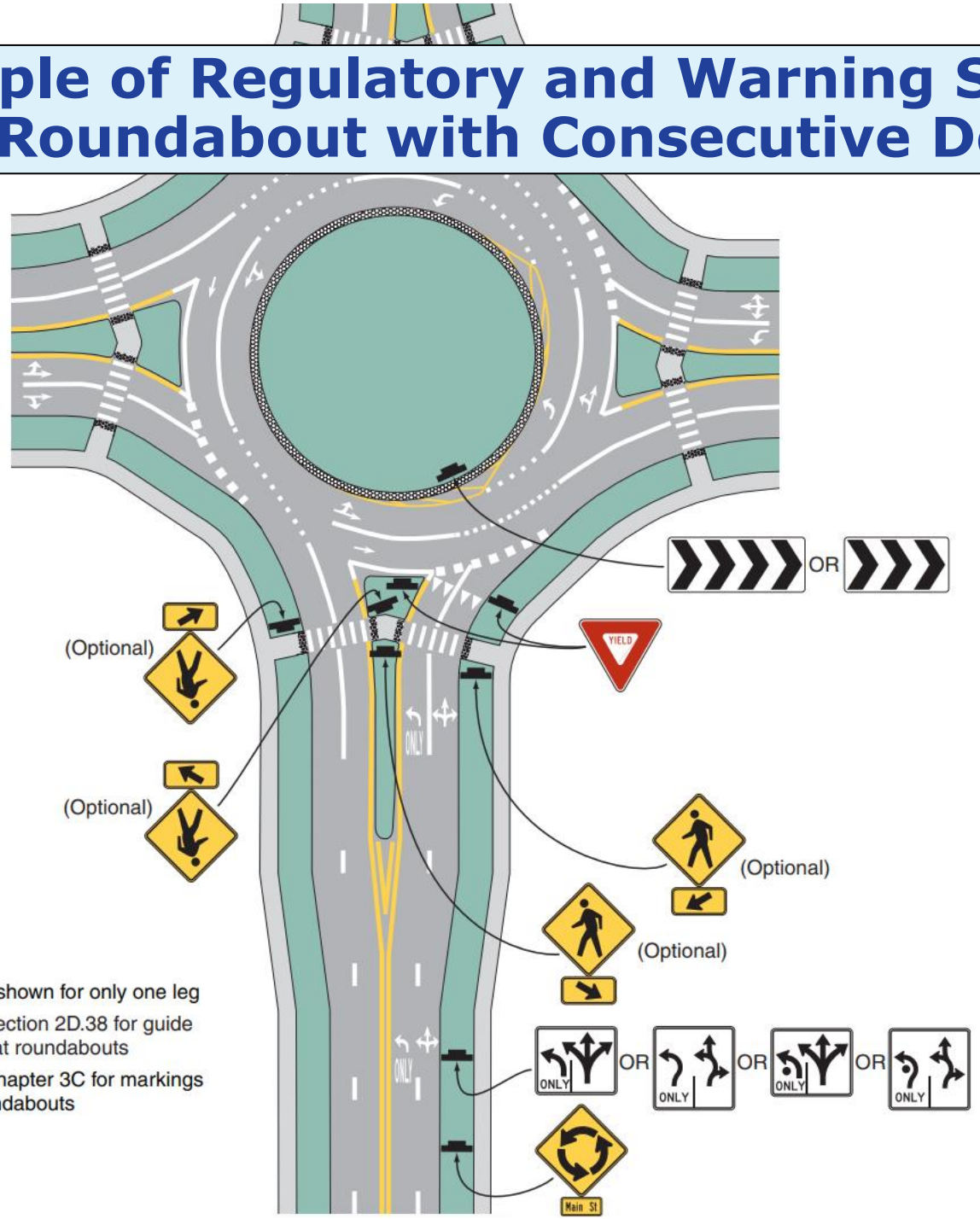
Example of Regulatory and Warning Signs for a Two-Lane Roundabout with Consecutive Double Lefts



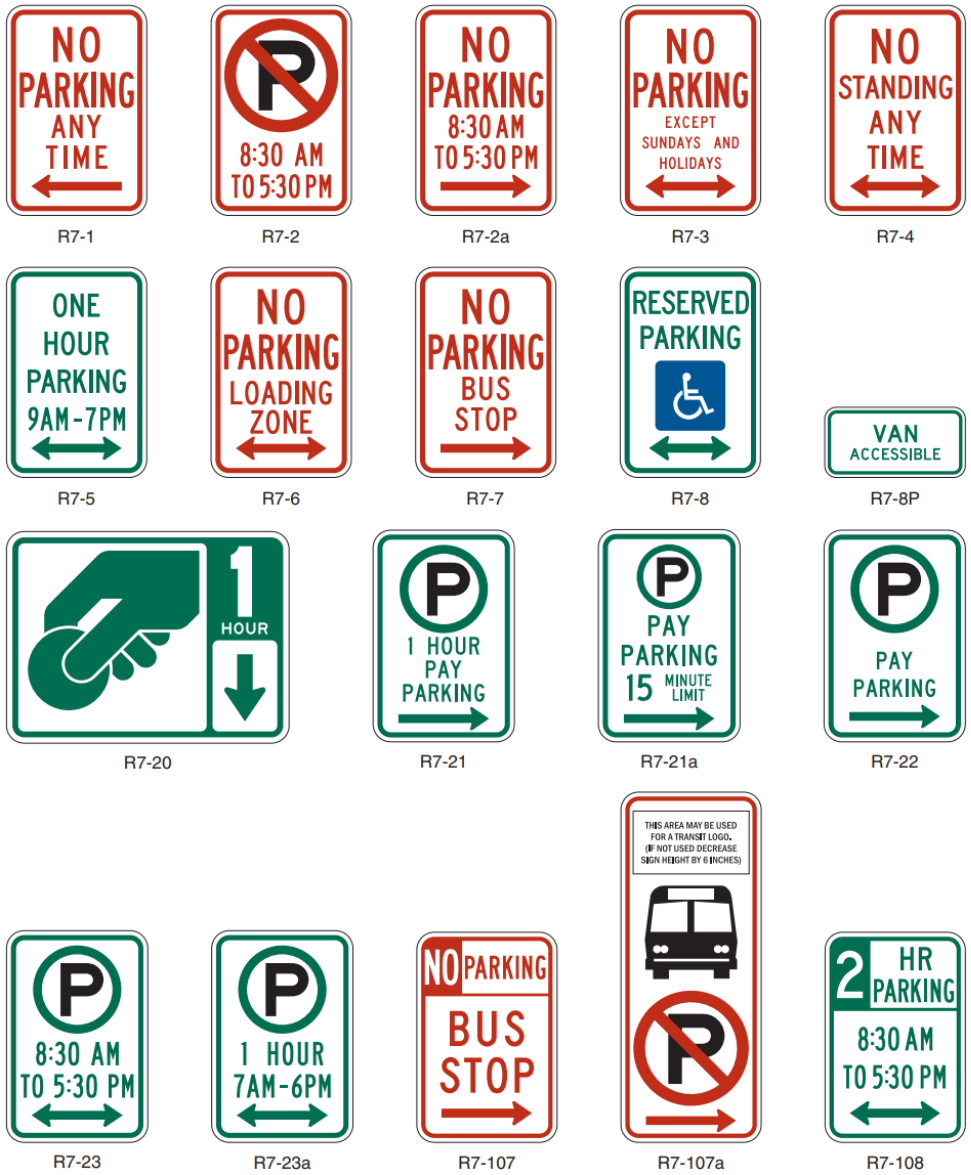
Notes:

1. Signs shown for only one leg
2. See Section 2D.38 for guide signs at roundabouts
3. See Chapter 3C for markings at roundabouts

Typical Examples of Parking, Stopping, and Standing Signs and Plaques

Use & Colors

- The legend on parking signs shall state applicable regulations.
- Parking signs shall comply with the standards of shape, color, and location.



No Parking Signs

Use

- Used to indicate that parking is prohibited.

Colors

- Legend: Red (retroreflective)
- Background: White (retroreflective)
- Symbol: Black

R7-1 NO PARKING

R7-2 NO PARKING

R7-2a NO PARKING

Selective Exclusion Signs

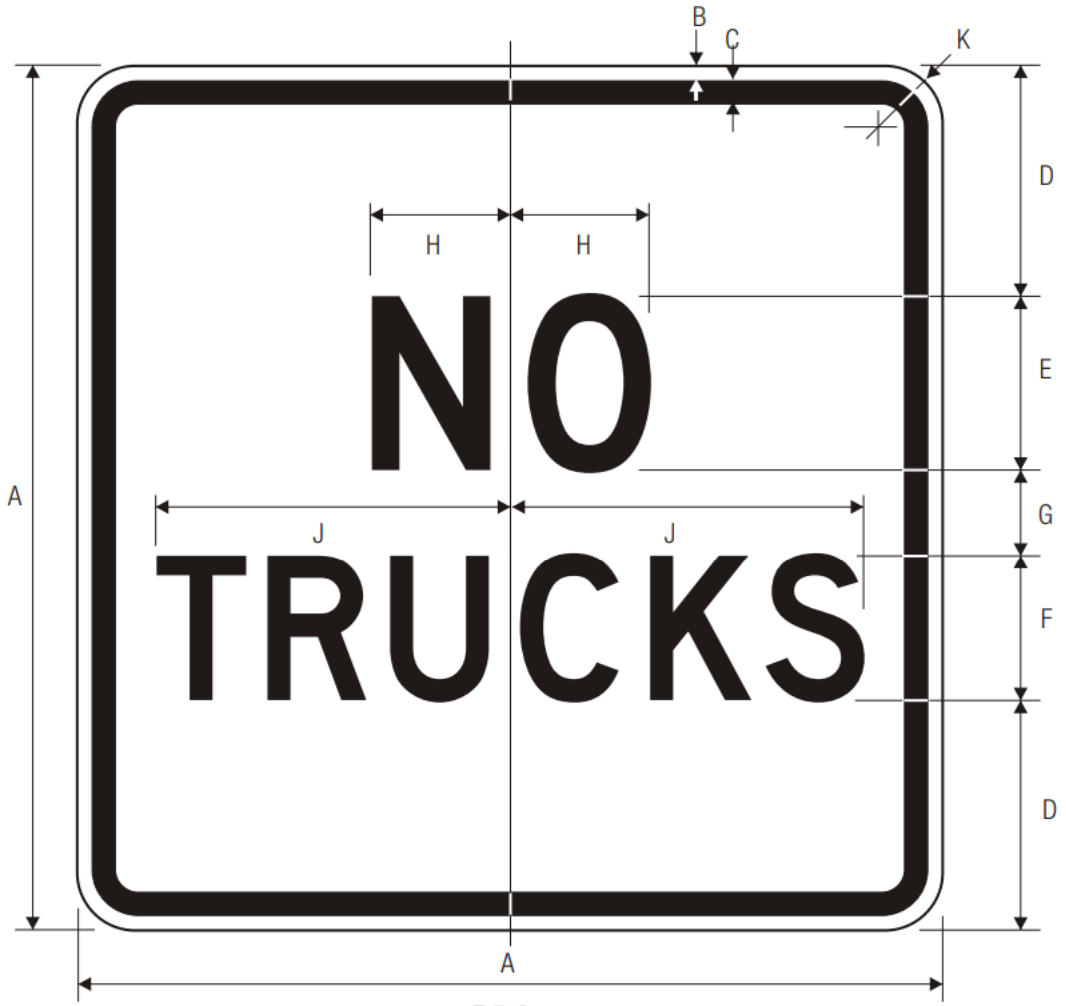
Use

- Used to inform road users of the prohibition of specific vehicles.

Colors

- Legend: White (retroreflective)
- Background: White (retroreflective)

	A	B	C	D	E	F	G	H	J	K
	12	.375	.375	3	2.5 D	2 D	1.5	2.003	4.877	1.5
C	24	.375	.625	6	5 D	4 D	3	4	9.767	1.5
	30	.5	.75	7.875	6 D	5 D	3.25	4.843	12.269	1.875
	36	.625	.875	9.25	7 D	6 D	4.5	5.604	14.651	2.25
	48	.75	1.25	12.5	9 D	8 D	6	7.225	19.534	3



R5-2a
NO TRUCKS

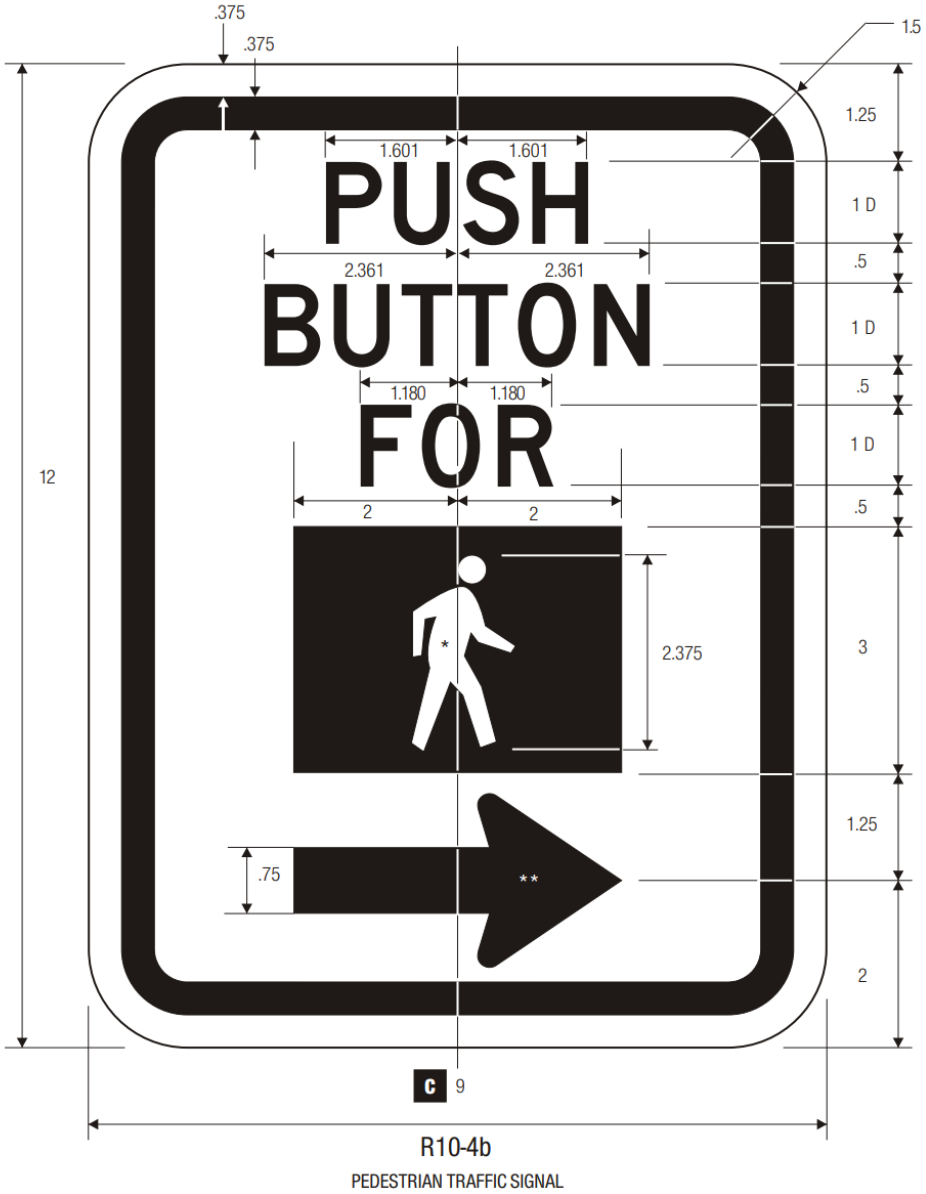
Traffic Signal Signs

Use

- To supplement traffic signal control, Traffic Signal signs R10-5 through R10-30 may be used to regulate road users.

Colors

- Legend: Black
- Symbol: White (retroreflective) on Black
- Background: White (retroreflective)



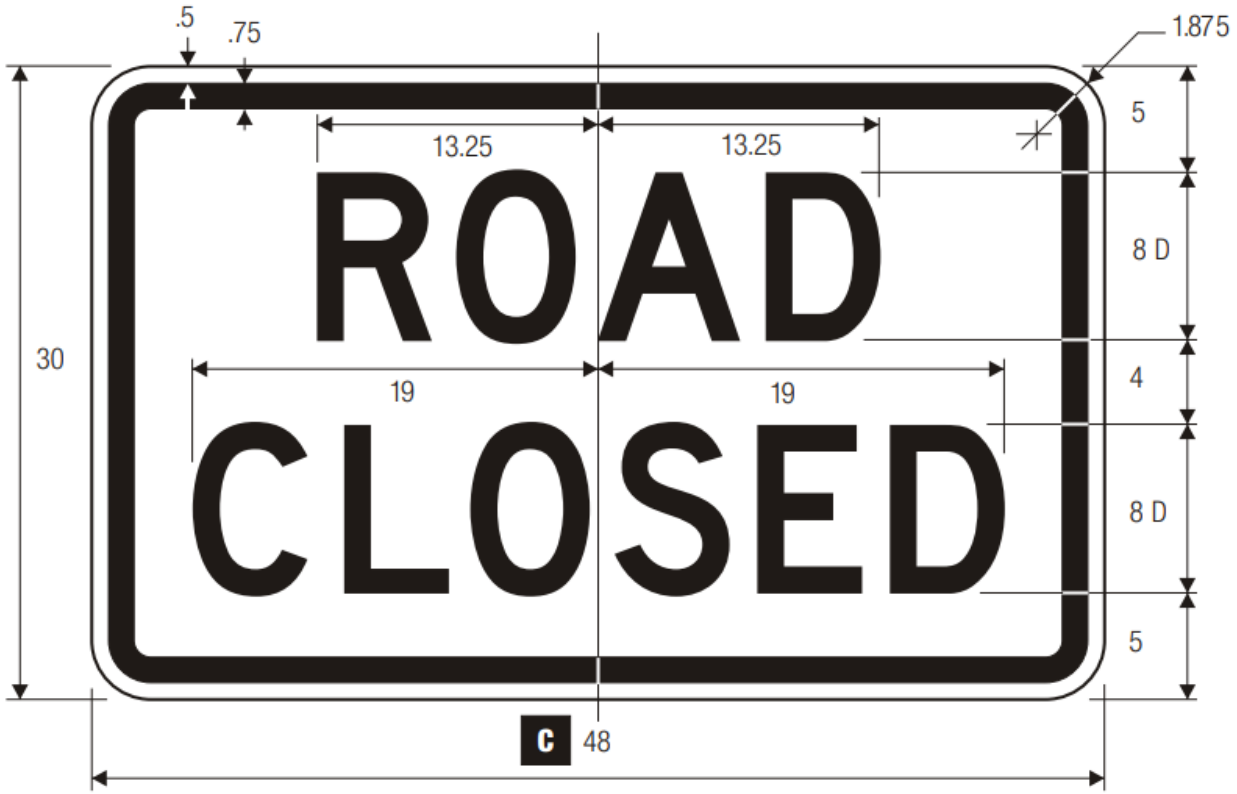
Road Closed Signs

Use

- The Road Closed (R11-2) sign should be installed where roads have been closed to all traffic (except authorized vehicles).

Colors

- Legend: Black
- Background: White (retroreflective)



R11-2

ROAD CLOSED

Weight Limit Signs

Use

- The Weight Limit (R12-1) sign carrying the legend WEIGHT LIMIT XX TONS may be used to indicate vehicle weight restrictions including load.

Colors

- Legend: Black
- Background: White (retroreflective)

R12-1
WEIGHT LIMIT

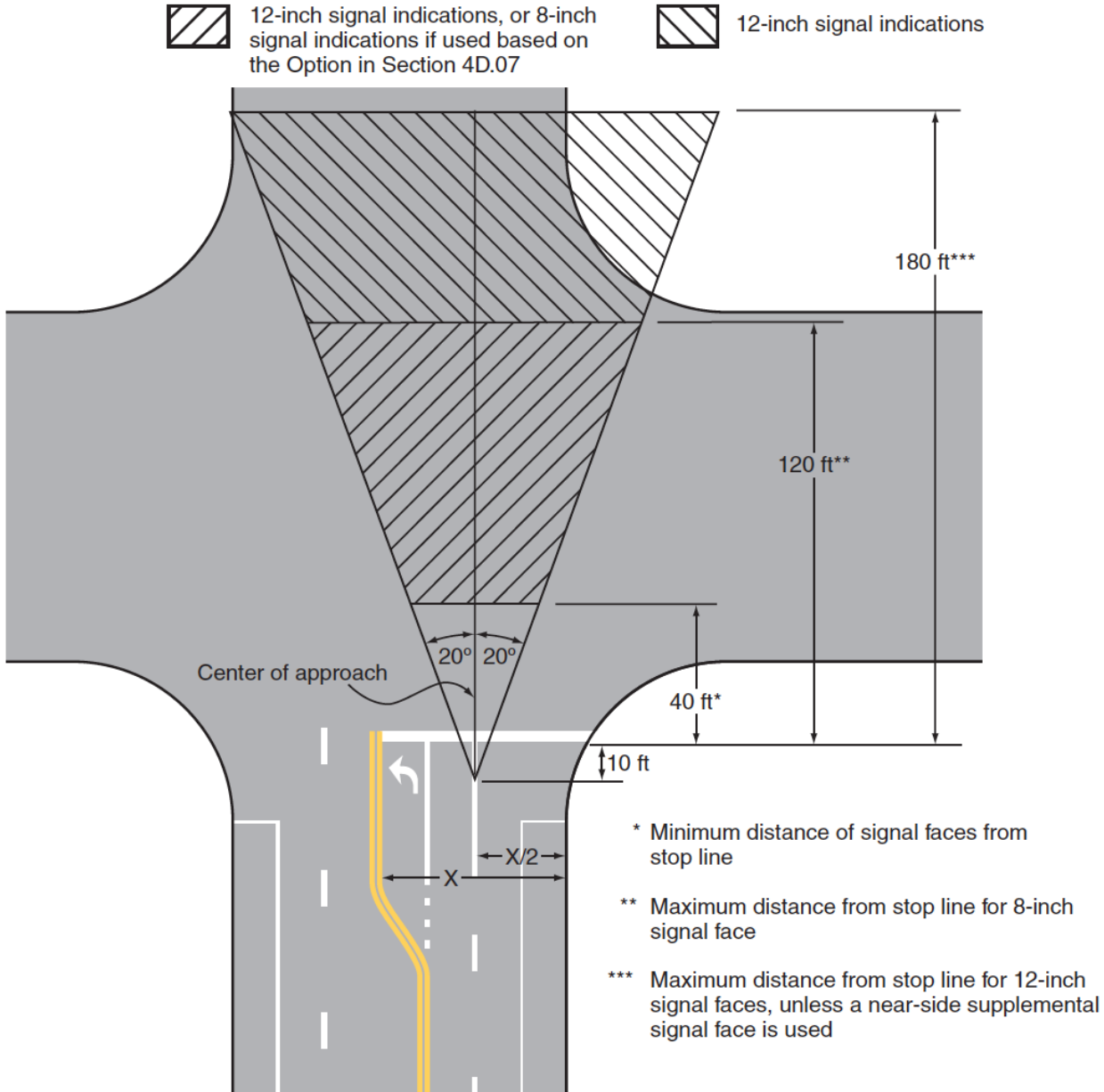
*Optically space numerals about centerline.

C	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q
	24	30	.375	.625	3	4 D	1.75	2.125	5 E	5D	9	9.5	6.313	8.25	1.5
	36	48	.625	.875	4.75	6 D	3	3.75	8 E	8 D	13.5	14.25	9.438	13.25	2.25

Lateral and Longitudinal Location of Primary Signal Faces

At least one and preferably two primary signal faces required for the through movement on the approach shall be located **between two lines intersecting with the center of the approach** at a point 10 feet behind the stop line:

- One signal face making an angle of 20 degrees to the **right of the center** of the approach extended.
- One signal face making an angle of 20 degrees to the **left of the center** of the approach extended.



Signs & Markings

Lesson 3: Warning Signs

Advancing the Future of Public Safety

Warning Signs Overview

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Application of Warning Signs

Warning Sign Purpose:

- Call attention to unexpected conditions that might not be readily apparent to road users.
- Alert road users to conditions that might call for action in the interest of safety and efficient traffic operations.

Warning Sign Placement:

Table 2C-4. Guidelines for Advance Placement of Warning Signs

Posted or 85th-Percentile Speed	Advance Placement Distance[1]								
	Condition A: Speed reduction and lane changing in heavy traffic[2]	Condition B: Deceleration to the listed advisory speed (mph) for the condition							
		0[3]	10[4]	20[4]	30[4]	40[4]	50[4]	60[4]	70[4]
20 mph	225 ft	100 ft[6]	N/A[5]	—	—	—	—	—	—
25 mph	325 ft	100 ft[6]	N/A[5]	N/A[5]	—	—	—	—	—
30 mph	460 ft	100 ft[6]	N/A[5]	N/A[5]	—	—	—	—	—
35 mph	565 ft	100 ft[6]	N/A[5]	N/A[5]	N/A[5]	—	—	—	—
40 mph	670 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]	—	—	—	—
45 mph	775 ft	175 ft	125 ft	100 ft[6]	100 ft[6]	N/A[5]	—	—	—
50 mph	885 ft	250 ft	200 ft	175 ft	125 ft	100 ft[6]	—	—	—
55 mph	990 ft	325 ft	275 ft	225 ft	200 ft	125 ft	N/A[5]	—	—
60 mph	1,100 ft	400 ft	350 ft	325 ft	275 ft	200 ft	100 ft[6]	—	—
65 mph	1,200 ft	475 ft	450 ft	400 ft	350 ft	275 ft	200 ft	100 ft[6]	—
70 mph	1,250 ft	550 ft	525 ft	500 ft	450 ft	375 ft	275 ft	150 ft	—
75 mph	1,350 ft	650 ft	625 ft	600 ft	550 ft	475 ft	375 ft	250 ft	100 ft[6]

Design of Warning Signs

Warning signs should be:

- Diamond (Unless specified otherwise)

Colors:

- Black legend and border on a yellow background

Colors for warning signs regarding conditions associated with pedestrians, bicyclists, and playgrounds:

- Black legend and border on a yellow or fluorescent yellow-green background

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Types of Warning Signs – MUTCD Standards

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

Size of Warning Signs

The following slides will cover the sizes for warning signs.

But first, a few notes:

- The minimum size for all diamond-shaped warning signs facing traffic on a multi-lane conventional road where the posted speed limit is higher than 35 mph shall be 36 x 36 inches.
- The minimum size for supplemental warning plaques that are not included in Table 2C-2 shall be as shown in Table 2C-3.

Table 2C-3. Minimum Size of Supplemental Warning Plaques

Size of Warning Sign	Size of Supplemental Plaque			
	Rectangular			Square
	1 Line	2 Lines	Arrow	
24 x 24	24 x 12	24 x 18	24 x 12	18 x 18
30 x 30				
36 x 36	30 x 18	30 x 24	30 x 18	24 x 24
48 x 48				

Notes: 1. Larger supplemental plaques may be used when appropriate
2. Dimensions in inches are shown as width x height

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Size of Warning Signs – MUTCD Standards

Sign or Plaque	Sign Designation	Section	Conventional Road		Expressway	Freeway	Minimum	Oversized
			Single Lane	Multi-Lane				
Horizontal Alignment	W1-1,2,3,4,5	2C.07	30 x 30*	36 x 36	36 x 36	36 x 36	—	48 x 48
Combination Horizontal Alignment/Advisory Speed	W1-1a,2a	2C.10	36 x 36	36 x 36	48 x 48	48 x 48	—	48 x 48
One-Direction Large Arrow	W1-6	2C.12	48 x 24	48 x 24	60 x 30	60 x 30	—	60 x 30
Two-Direction Large Arrow	W1-7	2C.47	48 x 24	48 x 24	—	—	—	60 x 30
Chevron Alignment	W1-8	2C.09	18 x 24	18 x 24	30 x 36	36 x 48	—	24 x 30
Combination Horizontal Alignment/Intersection	W1-10,10a, 10b,10c,10d, 10e	2C.11	36 x 36	36 x 36	36 x 36	48 x 48	—	—
Hairpin Curve	W1-11	2C.07	30 x 30	30 x 30	36 x 36	48 x 48	—	48 x 48
Truck Rollover	W1-13	2C.13	36 x 36	36 x 36	36 x 36	48 x 48	—	36 x 36
270-degree Loop	W1-15	2C.07	30 x 30	30 x 30	36 x 36	48 x 48	—	48 x 48
Intersection Warning	W2-1, 2,3,4,5,6,7,8	2C.46	30 x 30	30 x 30	36 x 36	—	24 x 24	48 x 48
Advanced Traffic Control	W3-1,2,3	2C.36	30 x 30	30 x 30	48 x 48	48 x 48	30 x 30	—
Be Prepared to Stop	W3-4	2C.36	36 x 36	36 x 36	48 x 48	48 x 48	30 x 30	—
Reduced Speed Limit Ahead	W3-5	2C.38	36 x 36	36 x 36	48 x 48	48 x 48	—	—
XX MPH Speed Zone Ahead	W3-5a	2C.38	36 x 36	36 x 36	48 x 48	48 x 48	—	—
Draw Bridge	W3-6	2C.39	36 x 36	36 x 36	48 x 48	—	—	60 x 60
Ramp Meter Ahead	W3-7	2C.37	36 x 36	36 x 36	—	—	—	—
Ramp Metered								

Horizontal Alignment Signs

Table 2C-5 indicates if horizontal alignment signs are needed.

Table 2C-5. Horizontal Alignment Sign Selection

Type of Horizontal Alignment Sign	Difference Between Speed Limit and Advisory Speed				
	5 mph	10 mph	15 mph	20 mph	25 mph or more
Turn (W1-1), Curve (W1-2), Reverse Turn (W1-3), Reverse Curve (W1-4), Winding Road (W1-5), and Combination Horizontal Alignment/Intersection (W10-1) (see Section 2C.07 to determine which sign to use)	Recommended	Required	Required	Required	Required
Advisory Speed Plaque (W13-1P)	Recommended	Required	Required	Required	Required
Chevrons (W1-8) and/or One Direction Large Arrow (W1-6)	Optional	Recommended	Required	Required	Required
Exit Speed (W13-2) and Ramp Speed (W13-3) on exit ramp	Optional	Optional	Recommended	Required	Required

Note: Required means that the sign and/or plaque shall be used, recommended means that the sign and/or plaque should be used, and optional means that the sign and/or plaque may be used.

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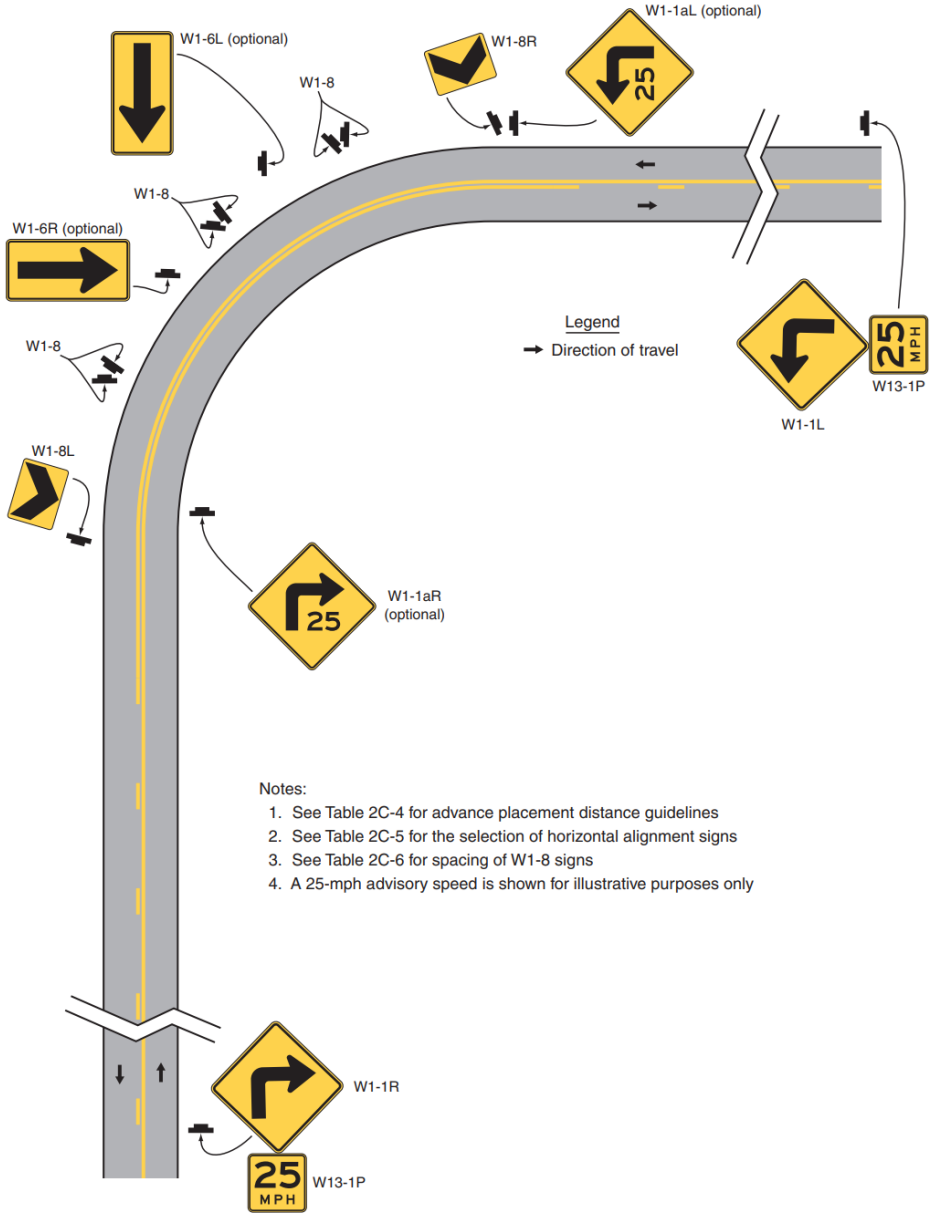
Example of Warning Signs For a Turn



Warning signs for a turn may include:

- Advisory speed plaque
- Chevron alignment sign
- One-direction large arrow sign
- Truck rollover warning sign

Table 2C-6. Typical Spacing of Chevron Alignment Signs on Horizontal Curves

Advisory Speed	Curve Radius	Sign Spacing
15 mph or less	Less than 200 feet	40 feet
20 to 30 mph	200 to 400 feet	80 feet
35 to 45 mph	401 to 700 feet	120 feet
50 to 60 mph	701 to 1,250 feet	160 feet
More than 60 mph	More than 1,250 feet	200 feet

Note: The relationship between the curve radius and the advisory speed shown in this table should not be used to determine the advisory speed.

Common Warning Signs

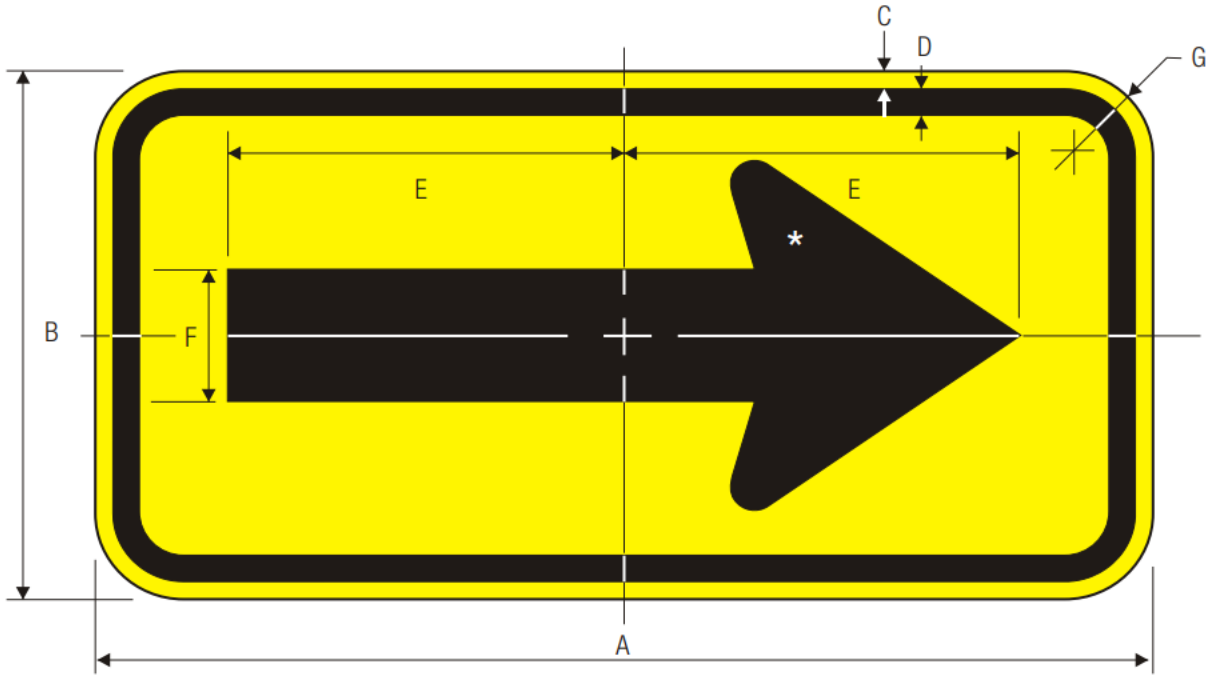
Single Arrow Signs

Use

- Used either as a supplement or alternative to Chevron Alignment signs in order to delineate change in horizontal alignment.

Colors

- Legend: Black
- Background: Yellow (retroreflective)



W1-6R

ONE DIRECTION LARGE ARROW

W1-6L

C	A	B	C	D	E	F	G
	24	12	.375	.625	10.375	3.25	1.5
	36	18	.375	.625	15.625	5	1.5
	48	24	.5	.75	20.5	6.5	1.875
	60	30	.625	.875	25.375	8	2.25

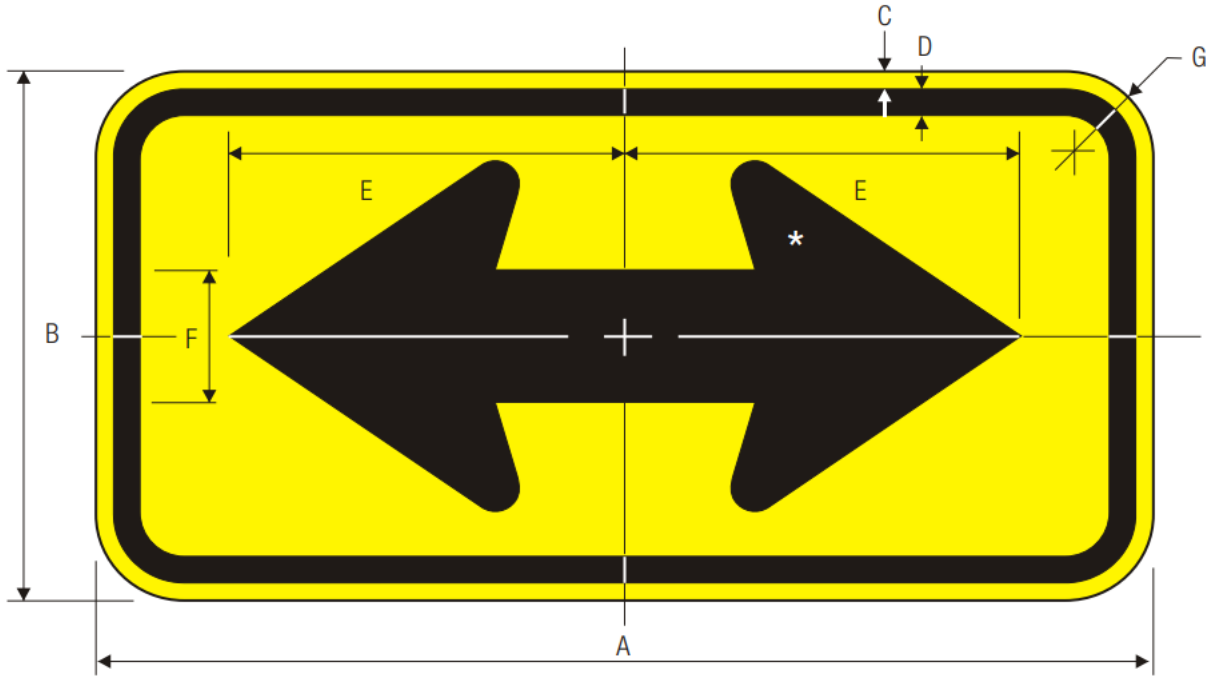
Double Arrow Signs

Use

- Used to advise road users that traffic is permitted to pass on either side of an island, obstruction, or gore in the roadway.

Colors

- Legend: Black
- Background: Yellow (retroreflective)



W1-7

TWO DIRECTION LARGE ARROW

	A	B	C	D	E	F	G
	24	12	.375	.625	10.375	3.25	1.5
	36	18	.375	.625	15.625	5	1.5
C	48	24	.5	.75	20.5	6.5	1.875
	60	30	.625	.875	25.375	8	2.25

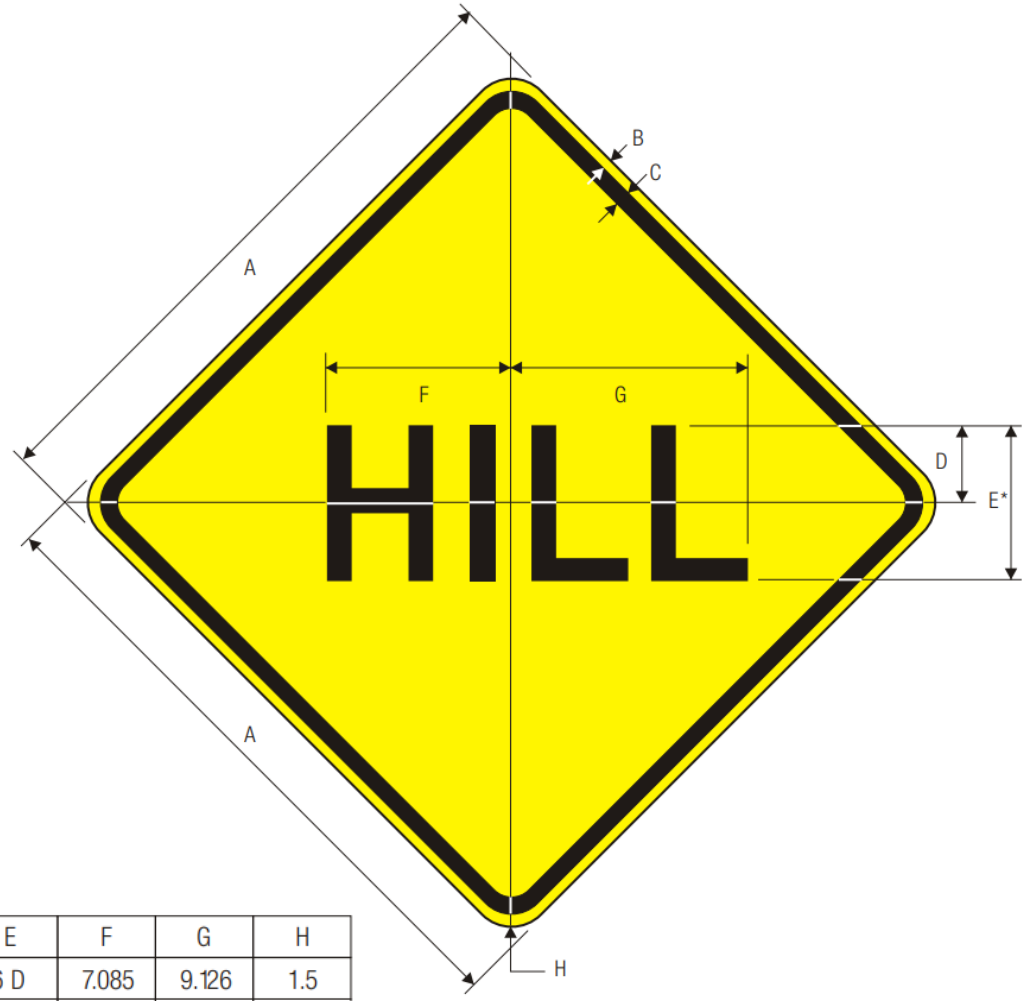
Hill Signs

Use

- Used in advance of a downgrade where the length, percent of grade, horizontal curvature, and/or other physical features require special precautions on the part of road users.

Colors

- Legend: Black
- Background: Yellow (retroreflective)



	A	B	C	D	E	F	G	H
C	24	.375	.625	3	6 D	7.085	9.126	1.5
	30	.5	.75	4	8 D	9.647	11.969	1.875
	36	.625	.875	5	10 D	12.169	14.851	2.25
	48	.75	1.25	6	12 D	14.531	17.893	3

W7-1a
HILL

*Series 2000 Standard Alphabets.

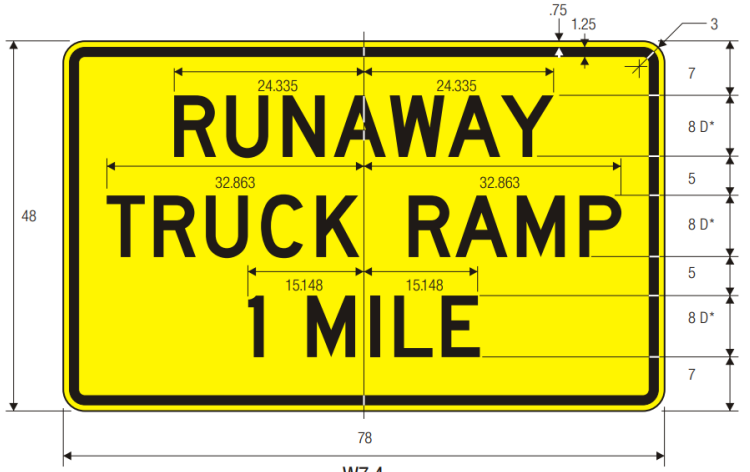
Truck Escape Routes

Use

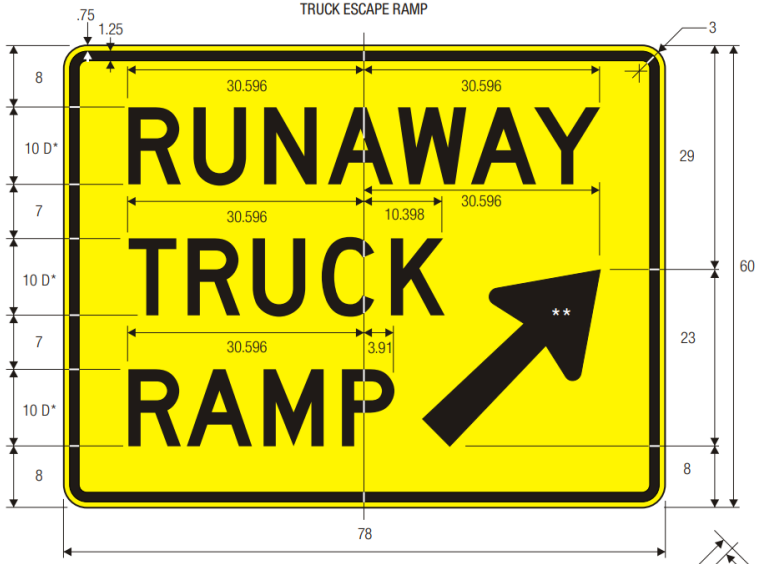
- Should be located approximately 1 mile and 1/2 mile in advance of the grade and of the ramp.

Colors

- Legend: Black
- Background: Yellow (retroreflective)

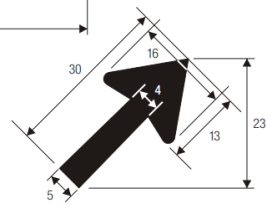


W7-4
TRUCK ESCAPE RAMP



W7-4b
TRUCK ESCAPE RAMP

*Series 2000 Standard Alphabets.
**See page 6-3 for arrow design.



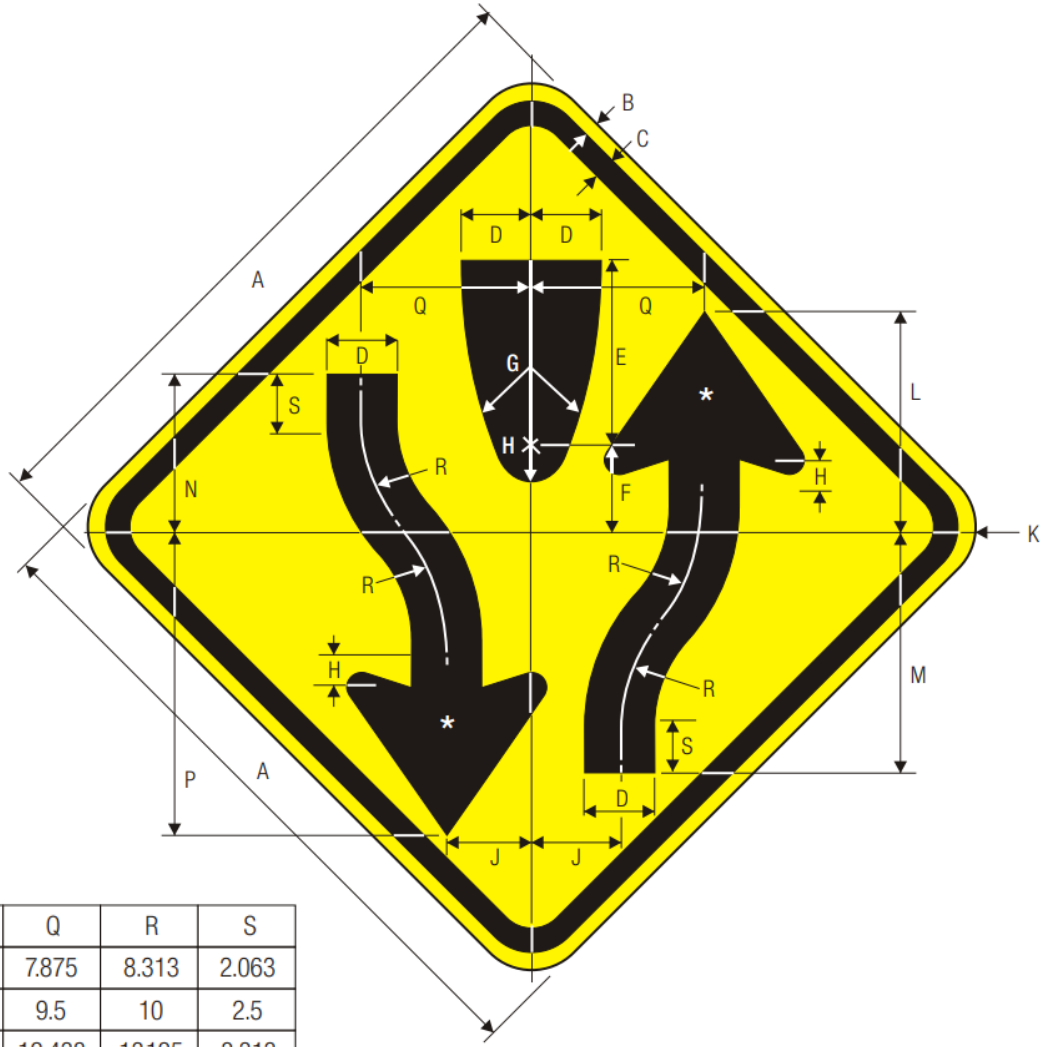
Divided Highway Signs

Use

- Used on the approaches to a section of highway where the opposing flows of traffic are separated by a median or other physical barrier.

Colors

- Legend: Black
- Background: Yellow (retroreflective)



W6-1

DIVIDED HIGHWAY

	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S
C	30	.5	.75	3.313	8.313	4.125	25	1.688	4.125	1.875	10	11.625	7.938	13.688	7.875	8.313	2.063
	36	.625	.875	4	10	5	30	2	5	2.25	12	14	9.5	16.5	9.5	10	2.5
	48	.75	1.25	5.25	13.125	6.563	39.313	2.625	6.563	3	16	18.688	12.688	22	12.438	13.125	3.313

Dead End/No Outlet Signs

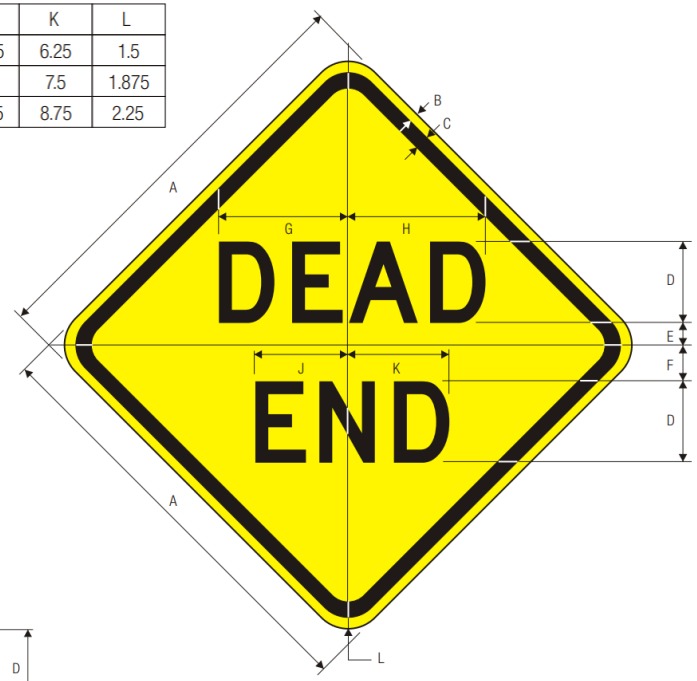
Use

- The Dead End sign may be used at the entrance of a single road or street that terminates in a dead end or cul-de-sac.
- The No Outlet (W14-2) sign may be used at the entrance to a road or road network from which there is no other exit.

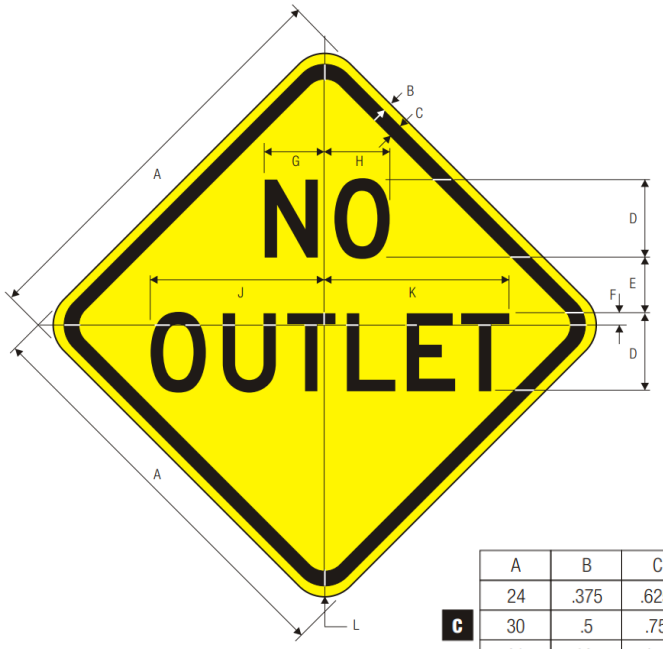
Colors

- Legend: Black
- Background: Yellow (retroreflective)

C	A	B	C	D	E	F	G	H	J	K	L
	24	.375	.625	5 D	1	2	8.25	8.563	5.625	6.25	1.5
	30	.5	.75	6 D	1.5	2.5	9.75	10.25	6.75	7.5	1.875
	36	.625	.875	7 D	2	3	11.375	11.938	7.875	8.75	2.25



W14-1
DEAD END



W14-2
NO OUTLET

C	A	B	C	D	E	F	G	H	J	K	L
	24	.375	.625	5 D	3	.75	4.125	4.5	11.625	12.063	1.5
	30	.5	.75	6 D	4	.938	5	5.375	13.938	14.5	1.875
	36	.625	.875	7 D	5	1.125	5.875	6.25	16.25	16.938	2.25

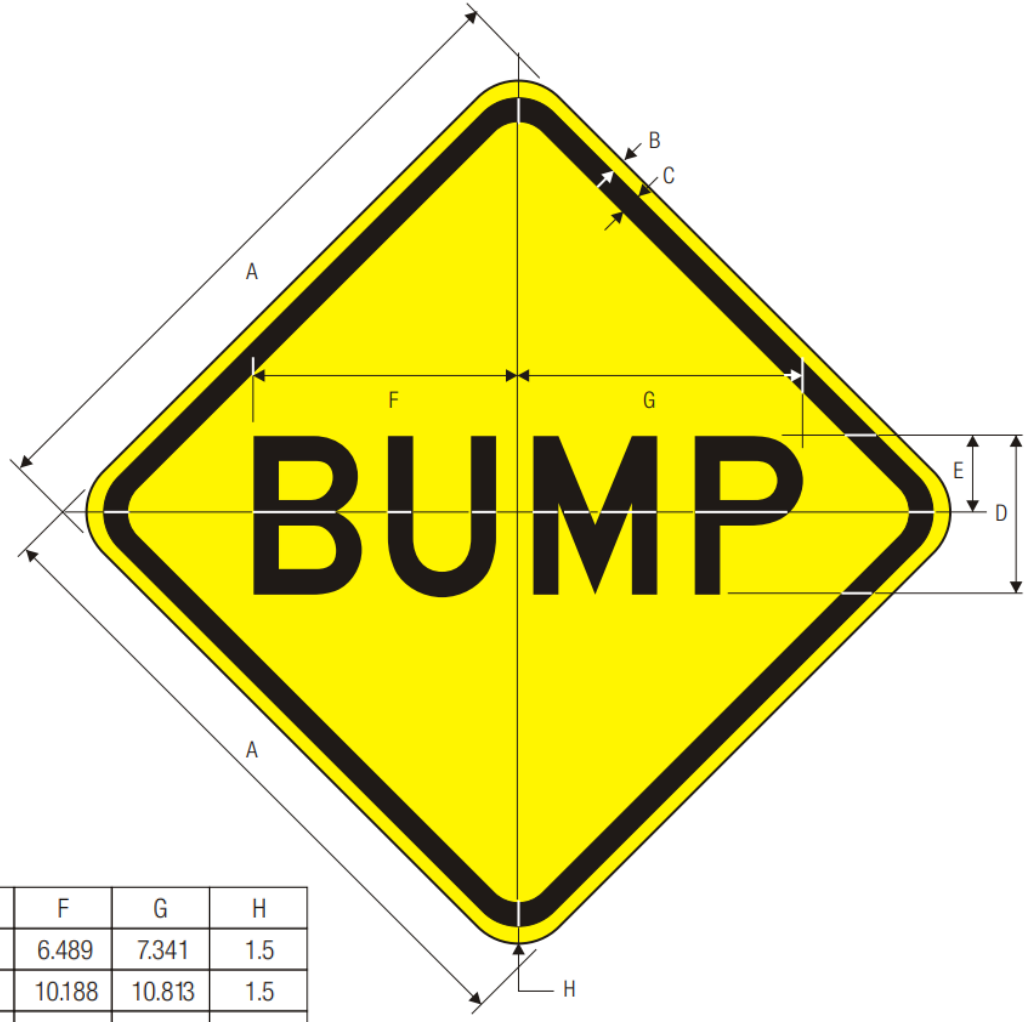
Bump Signs

Use

- Used to give warning of a sharp rise in the profile of the road.

Colors

- Legend: Black
- Background: Yellow (retroreflective)



W8-1
BUMP

C	A	B	C	D	E	F	G	H
	18	.375	.625	4 D	2	6.489	7.341	1.5
	24	.375	.625	6 D	3	10.188	10.813	1.5
	30	.5	.75	8 D	4	13.625	14.375	1.875
	36	.625	.875	10 D	5	16.938	17.938	2.25
	48	.75	1.25	12 D	6	20.375	21.625	3

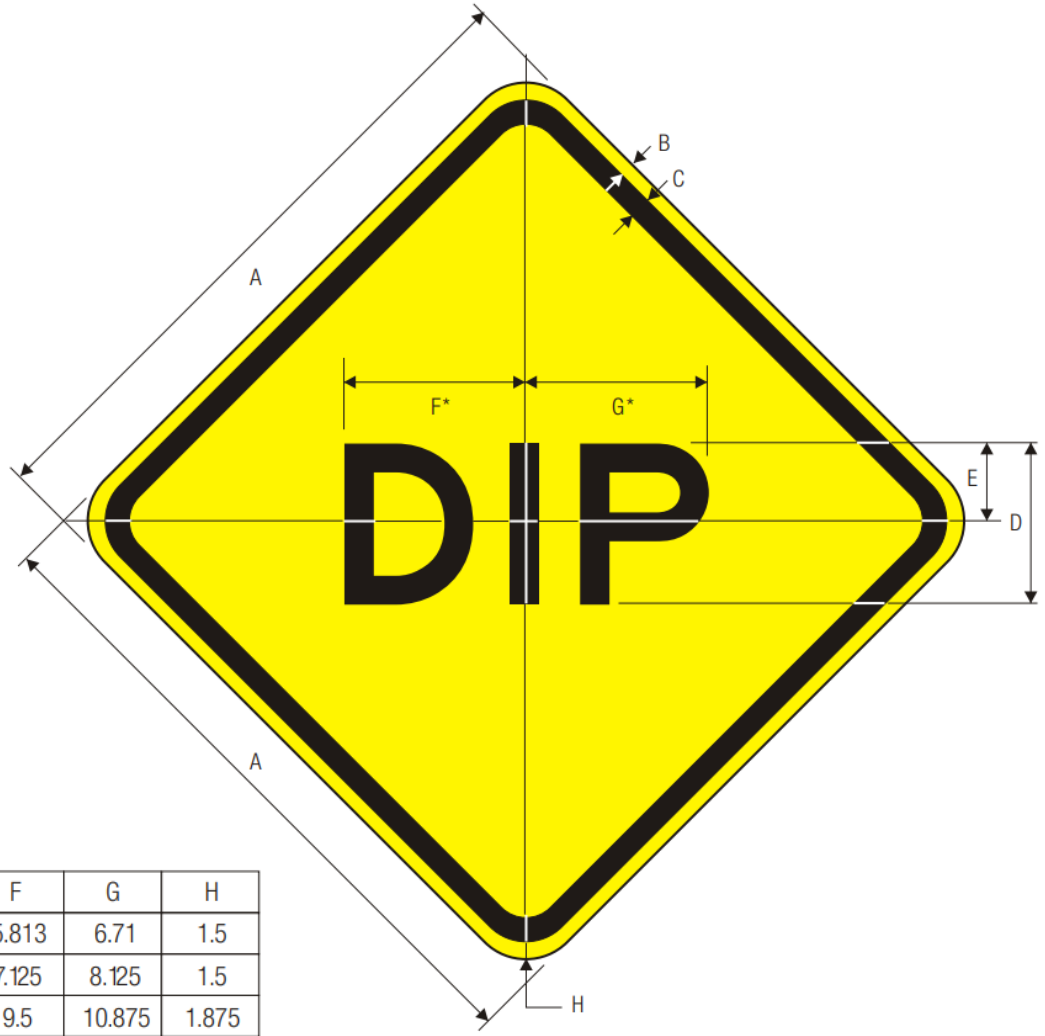
Dip Signs

Use

- Used to give warning of a sharp depression in the profile of the road.

Colors

- Legend: Black
- Background: Yellow (retroreflective)



W8-2
DIP

*Increase spacing 50%

C

A	B	C	D	E	F	G	H
18	.375	.625	5 E	2.5	5.813	6.71	1.5
24	.375	.625	6 E	3	7.125	8.125	1.5
30	.5	.75	8 E	4	9.5	10.875	1.875
36	.625	.875	10 E	5	11.875	13.5	2.25
48	.75	1.25	12 E	6	14.25	16.25	3

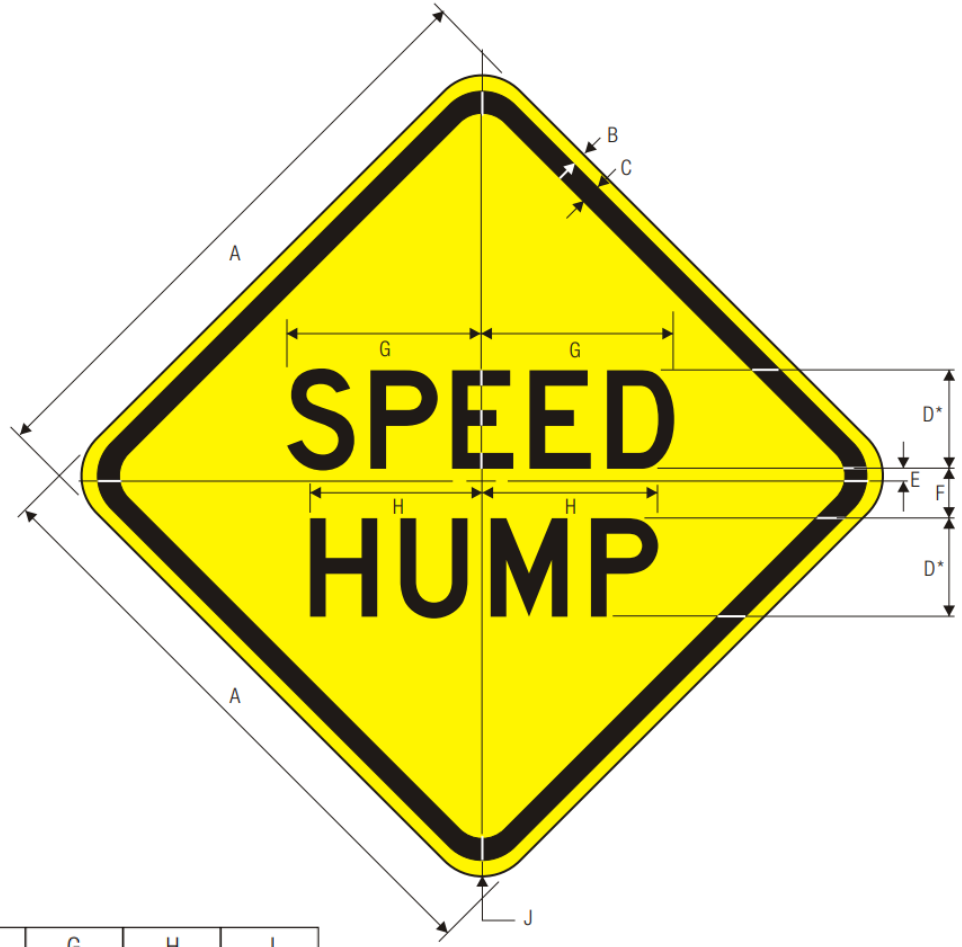
Speed Hump Signs

Use

- Used to give warning of a vertical deflection in the roadway that is designed to limit the speed of traffic.

Colors

- Legend: Black
- Background: Yellow (retroreflective)



W17-1
SPEED HUMP

C	A	B	C	D	E	F	G	H	J
	24	.375	.625	4 D	.25	2	7.845	7.045	1.5
	30	.5	.75	5 D	.5	2.5	9.827	8.826	1.875
	36	.625	.875	6 D	.75	3	11.788	10.588	2.25

*Series 2000 Standard Alphabets.

Pavement Ends Signs

Use

- Used where a paved surface changes to either a gravel treated surface or an earth road surface.

Colors

- Legend: Black
- Background: Yellow (retroreflective)

W8-3

PAVEMENT ENDS

C

A	B	C	D	E	F	G	H	J	K
24	.375	.625	4 C	2.5	.5	11.188	5.313	5.438	1.5
30	.5	.75	5 C	3	.75	13.938	6.625	6.875	1.875
36	.625	.875	6 C	3.5	1	16.75	7.875	8.25	2.25

Advance Traffic Control Signs

Use

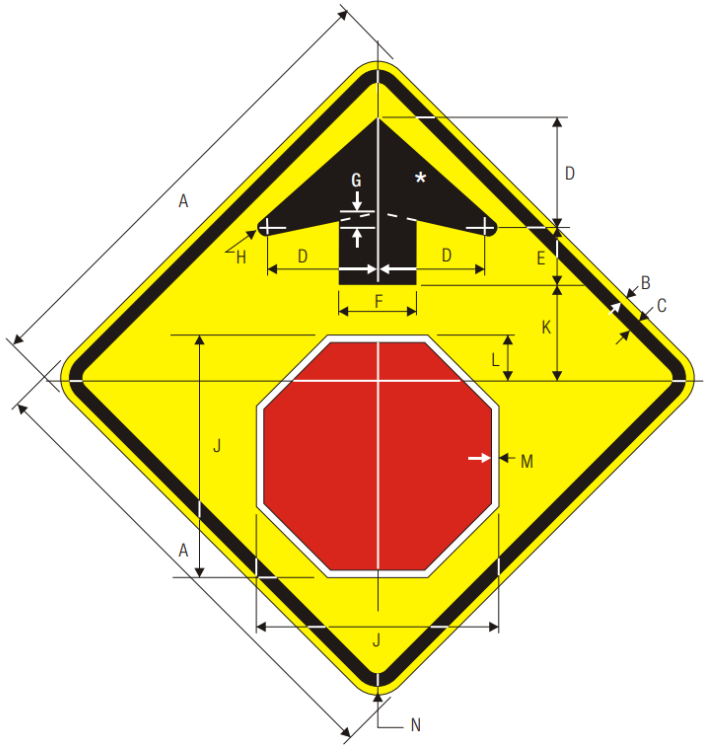
- These signs shall be installed on an approach to a primary traffic control device that is not visible for a sufficient distance to permit the road user to respond to the device.

Includes

- Stop Ahead (W3-1)
- Yield Ahead (W3-2)
- Signal Ahead (W3-3)

Colors

- Border & Arrow: Black
- Symbol: White border/red background (retroreflective)
- Background: Yellow (retroreflective)



W3-1
STOP AHEAD

A	B	C	D	E	F	G	H	J	K	L	M	N
18	.375	.625	4.5	2.25	3	.375	.187	9.5	3	1.75	.313	1.5
24	.375	.625	6	3	4	.5	.25	12.562	5	2.25	.375	1.5
30	.5	.75	7.5	3.75	5	.625	.313	15.75	6.25	2.875	.5	1.875
36	.625	.875	9	4.5	6	.75	.375	19	7.5	3.5	.625	2.25
48	.75	1.25	12	6	8	1	.5	25.125	10	4.5	.75	3

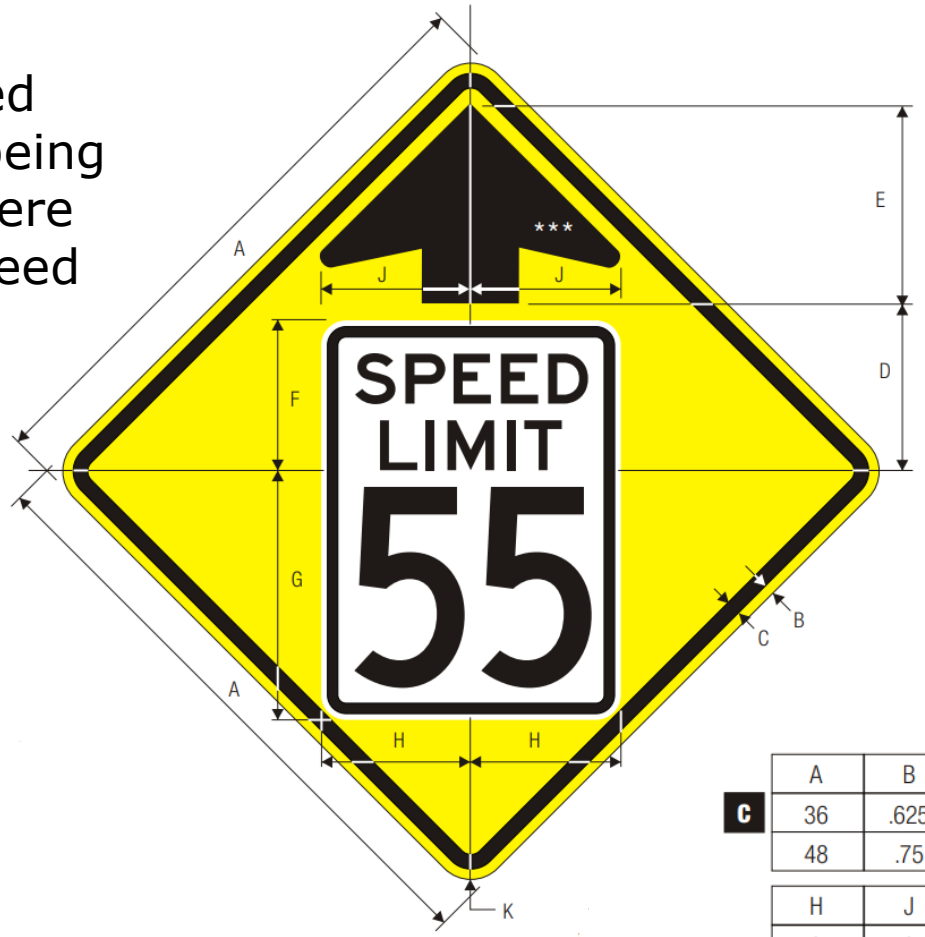
Reduced Speed Limit Ahead Signs

Use

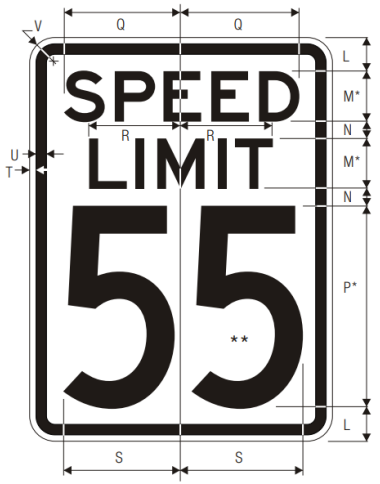
- Used to inform road users of a reduced speed zone where the speed limit is being reduced by more than 10 mph, or where engineering judgment indicates the need for advance notice to comply with the posted speed limit ahead.

Colors

- Boarder & Arrow: Black
- Symbol: Same as R2-1
- Background: Yellow (retroreflective)



W3-5
SPEED REDUCTION



C

A	B	C	D	E	F	G
36	.625	.875	10	12	9	15
48	.75	1.25	11.75	18	10.75	19.25

H	J	K	L	M	N	P
9	9	2.25	2	3 E	1	12 C
12	12	3	2.25	4 E	1.25	15 C

Q	R	S	T	U	V
7	5.46	7.126	.375	.625	2.25
9.327	7.279	9.258	.375	.625	3

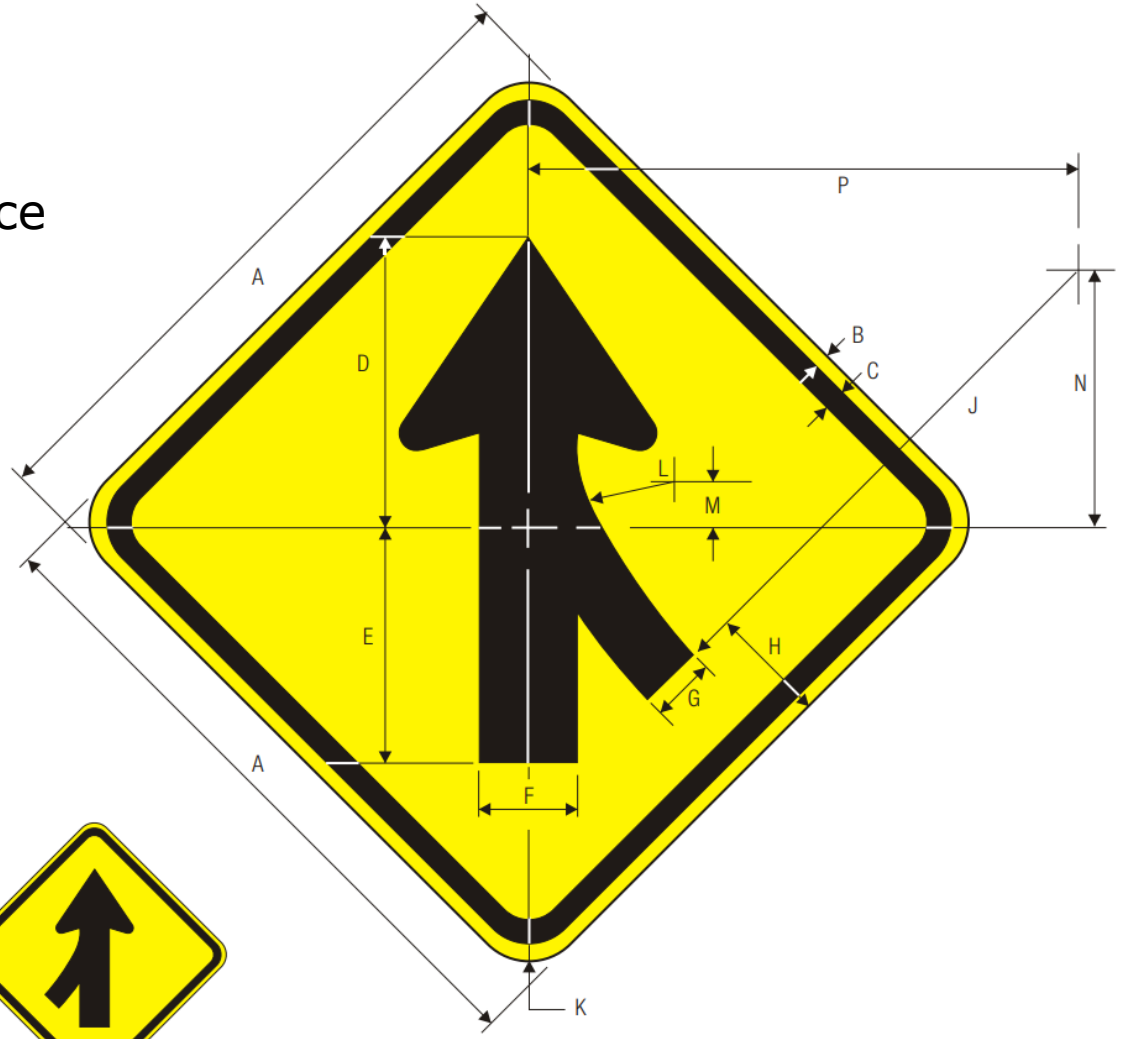
Merge Signs

Use

- Used to warn road users on the major roadway that merging movements might be encountered in advance of a point where lanes from two separate roadways converge as a single traffic lane and no turning conflict occurs.

Colors

- Symbol: Black
- Background: Yellow (retroreflective)



W4-1L

W4-1R
MERGE

C

A	B	C	D	E	F	G	H	J	K	L	M	N	P
24	.375	.625	10.25	8.75	3.5	2.375	4.188	22.25	1.5	6.375	2.625	10.375	22.188
30	.5	.75	13	11	4.375	3	5.25	28	1.875	8	3	13	27.75
36	.625	.875	15.75	13.25	5.25	3.625	6.313	33.625	2.25	9.625	4	15.625	33.313
48	.75	1.25	20.5	17.5	7	4.75	8.375	45	3	12.813	5.25	20.75	44.375

Lane Ends Signs

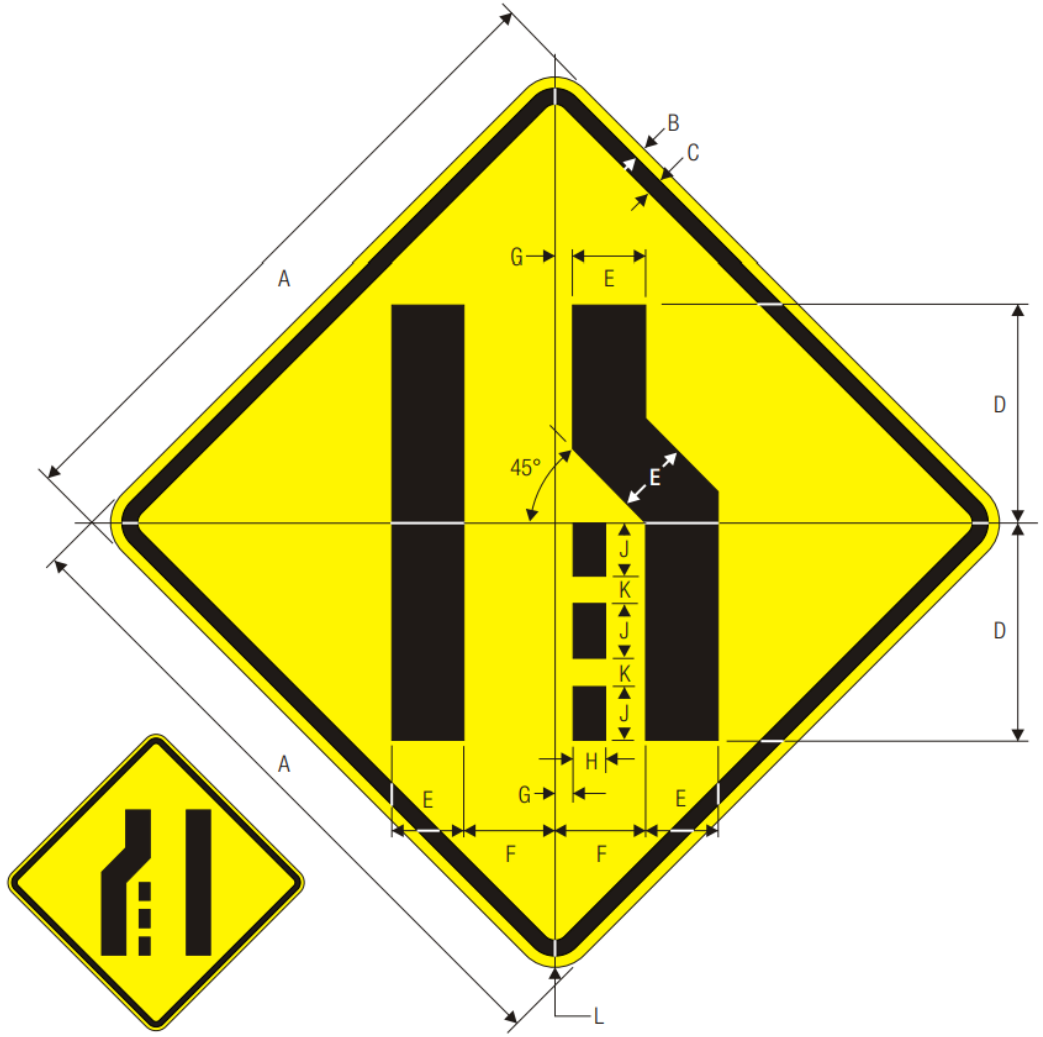
Advancing the Future of Public Safety

Use

- Used to warn of the reduction in the number of traffic lanes in the direction of travel on a multi-lane highway.

Colors

- Symbol: Black
- Background: Yellow (retroreflective)



W4-2L

W4-2R

LANE ENDS

C	A	B	C	D	E	F	G	H	J	K	L
	30	.5	.75	10	3.375	4.188	.875	1.5	2.5	1.25	1.875
	36	.625	.875	12	4	5	1	1.75	3	1.5	2.25
	48	.75	1.25	16	5.375	6.688	1.25	2.375	4	2	3

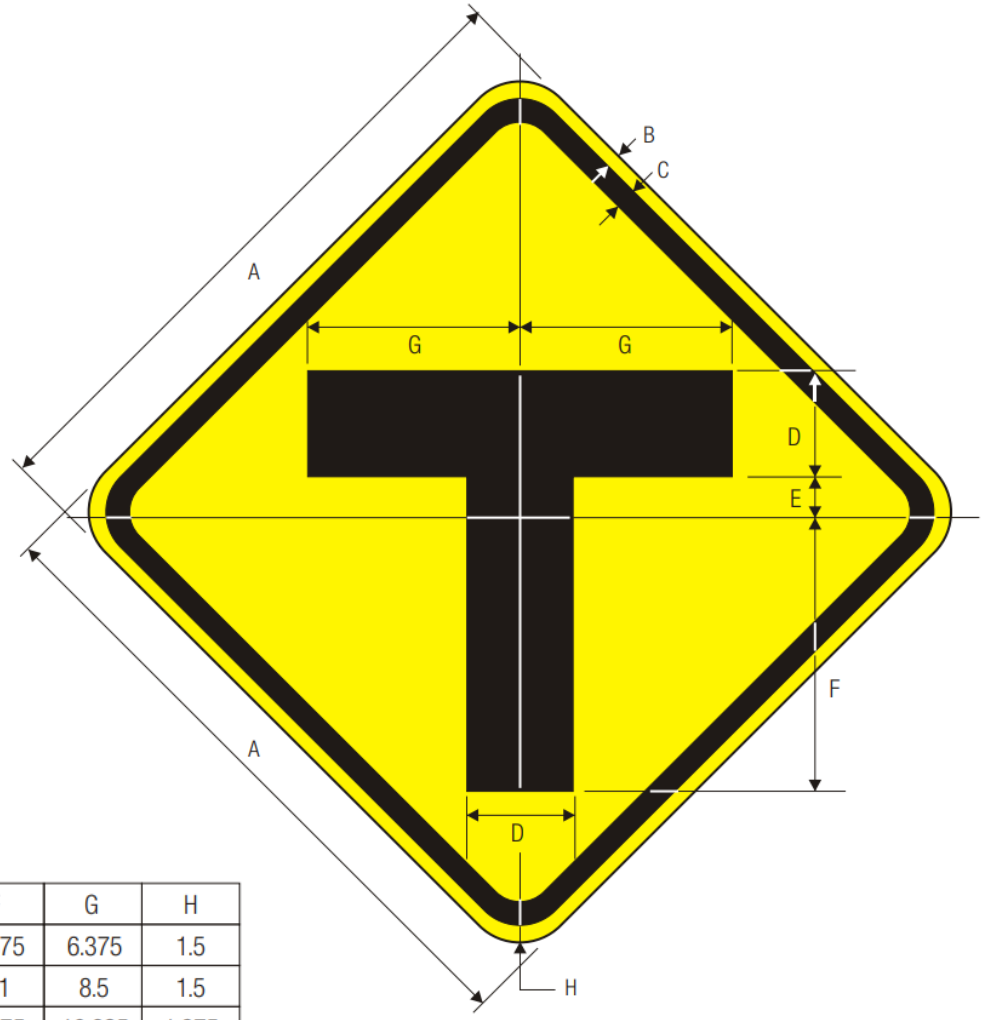
Intersection Warning Signs

Use

- Used in advance of an intersection to indicate the presence of an intersection and the possibility of turning or entering traffic.

Colors

- Legend: Black
- Background: Yellow (retroreflective)



W2-4

T-SYMBOL

C

A	B	C	D	E	F	G	H
18	.375	.625	3	1.25	8.375	6.375	1.5
24	.375	.625	4	1.5	11	8.5	1.5
30	.5	.75	5	1.875	13.75	10.625	1.875
36	.625	.875	6	2.25	16.5	12.75	2.25
48	.75	1.25	8	3	22	17	3

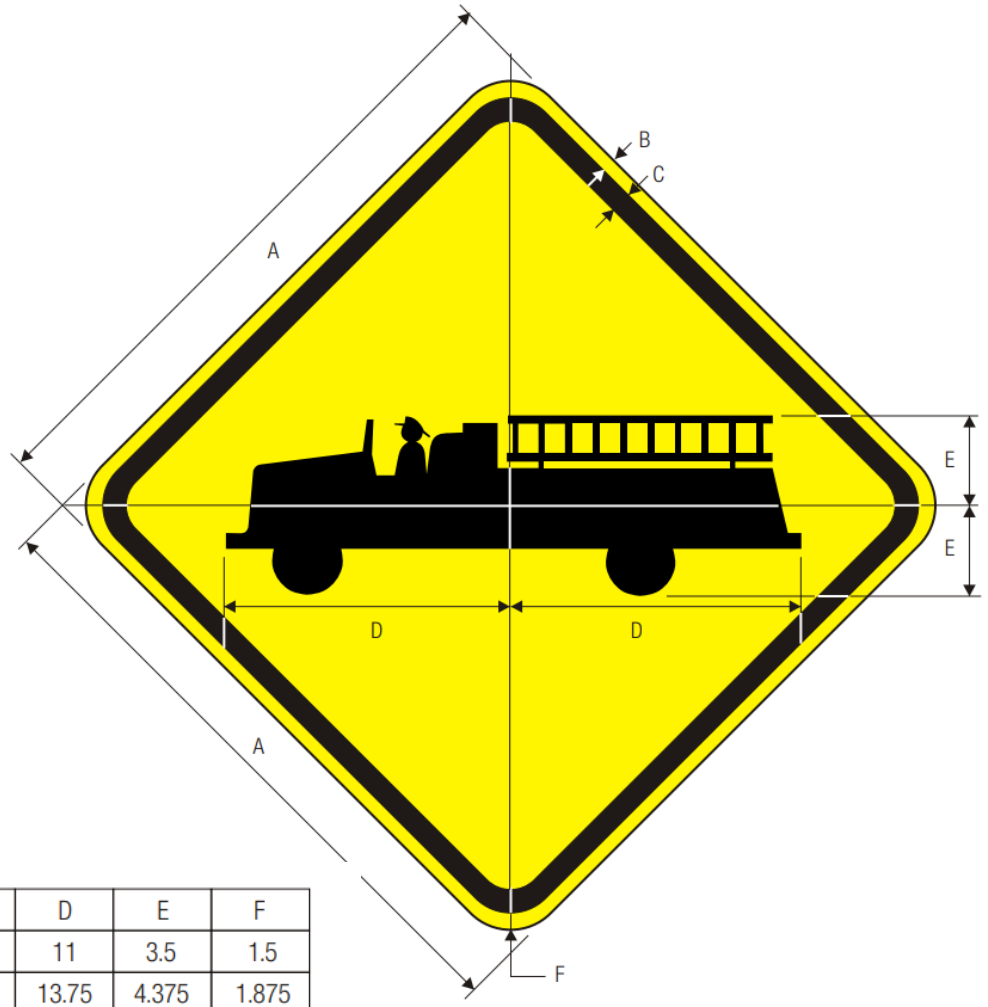
Vehicular Traffic Warning Signs

Use

- Used to alert road users to locations where unexpected entries into the roadway by trucks, bicyclists, farm vehicles, emergency vehicles, golf carts, horse-drawn vehicles, or other vehicles might occur.

Colors

- Legend: Black
- Background: Yellow (retroreflective)



W11-8

EMERGENCY VEHICLE

C	A	B	C	D	E	F
	24	.375	.625	11	3.5	1.5
	30	.5	.75	13.75	4.375	1.875
	36	.625	.875	16.5	5.25	2.25
	48	.75	1.25	22	7	3

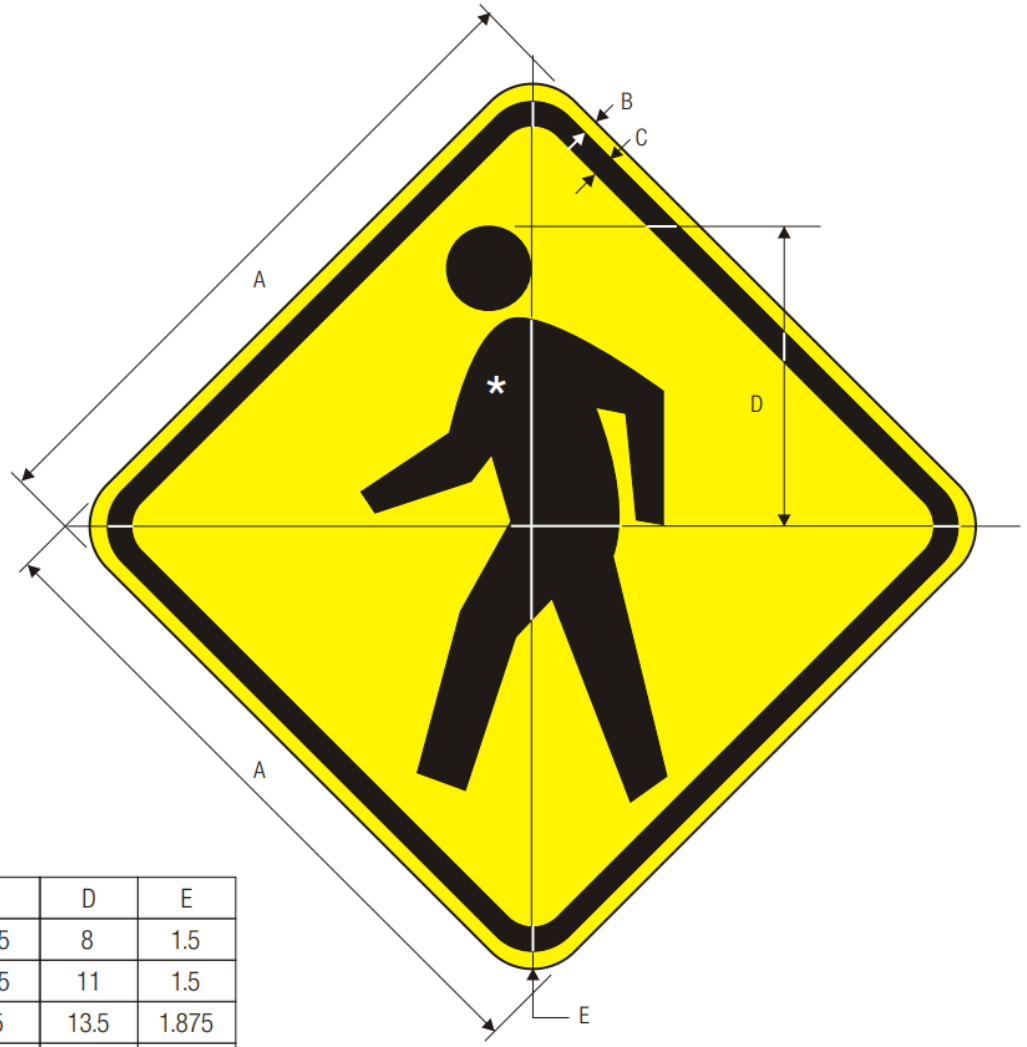
Non-Vehicular Warning Signs

Use

- Used to alert road users in advance of locations where unexpected entries into the roadway might occur or where shared use of the roadway by pedestrians, animals, or equestrians might occur.

Colors

- Symbol: Black
- Background: Yellow (retroreflective)



W11-2
PEDESTRIAN TRAFFIC

C

A	B	C	D	E
18	.375	.625	8	1.5
24	.375	.625	11	1.5
30	.5	.75	13.5	1.875
36	.625	.875	16	2.25
48	.75	1.25	22	3

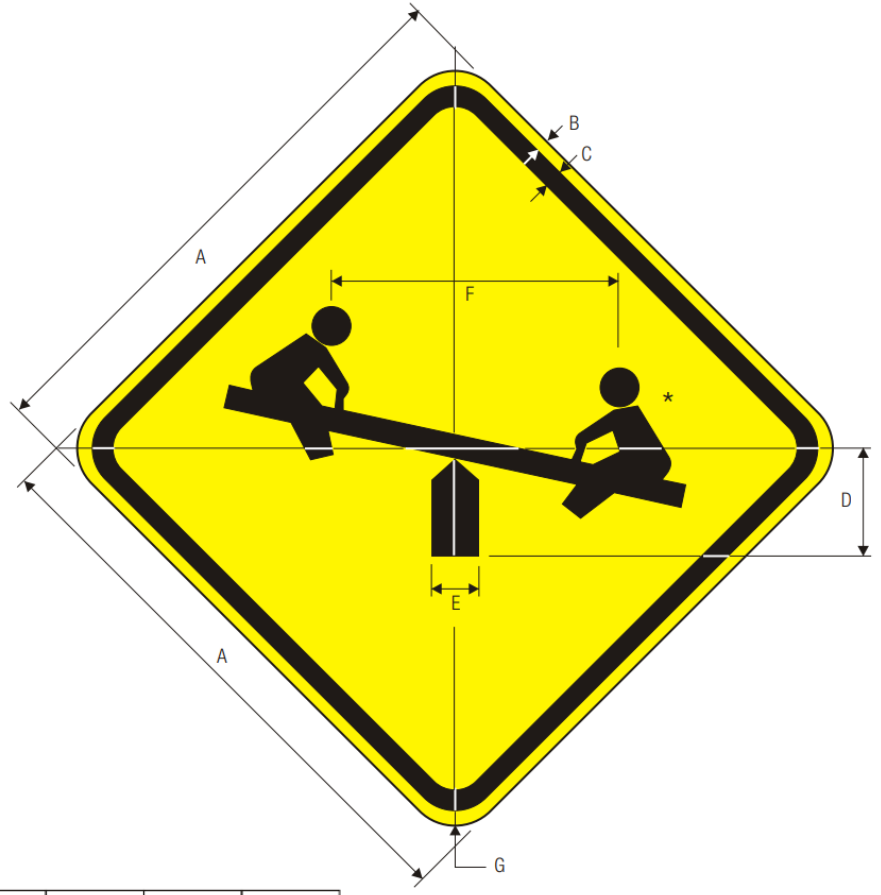
Playground Signs

Use

- Used to give advance warning of a designated children's playground that is located adjacent to the road.

Colors

- Symbol: Black
- Background: Yellow (retroreflective)/FYG (retroreflective)



W15-1
PLAYGROUND

	A	B	C	D	E	F	G
	18	.375	.625	3.5	1.5	9.312	1.5
	24	.375	.625	4.6	2	12.4	1.5
C	30	.5	.75	5.75	2.5	15.5	1.875
	36	.625	.875	7	3	18.625	2.25

Use of Supplemental Warning Plaques

Use

- Used only in combination with warning or regulatory signs, they shall not be mounted alone or displayed alone.

Colors

- Legend: Black
- Background: Yellow (retroreflective)

W16-1

	A	B	C	D	E	F	G	H	J	K	L
C	18	24	.375	.625	3.5	4 C	2.5	6.865	3.862	5.505	1.5
	24	30	.375	.625	4.25	5 C	3.25	8.586	4.823	6.885	1.5

Note: For use with Warning Signs for slower forms of transportation such as the Bicycle, Golf Cart, Farm Machinery, Horse Drawn Vehicle and ATV Warning Signs.

Cross Traffic Does Not Stop Plaques

Use

- Used in combination with a Stop sign when engineering judgment indicates that conditions are present that are causing or could cause drivers to misinterpret the intersection as an all-way stop.

Colors

- Legend: Black
- Background: Yellow (retroreflective)

W4-4p

TRAFFIC DOES NOT STOP

W4-4a

W4-4b

FOR USE WITH R1-1 STOP SIGN

*Series 2000 Standard Alphabets.

C	A	B	C	D	E	F	G	H	J	K	L	M	N
	24	12	.375	.625	3	2.25 C	1.5	9.314	9.63	1.5	10.106	9.779	2.25 B
	30	15	.5	.75	3.5	3 C	2	12.423	12.423	1.875	12.902	13.039	3 B
	36	18	.625	.875	4	3.5 C	3	14.487	14.978	2.25	15.721	15.212	3.5 B
	48	24	.75	1.25	5.5	4.5 C	4	18.628	19.259	3	20.214	19.56	4.5 B

Object Marker Design and Placement Height

Use

- Used to mark obstructions within or adjacent to the roadway.

OM1 Colors

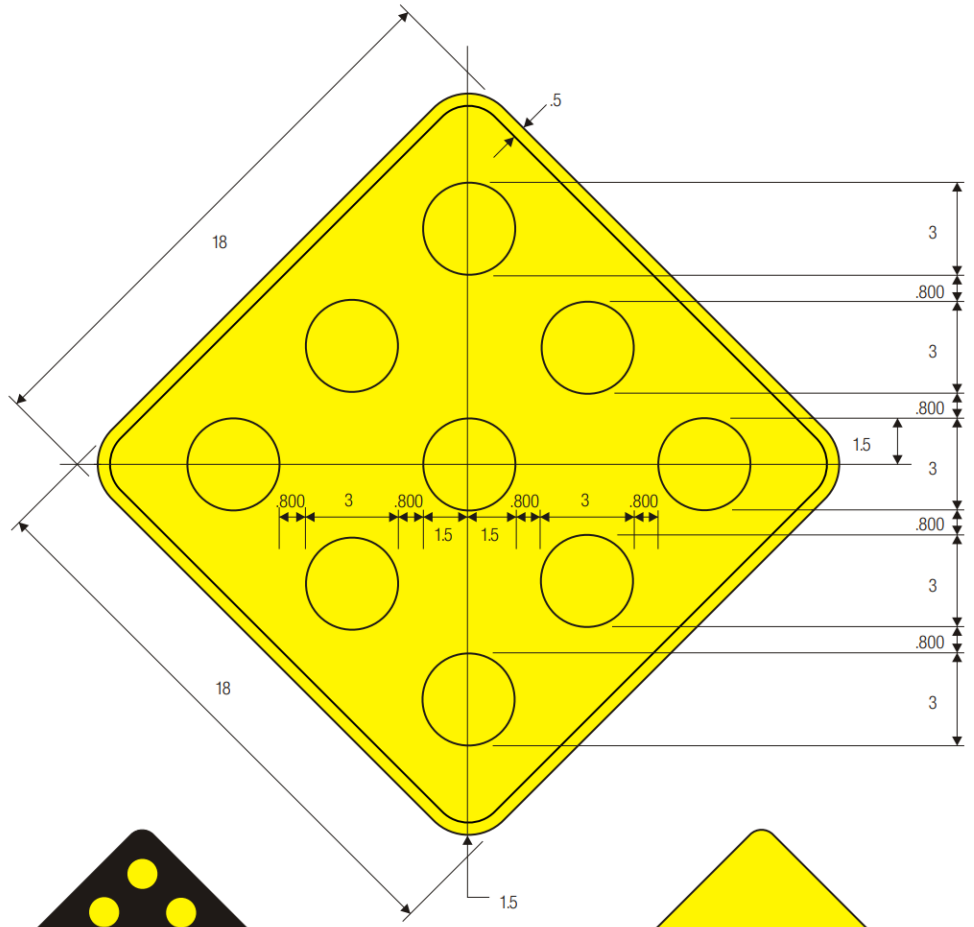
- Background: Black
- Reflectors: Yellow (retroreflective)

OM2 Colors

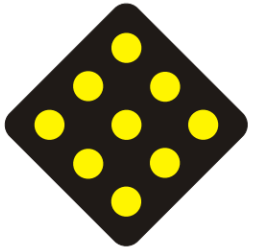
- Border: Yellow
- Background: Yellow
- Reflectors: Yellow (retroreflective)

OM3 Colors

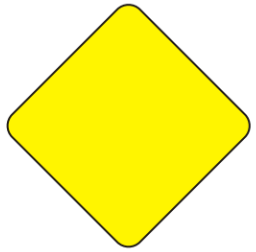
- Sign Panel: Yellow (retroreflective)



OM1-1



OM1-2



OM1-3

Object Markers for Obstructions Adjacent to the Roadway

Use

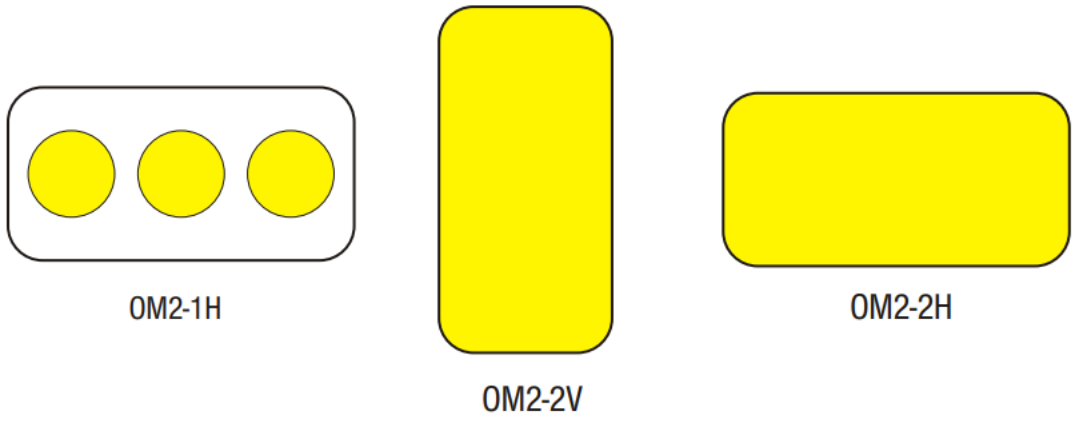
- Obstructions not actually within the roadway are sometimes so close to the edge of the road that they need a marker.

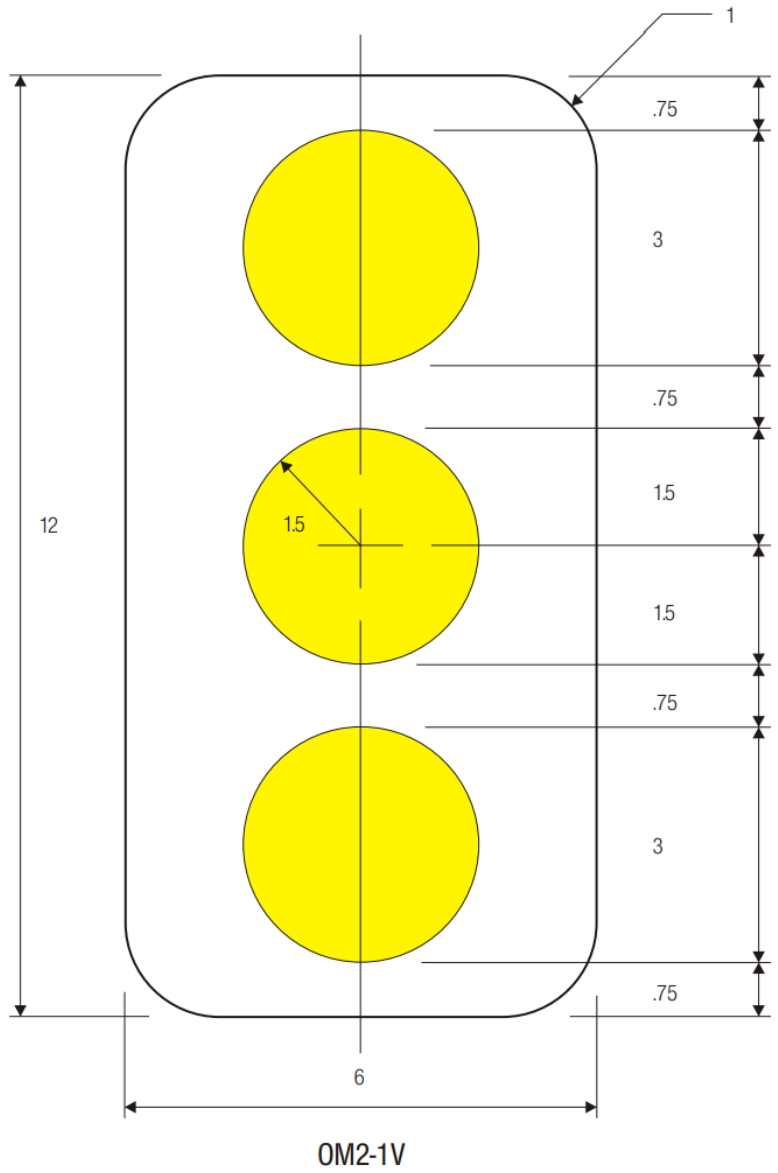
OM2-1 Colors

- Reflectors: Yellow (retroreflective)
- Background: Yellow (retroreflective)

OM2-2 Colors

- Sign Panel: Yellow (retroreflective)





Object Markers for Obstructions Within the Roadway

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Use

- Obstructions within the roadway shall be marked with a Type 1 or Type 3 object marker.

Colors

- Stripes: Black
- Background: Yellow (retroreflective)

Object Markers for Ends of Roadways

Use

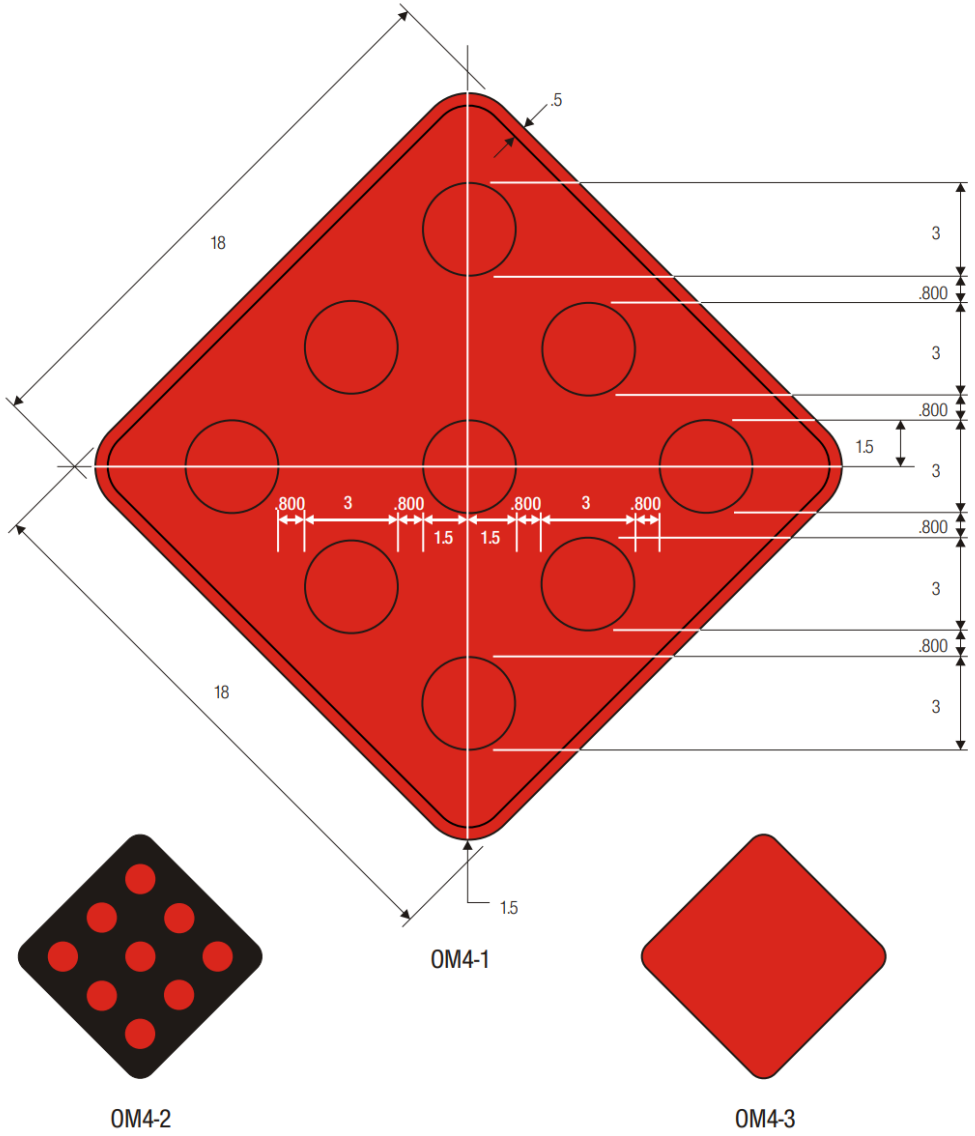
- Used to warn and alert road users of the end of a roadway in other than construction or maintenance areas.

OM4-2 Colors

- Reflectors: Red (retroreflective)
- Background: Black

OM4-3 Colors

- Sign Panel: Red (retroreflective)



Signs & Markings

Lesson 4: Other Types of Signs

Advancing the Future of Public Safety

Lesson Introduction


Common Guide Signs


School Signs


Preferential and Managed Lane Signs


General Information Signs


General Service Signs


Tourist-Oriented Directional Signs


Changeable Message Signs


Recreational and Cultural Interest Area Signs


Emergency Management Signing

Definitions

Freeways

- A divided highway with full control of access

Conventional road

- A street or highway other than a low-volume road, expressway, or freeway

Expressway

- A divided highway with partial control of access

Common Guide Signs

Application of Guide Signs

Guide Sign Purpose:

- Direct road users along streets and highways.
- Inform them of intersecting routes.
- Direct them to important destinations.
- Identify nearby natural and historical sites.

Guide Sign Design:

- Most guide signs should use a white message and border on a green background.

Street Name Signs

Lettering:

- Composed of a combination of lower-case letters with initial upper-case letters.
- Upper case letters at least 6 inches in height.
- Lower-case letters at least 4.5 inches in height.
- BUT for multi-lane streets with speed limits greater than 40 mph:
  - Upper-case letters at least 8 inches in height
  - Lower-case letters at least 6 inches in height

Colors:

- Legend: White (retroreflective)
- Background: Green (retroreflective)

D-3
STREET NAME

D-3
STREET NAME

Signing on Conventional Roads on Approaches to Interchanges

Advancing the Future of Public Safety

Use:

- Indicates how to turn to access the freeway/expressway ramp in the desired direction.

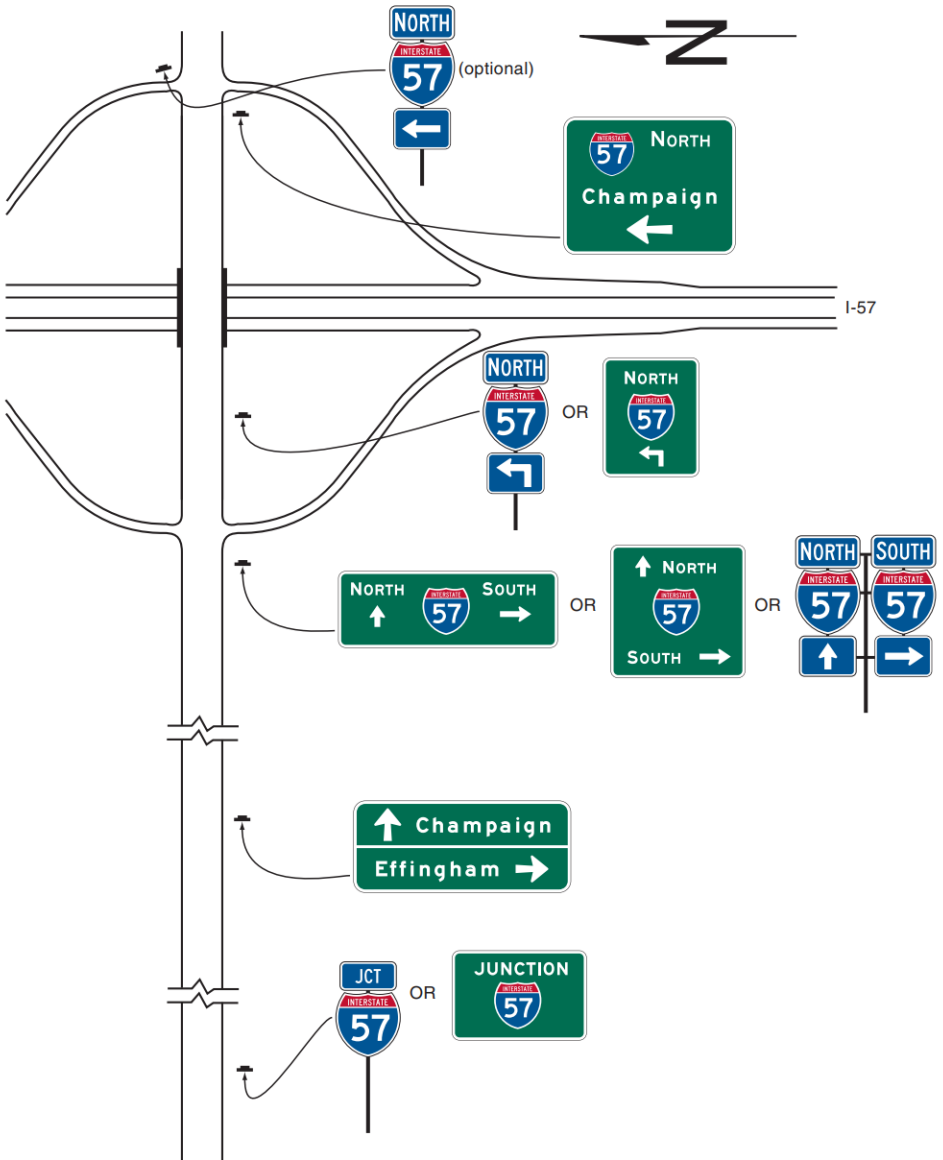
Colors:

- Legend: White (retroreflective)
- Background: Green (retroreflective)

Entrance Direction Sign Includes:

- Freeway or expressway route shield(s).
- Cardinal direction.
- Directional arrow(s).

Figure 2D-11. Example of Interchange Crossroad Signing for a One-Lane Approach



Signing on Conventional Roads on Approaches to Interchanges

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Figure 2D-12. Example of Minor Interchange Crossroad Signing

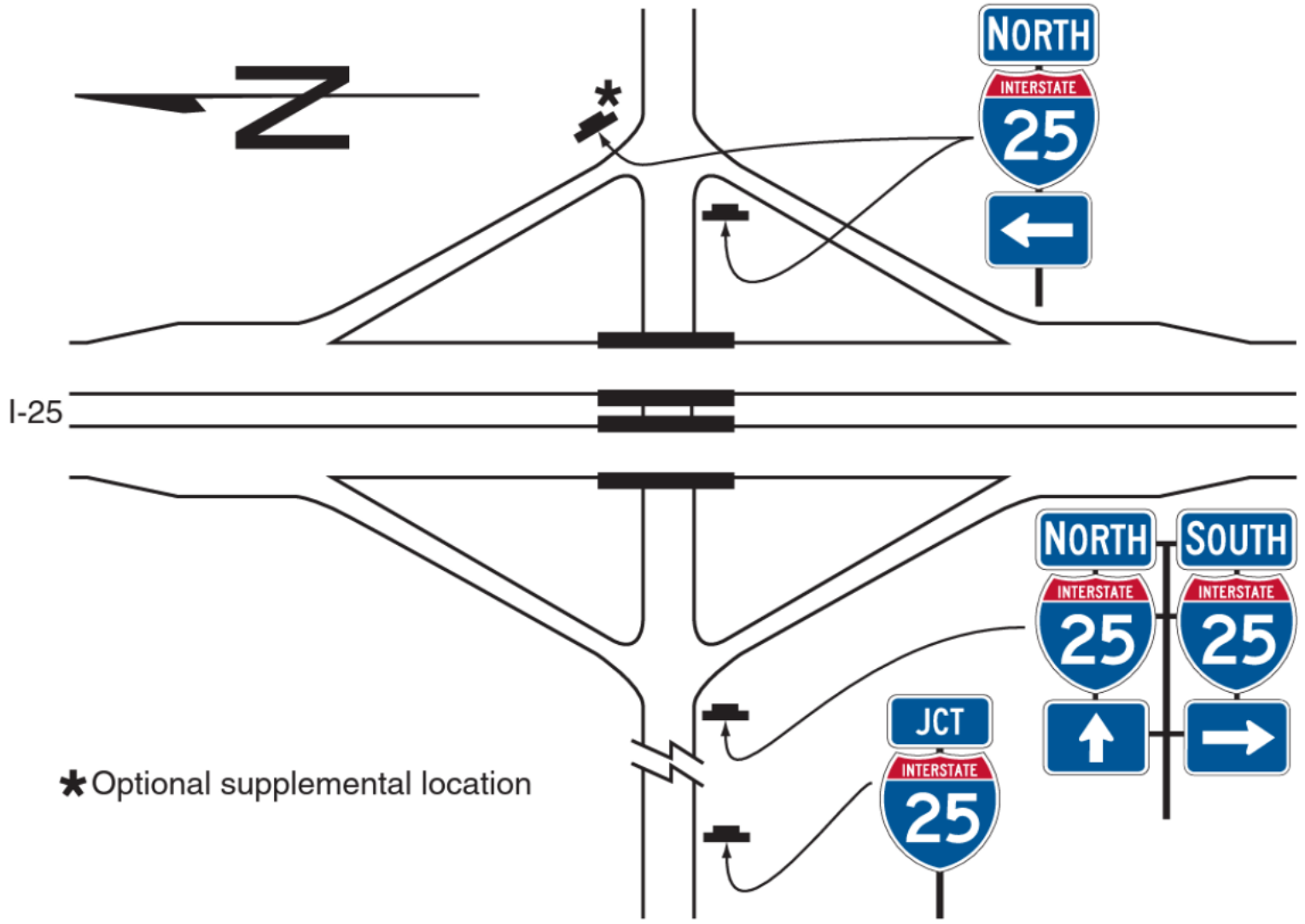
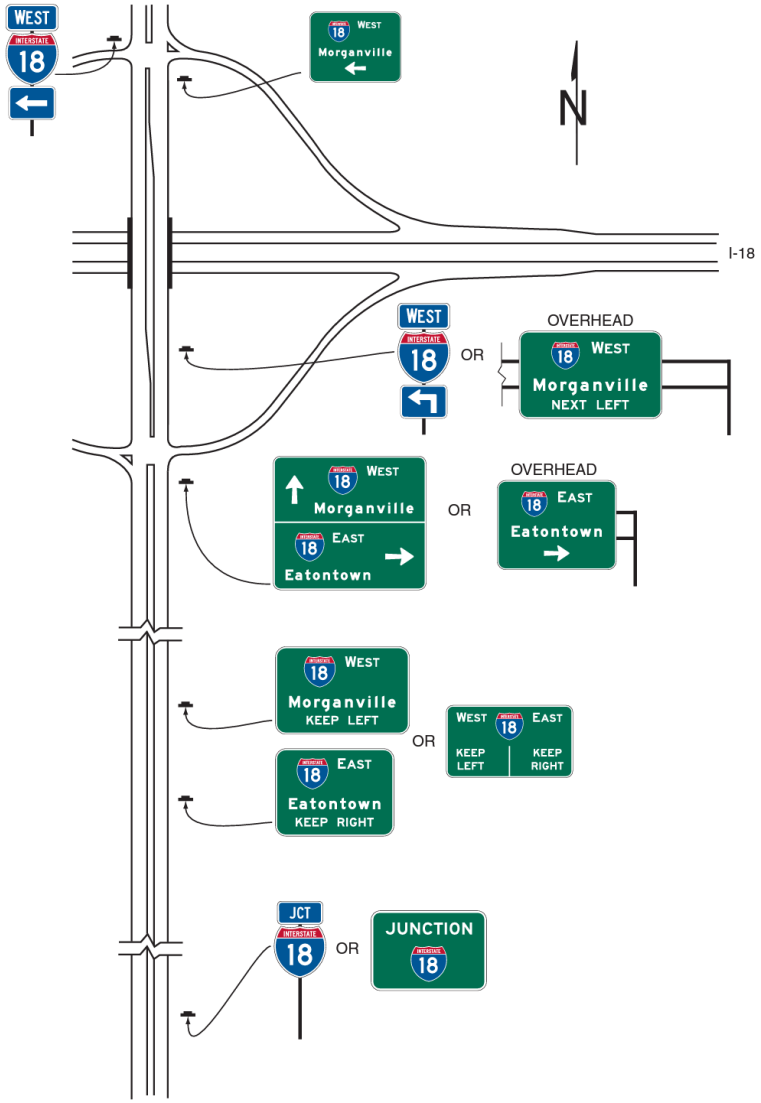


Figure 2D-13. Examples of Multi-Lane Crossroad Signing for a Diamond Interchange



Signing on Conventional Roads on Approaches to Interchanges

Advancing the Future of Public Safety

Figure 2D-14. Examples of Multi-Lane Crossroad Signing for a Partial Cloverleaf Interchange

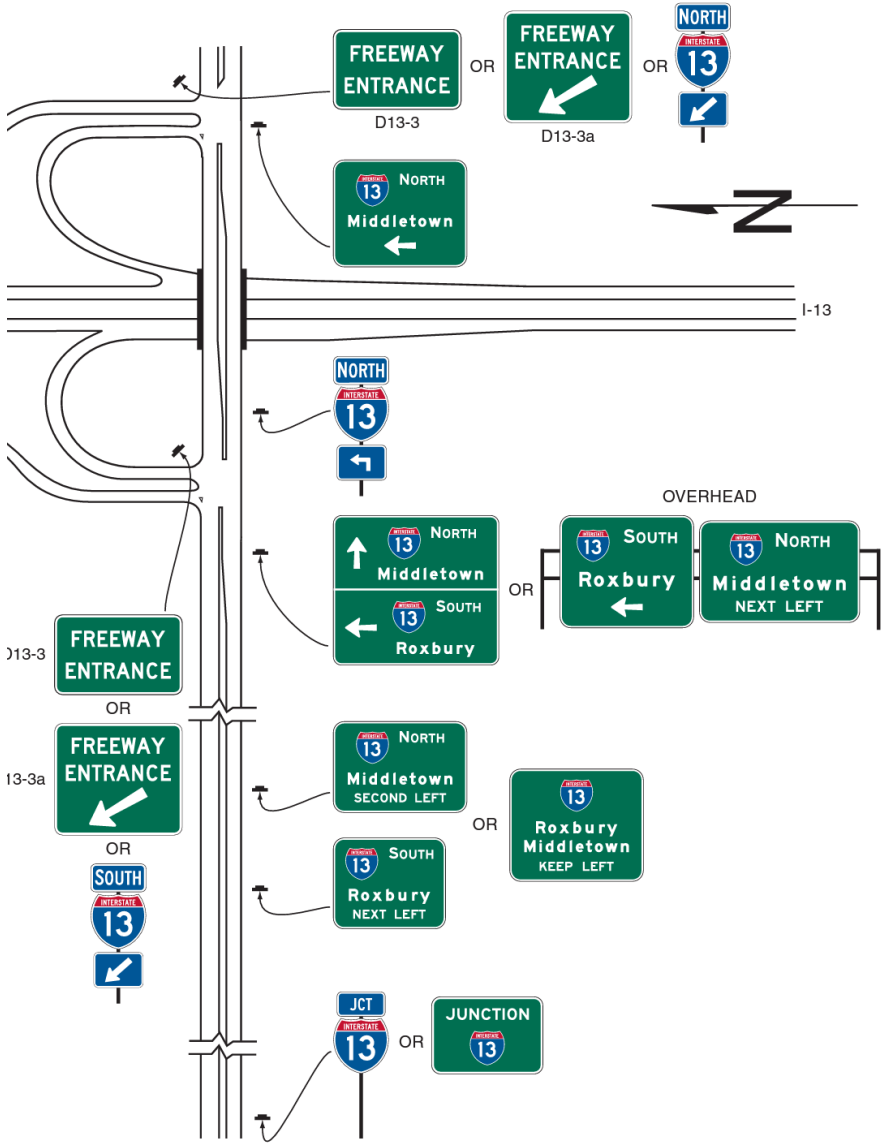
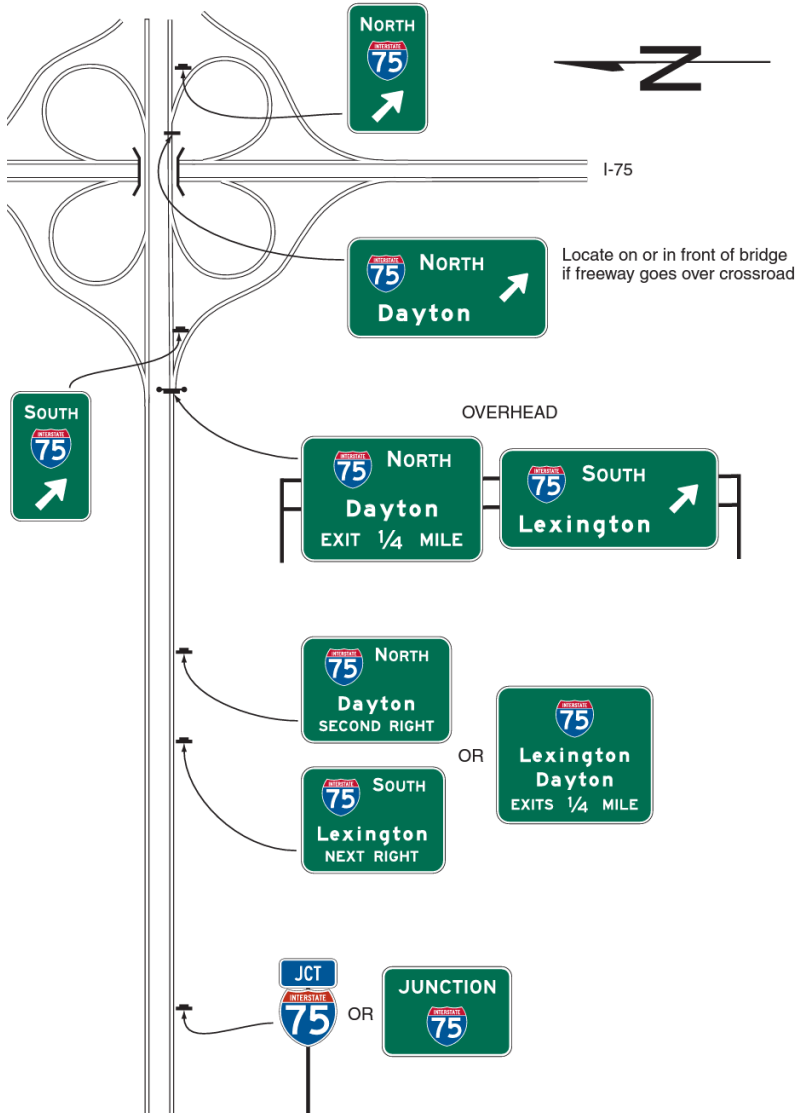


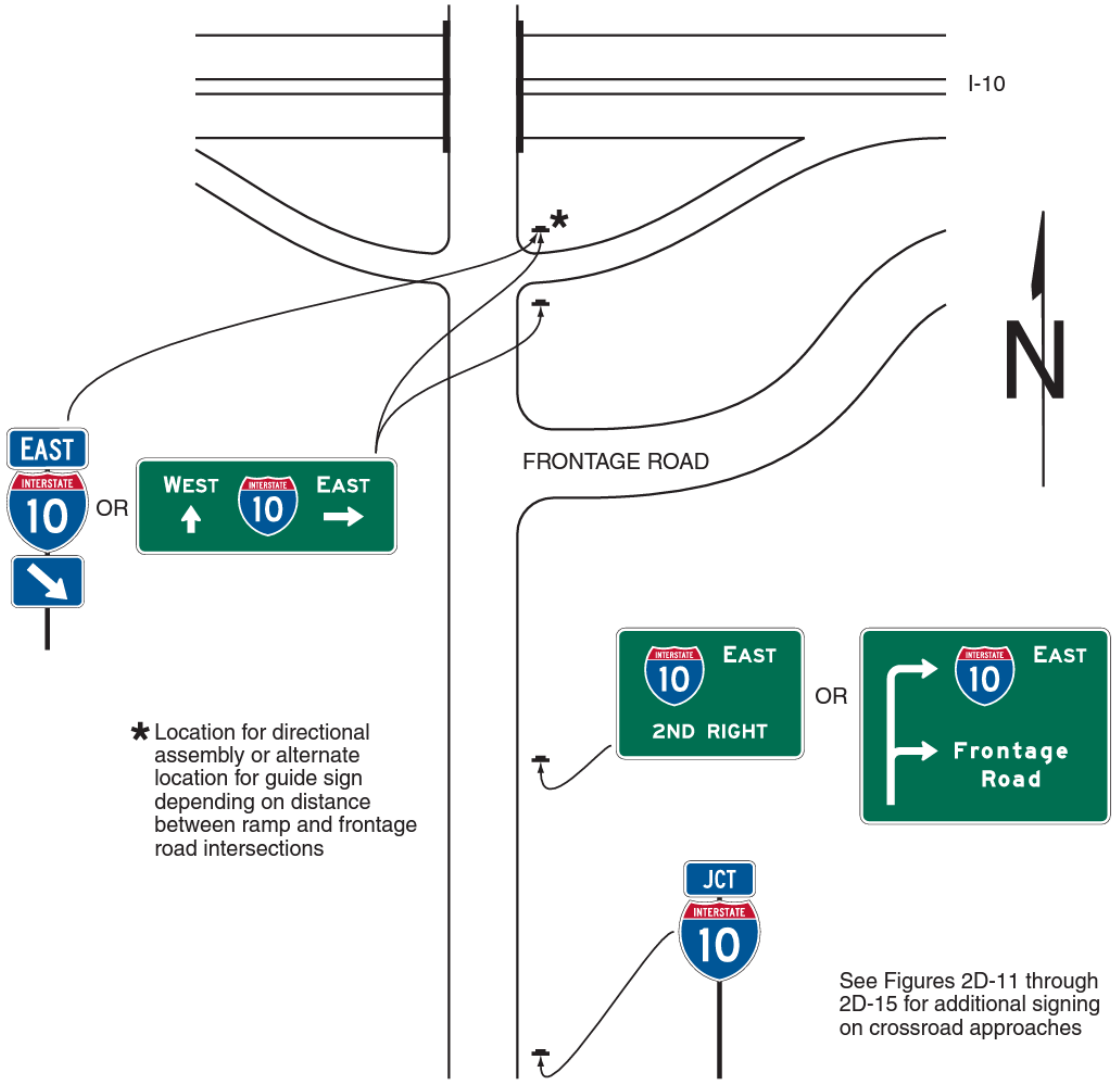
Figure 2D-15. Examples of Multi-Lane Crossroad Signing for a Cloverleaf Interchange



Signing on Conventional Roads on Approaches to Interchanges

Advancing the Future of Public Safety

Figure 2D-16. Example of Crossroad Signing for an Entrance Ramp with a Nearby Frontage Road



Community Wayfinding Signs

Use:

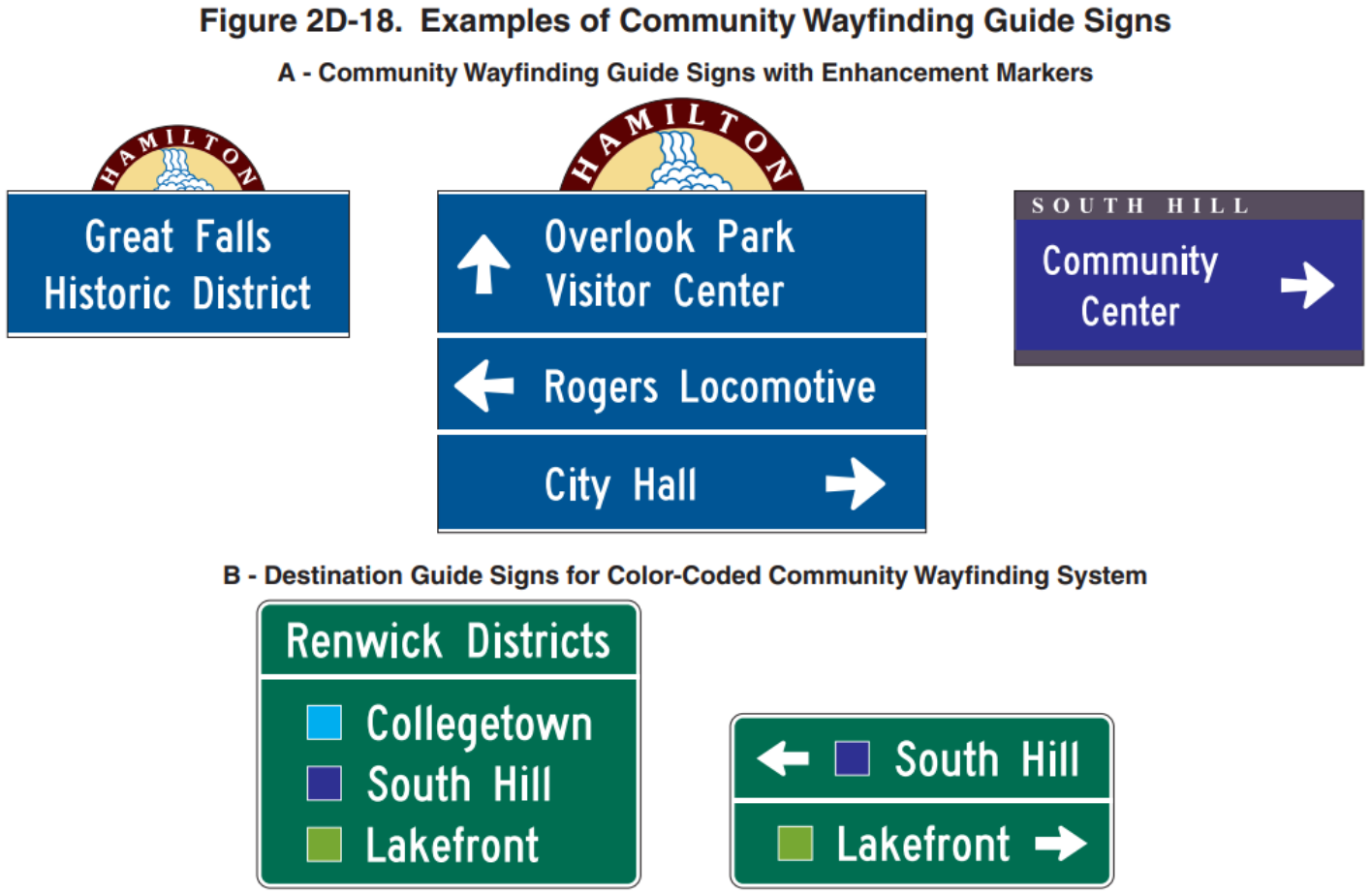
- Part of a coordinated and continuous system of signs that direct tourists to key areas.

Location:

- Limited to conventional roads.

Do Not Use For:

- Should not be used to provide direction to primary destinations or highway routes or streets.



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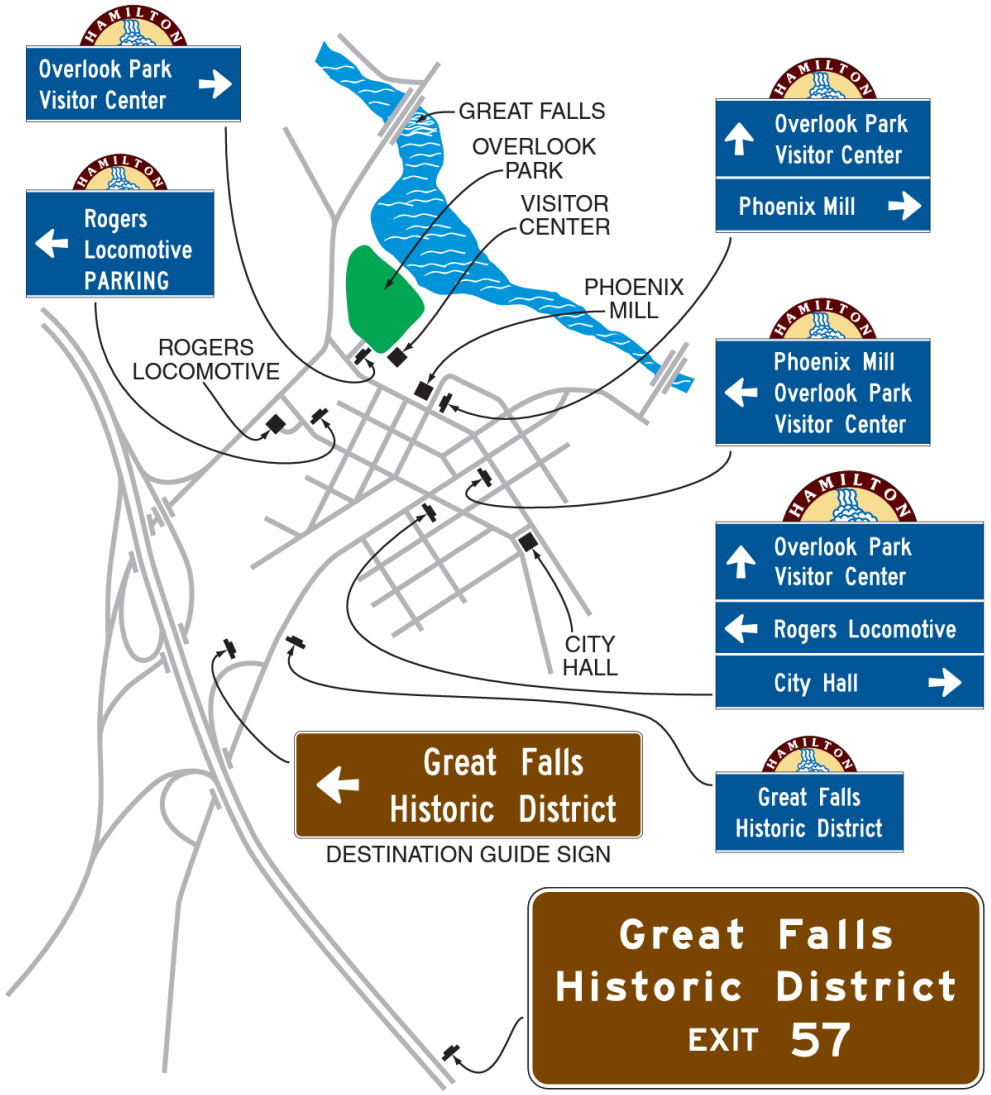
Community Wayfinding Signs

Figure 2D-19. Example of a Community Wayfinding Guide Sign System Showing Direction from a Freeway or Expressway



School Signs

School Signs

Advancing the Future of Public Safety

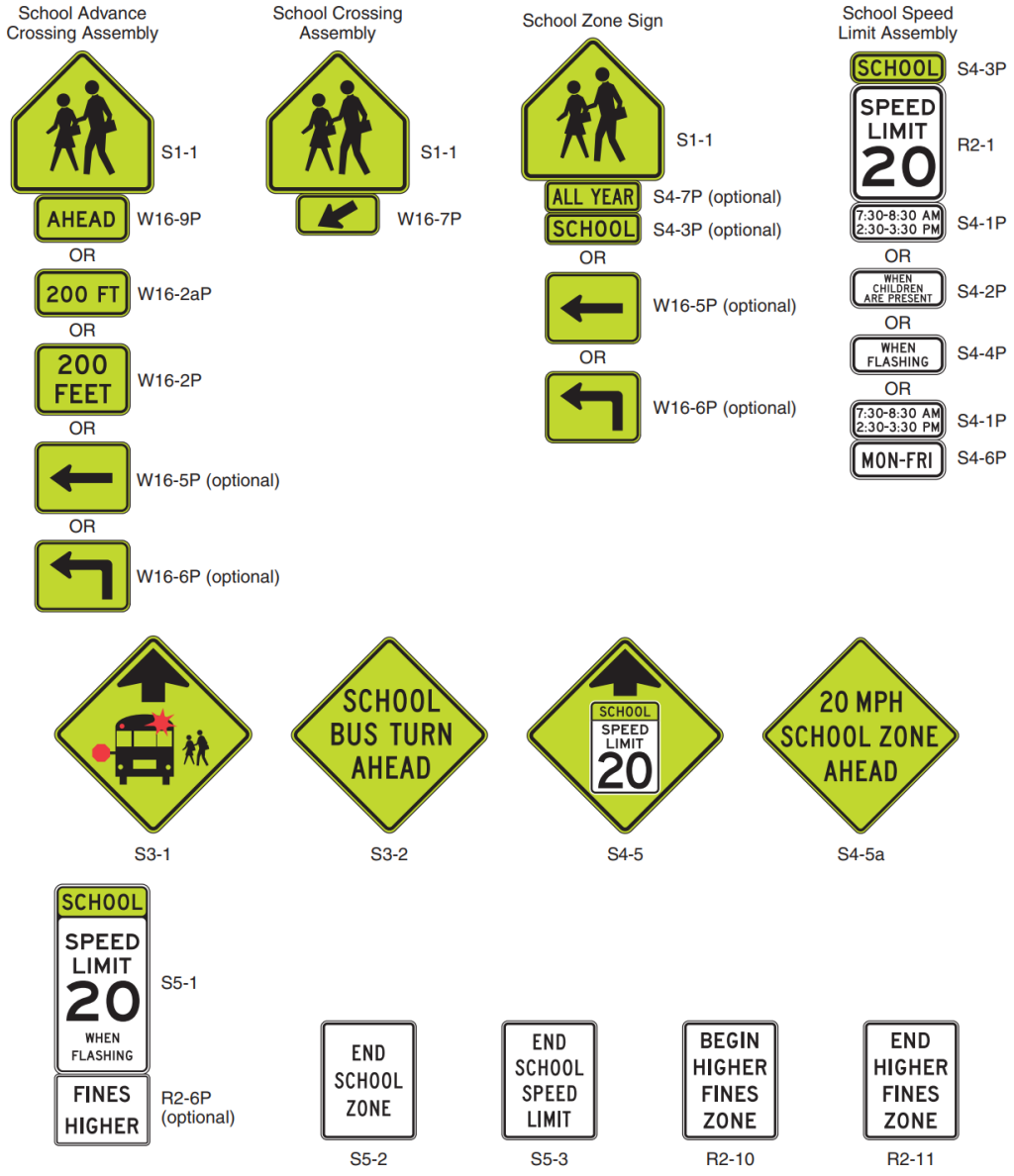
Use:

- Uniform approach to school areas.
- Establish a safe route for schoolchildren.

Size:

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



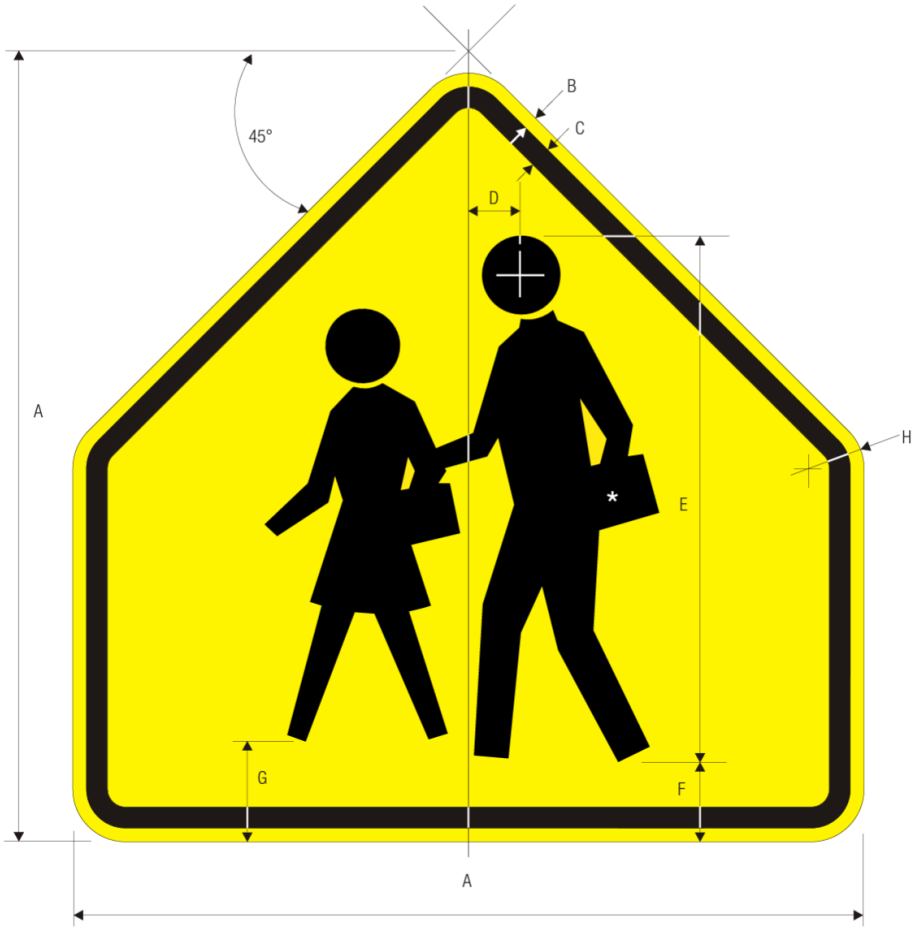
School Sign S1-1

Use:

- **School Area** – warn road users that they are approaching a school area.
- **School Zone** – identify the location of the beginning of a designated school zone.
- **School Advance Crossing** – can be used with plaques to warn road users that they are approaching a crossing.
- **School Crossing** – if combined with an arrow plaque, the S1-1 sign can be used to warn users of the location of a crossing.

Color:

- Symbol: Black
- Background: Yellow (retroreflective) or FYG (retroreflective)



S1-1
SCHOOL

*See page 6-58 for symbol design.

	A	B	C	D	E	F	G	H
	30	.5	.75	2	20	3	3.75	1.875
C	36	.625	.875	2.5	24	3.5	4.5	2.25
	48	.75	1.25	3.25	32	5	6	3

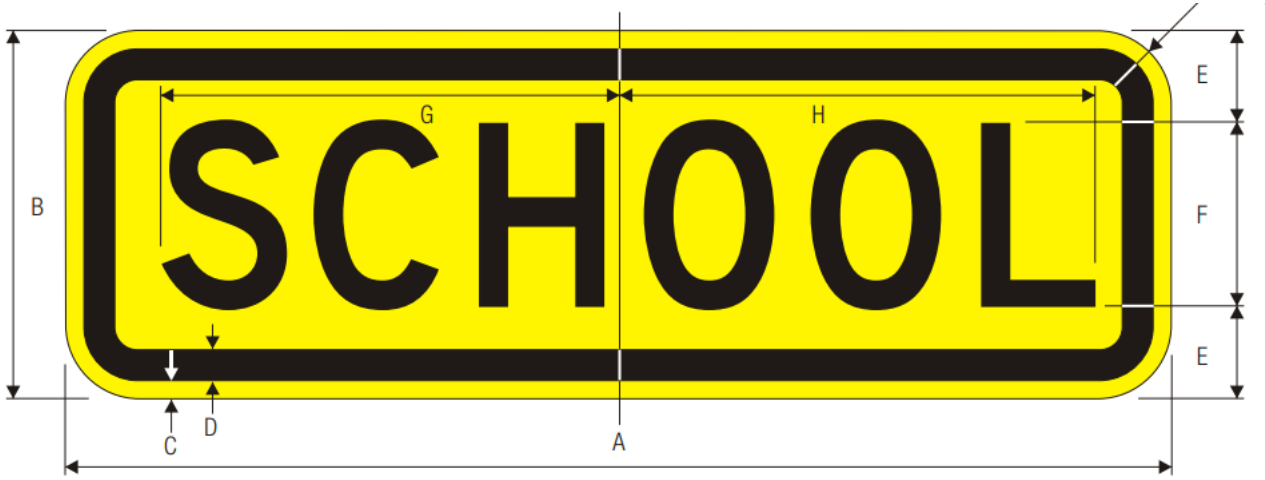
School Sign S4-3

Use:

- Used as part of assemblies such as the school zone sign and school speed limit assembly.

Color:

- Symbol: Black
- Background: Yellow (retroreflective) or FYG (retroreflective)



S4-3

SCHOOL

	A	B	C	D	E	F	G	H	J
C	12	6	.375	.438	2	2 C	4.1	4.46	1.5
	24	8	.375	.625	2	4 D	10	10.25	1.5
	36	12	.625	.875	3	6 D	15	15.375	2.25
	48	16	.75	1.25	4	8 D	20	20.5	3

School Sign S4-5

*Series 2000 Standard Alphabets.
**Optically center numerals about centerline.

S4-5

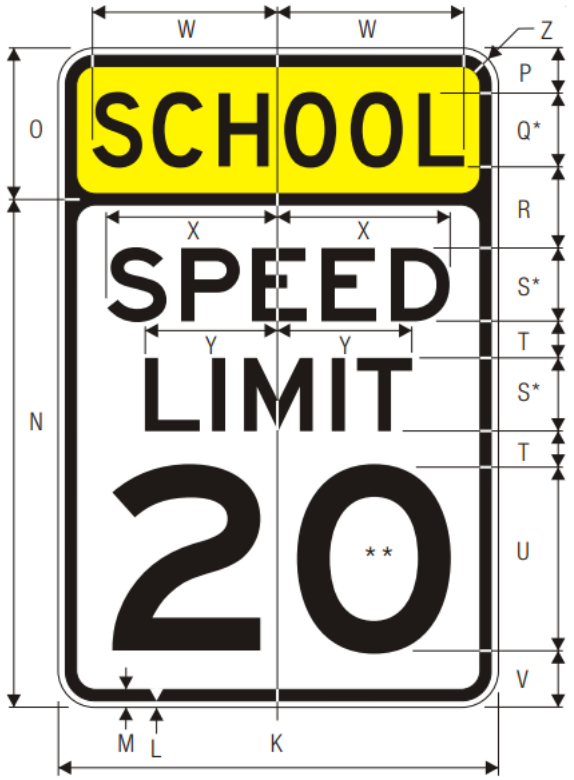
REDUCED SPEED (SCHOOL) ZONE AHEAD

A	B	C	D	E	F	G
36	.625	.875	8.25	13.5	7.5	15
48	.75	1.25	11	18	10	20

H	I	J	K	L	M	N
7.5	9	2.25	15	.25	.375	17.325
10	12	3	20	.3	.5	23.1

O	P	Q	R	S	T	U
5.175	1.5	2.5 D	2.75	2.5 E	1.25	6.25
6.9	2	3.3 D	3.7	3.3 E	1.625	8.3 E

V	W	X	Y	Z
2	6.336	5.832	4.551	1.25
2.85	8.449	7.777	6.069	1.6



Advancing the Future of Public Safety

School Sign Locations

Figure 7B-2. Example of Signing for a Higher Fines School Zone without a School Crossing

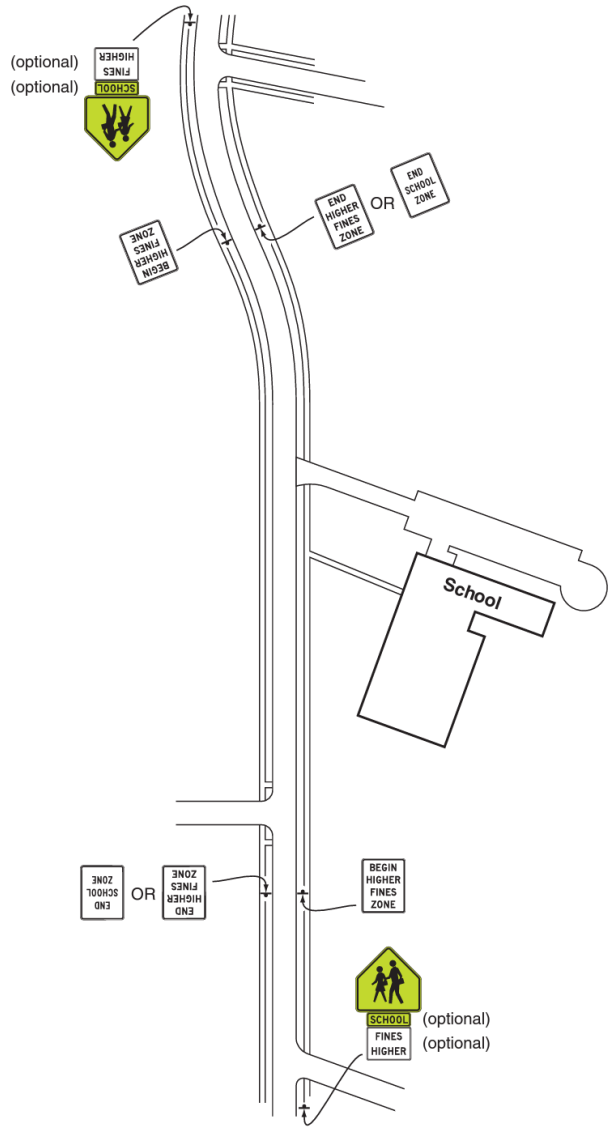
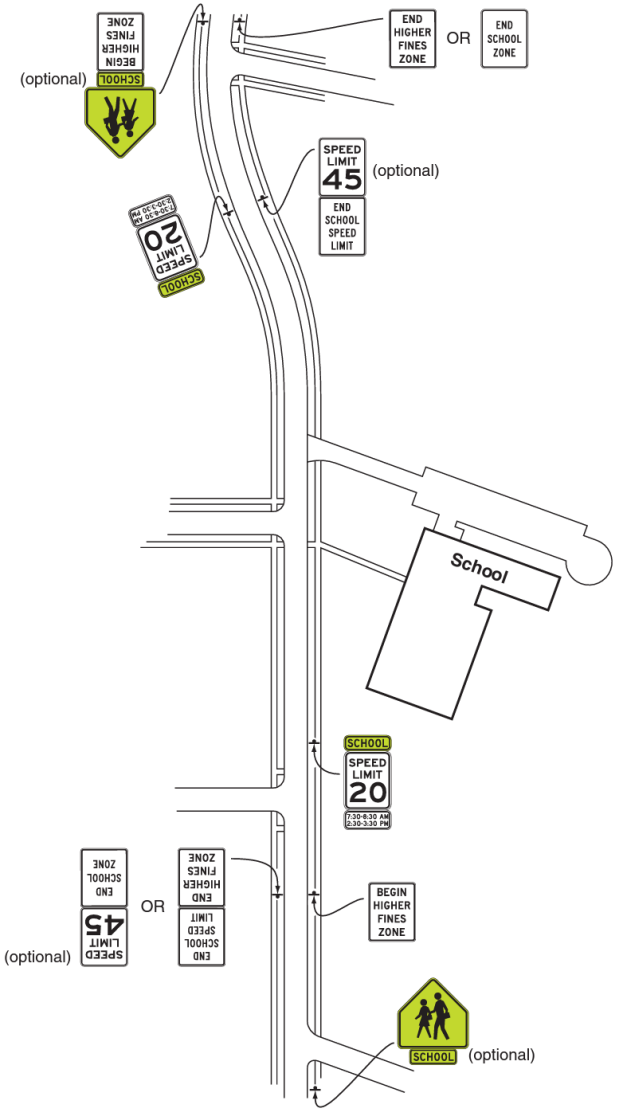


Figure 7B-3. Example of Signing for a Higher Fines School Zone with a School Speed Limit



School Sign Locations

Figure 7B-4. Example of Signing for a School Crossing Outside of a School Zone

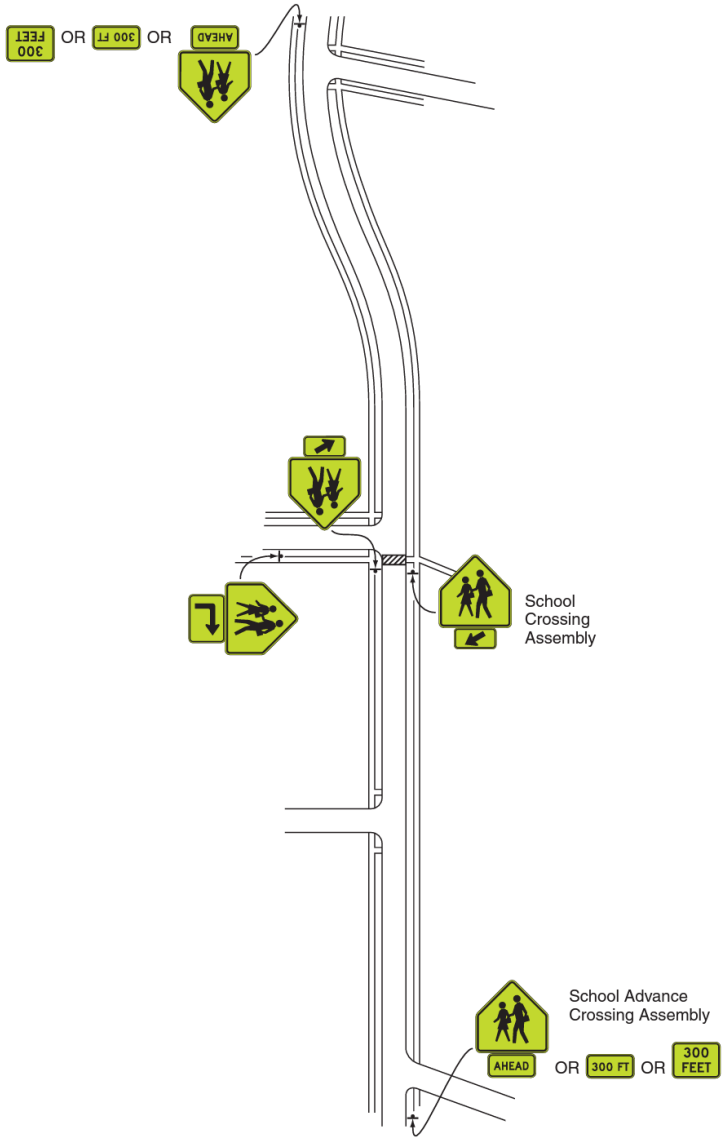
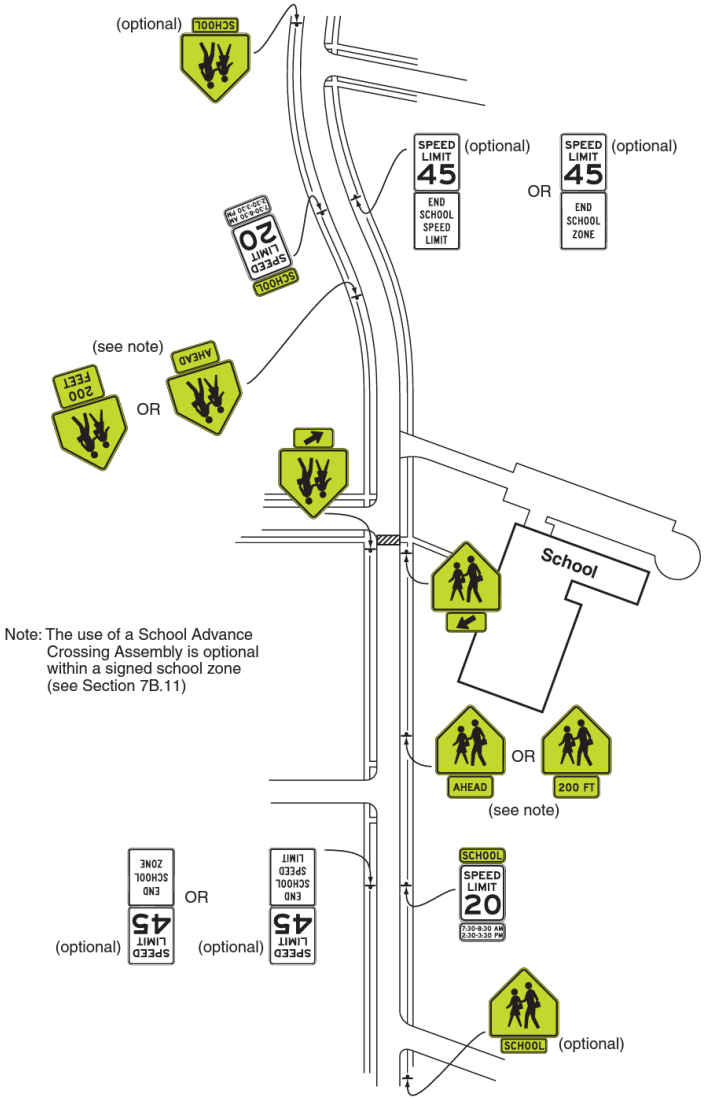


Figure 7B-5. Example of Signing for a School Zone with a School Speed Limit and a School Crossing



Preferential and Managed Lane Signs

Preferential and Managed Lane Signs

Advancing the Future of Public Safety

Purpose:

- Signaling lanes designated for special traffic uses such as high-occupancy vehicles (HOVs), light rail, buses, taxis, or bicycles.

Size:

Sign or Plaque	Sign Designation	Section	Conventional Road		Expressway	Freeway	Oversized
			Single Lane	Multi-Lane			
Preferential Lane Vehicle Occupancy Definition (post-mounted)	R3-10,10a	2G.04	30 x 42	30 x 42	36 x 60	78 x 96	78 x 96
Preferential Lane Periods of Operation (post-mounted)	R3-11 series	2G.05	30 x 42	30 x 42	36 x 60	78 x 96	78 x 96
Motorcycles Allowed (plaque)	R3-11P	2G.03	30 x 15	30 x 15	36 x 18	78 x 36	78 x 36
Preferential Lane Ahead or Ends (post-mounted)	R3-12 series	2G.06	30 x 42	30 x 42	36 x 60	48 x 84	48 x 84
Preferential Lane Vehicle Occupancy Definition (overhead)	R3-13,13a	2G.04	66 x 36	66 x 36	84 x 48	144 x 78	144 x 78
HOV Lane Periods of Operation (overhead)	R3-14,14a,14b	2G.05	72 x 60	72 x 60	96 x 72	144 x 108	144 x 108
Preferential Lane Periods of Operation (overhead)	R3-14c	2G.05	90 x 60	90 x 60	108 x 72	156 x 102	168 x 102
HOV Lane Ahead (overhead)	R3-15	2G.06	66 x 36	66 x 36	84 x 48	102 x 60	102 x 60
HOV Lane Begins XX Miles (overhead)	R3-15a	2G.06	78 x 42	78 x 42	102 x 54	132 x 72	132 x 72
HOV Lane Ends (overhead)	R3-15b,15c	2G.07	66 x 36	66 x 36	84 x 48	102 x 60	102 x 60
Preferential Lane Ahead or Ends (overhead)	R3-15d,15e	2G.07	42 x 36	42 x 36	54 x 48	72 x 60	72 x 60
Priced Managed Lane Vehicle Occupancy Definition (post-mounted)	R3-40	2G.17	—	—	54 x 66	54 x 66	66 x 78
Priced Managed Lane Ends (post-mounted)	R3-42,42b	2G.17	—	—	48 x 60	48 x 60	60 x 78
Priced Managed Lane Ends Advance (post-mounted)	R3-42a,42c	2G.17	—	—	48 x 66	48 x 66	60 x 84
Priced Managed Lane Vehicle Occupancy Definition	R3-43	2G.17	—	—	138 x 66	138 x 66	—
Priced Managed Lane Periods of Operation (overhead)	R3-44	2G.17	—	—	90 x 84	90 x 84	—
Priced Managed Lane Periods of Operation (overhead)	R3-44a	2G.17	—	—	132 x 84	132 x 84	—
Priced Managed Lane Ends (overhead)	R3-45	2G.17	—	—	90 x 66	90 x 66	—
Priced Managed Lane Ends (overhead)	R3-45a	2G.17	—	—	114 x 66	114 x 66	—
Priced Managed Lane Toll Rate	R3-48	2G.17	—	—	Varies	Varies	—
Priced Managed Lane Toll Rate	R3-48a	2G.17	—	—	Varies	Varies	—
HOV (plaque)	W16-11P	2G.09	24 x 12	24 x 12	30 x 18	30 x 18	30 x 18
Preferential Lane Entrance Gore	E8-1	2G.10	—	—	48 x 96	48 x 96	—
Preferential Lane Intermediate Entrance Gore	E8-1a	2G.10	—	—	48 x 84	48 x 84	—
Preferential Lane Entrance Direction (overhead)	E8-2	2G.11	—	—	222 x 72	222 x 72	—
Preferential Lane Entrance Direction (post-mounted)	E8-2a	2G.11	—	—	186 x 108	186 x 108	—
Preferential Lane Entrance Advance	E8-3	2G.11	—	—	186 x 96	186 x 96	—
Preferential Lane Direct Exit Gore	E8-4	2G.15	—	—	60 x 78	60 x 78	—
Preferential Lane Intermediate Egress Direction	E8-5	2G.13	—	—	Varies x 90	Varies x 90	—
Preferential Lane Intermediate Egress Advance	E8-6	2G.13	—	—	Varies x 84	Varies x 84	—

Preferential Lane Advance Regulatory Sign Example

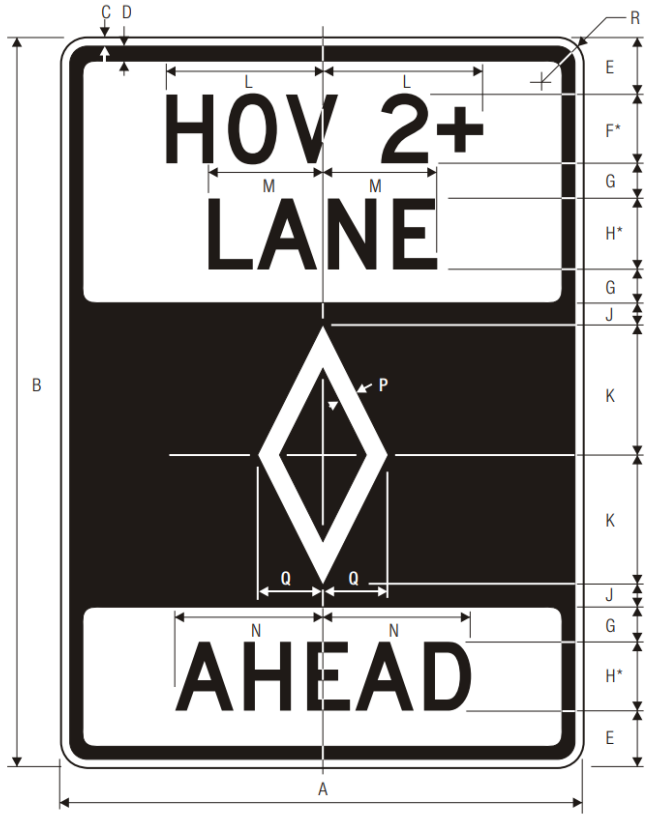
Advancing the Future of Public Safety

Use:

- Warns road users of special lanes ahead.

Color:

- Legend: White on Black
- Symbol: White on Black
- Background: White (retroreflective)



C	A	B	C	D	E	F	G	H	J	K	L	M
	30	42	.5	.75	3	4 D	2	4 D	1.5	7.5	9.187	6.424
	36	60	.625	.875	4	6 D	3	6 D	2.5	10	13.781	9.636
	48	84	.75	1.25	5	8 D	4	8 D	4	15	18.374	12.848

N	P	Q	R
8.57	1.125	3.75	1.875
12.855	1.5	5	2.25
17.14	2.25	7.5	3

COLORS: LEGEND – BLACK
SYMBOL – WHITE (RETROREFLECTIVE) ON BLACK
BACKGROUND – WHITE (RETROREFLECTIVE)

Guide Signs for Direct Entrances to Preferential Lanes from Another Highway

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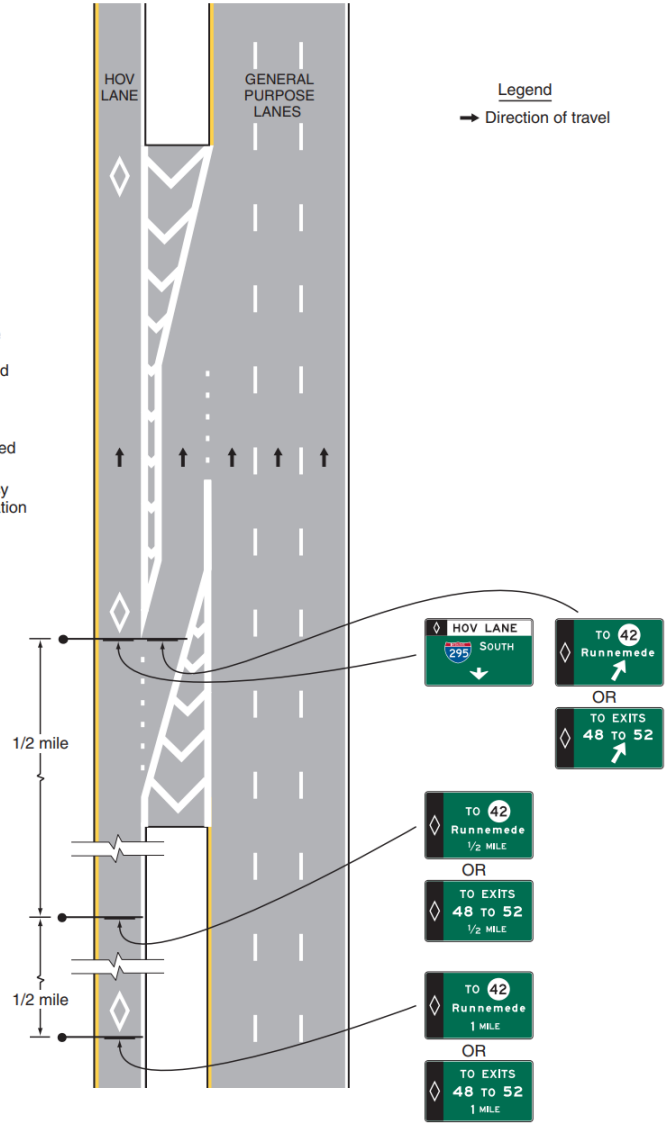
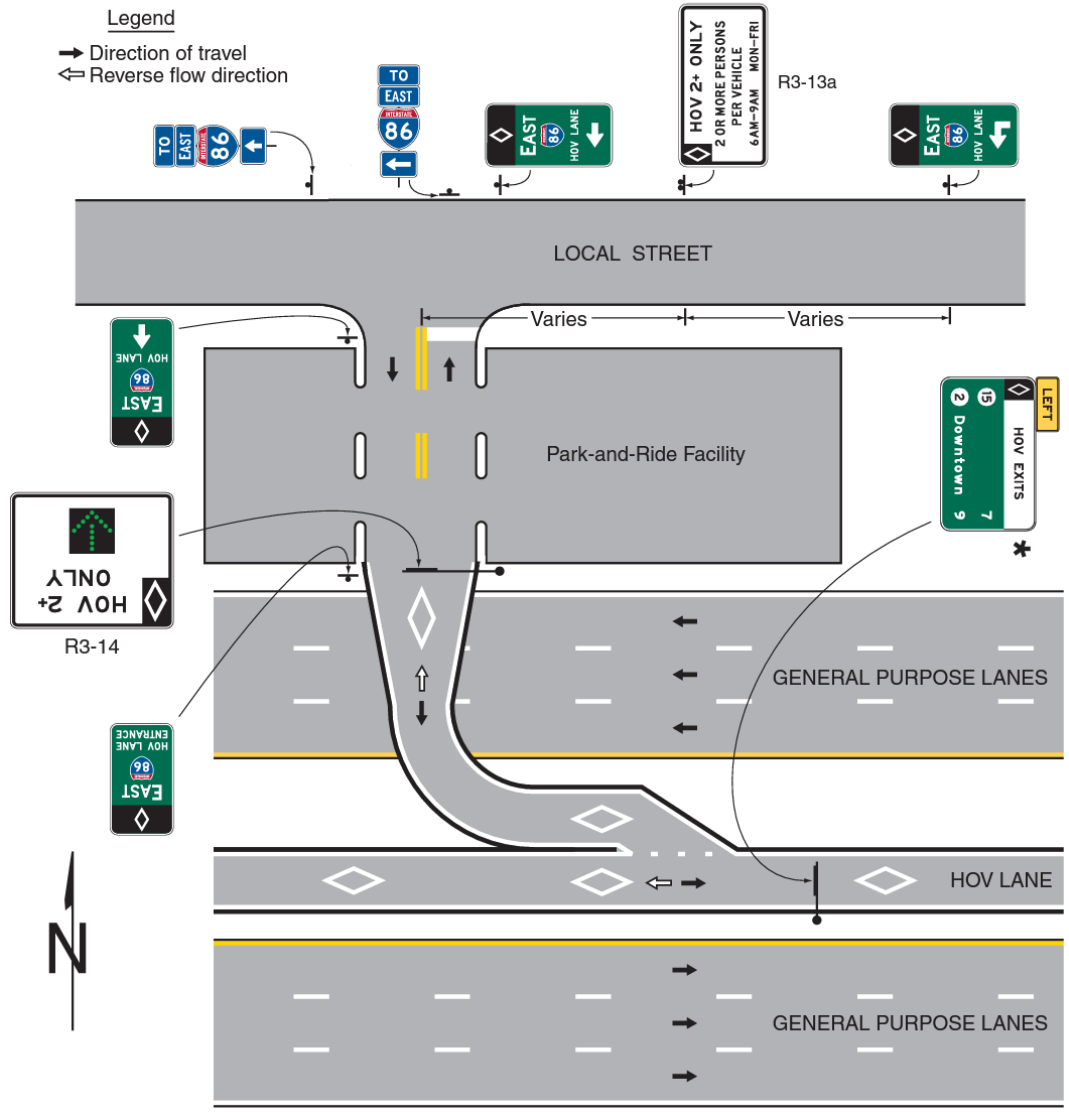
Figure 2G-12. Examples of Signs for an Intermediate Egress from a Barrier- or Buffer-Separated HOV Lane



Notes:

1. For an exit on the left-hand side from an HOV lane, the same signing sequence would be used with adjustments made to sign messages
2. Geometry is for illustrative purposes only; use locally applied geometric criteria
3. The minimum vehicle occupancy requirement and hours of operation on the sign may vary for each facility
4. See Sections Chapter 3D for pavement markings
5. Warning signs are not shown

Figure 2G-13. Example of Signing for a Direct Entrance Ramp to an HOV Lane from a Park-and-Ride Facility and a Local Street



General Information Signs

General Information Signs

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Purpose:

- General information signs contain information that is of interest, but not directly related to, driving. These can include city limits, landmarks, time zones, etc.

Color:

Background: Green

Symbol: White

Sign	Sign Designation	Section	Conventional Road	Freeway or Expressway
Reference Location (1 digit)	D10-1	2H.05	10 x 18	12 x 24
Intermediate Reference Location (2 digits)	D10-1a	2H.05	10 x 27	12 x 36
Reference Location (2 digits)	D10-2	2H.05	10 x 27	12 x 36
Intermediate Reference Location (3 digits)	D10-2a	2H.05	10 x 36	12 x 48
Reference Location (3 digits)	D10-3	2H.05	10 x 36	12 x 48
Intermediate Reference Location (4 digits)	D10-3a	2H.05	10 x 48	12 x 60
Enhanced Reference Location	D10-4	2H.06	18 x 54	18 x 54
Intermediate Enhanced Reference Location	D10-5	2H.06	18 x 60	18 x 60
Acknowledgement	D14-1	2H.08	36 x 30*	72 x 48*
Acknowledgement	D14-2	2H.08	36 x 30*	72 x 48*
Acknowledgement	D14-3	2H.08	42 x 24*	96 x 36*
Signals Set for XX MPH	I1-1	2H.03	24 x 36	—
Jurisdictional Boundary	I-2	2H.04	Varies x 18**	Varies x 36**
Geographical Features	I-3	2H.04	Varies x 18**	Varies x 36**
Airport	I-5	2H.02	24 x 24	30 x 30
Bus Station	I-6	2H.02	24 x 24	30 x 30
Train Station	I-7	2H.02	24 x 24	30 x 30
Library	I-8	2H.02	24 x 24	30 x 30
Vehicle Ferry Terminal	I-9	2H.02	24 x 24	30 x 30
Recycling Collection Center	I-11	2H.02	30 x 48	—
Light Rail Transit Station	I-12	2H.02	24 x 24	—

Example: Traffic Signal Speed Sign

Use:

- Indicates a section of street where the traffic control signals are coordinated into a progressive system timed for a specified speed at all hours during which they are operated in a coordinated mode.

Color:

- Symbol: White
- Background: Green

General Service Signs

General Service Signs

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Purpose:

- General information signs contain information that is of interest, but not directly related to, driving. These can include city limits, landmarks, time zones, etc.

Color:

- Background: Blue
- Symbol: White

Size:

Sign or Plaque	Sign Designation	Section	Conventional Road	Freeway or Expressway
Rest Area XX Miles	D5-1	2I.05	66 x 36*	96 x 54*
Rest Area Next Right	D5-1a	2I.05	78 x 36*	120 x 60* (F) 114 x 48* (E)
Rest Area (with arrow)	D5-2	2I.05	66 x 36*	96 x 54*
Rest Area Gore	D5-2a	2I.05	42 x 48*	78 x 78* (F) 66 x 72* (E)
Rest Area (with horizontal arrow)	D5-5	2I.05	42 x 48*	—
Next Rest Area XX Miles	D5-6	2I.05	60 x 48*	90 x 72*
Rest Area Tourist Info Center XX Miles	D5-7	2I.08	90 x 72*	114 x 102* (F) 132 x 96* (E)
Rest Area Tourist Info Center (with arrow)	D5-8	2I.08	84 x 72*	120 x 102* (F)

Figure 2I-1. General Service Signs and Plaques

General Service Sign Example

Use:

- Indicates when a hospital is nearby.

Color:

- Symbol: White
- Background: Blue

Tourist-Oriented Directional Signs

Tourist-Oriented Directional Signs

Purpose:

- Tourist-oriented directional signs are guide signs with one or more sign panels that display the business identification of and directional information for eligible business, service, and activity facilities.

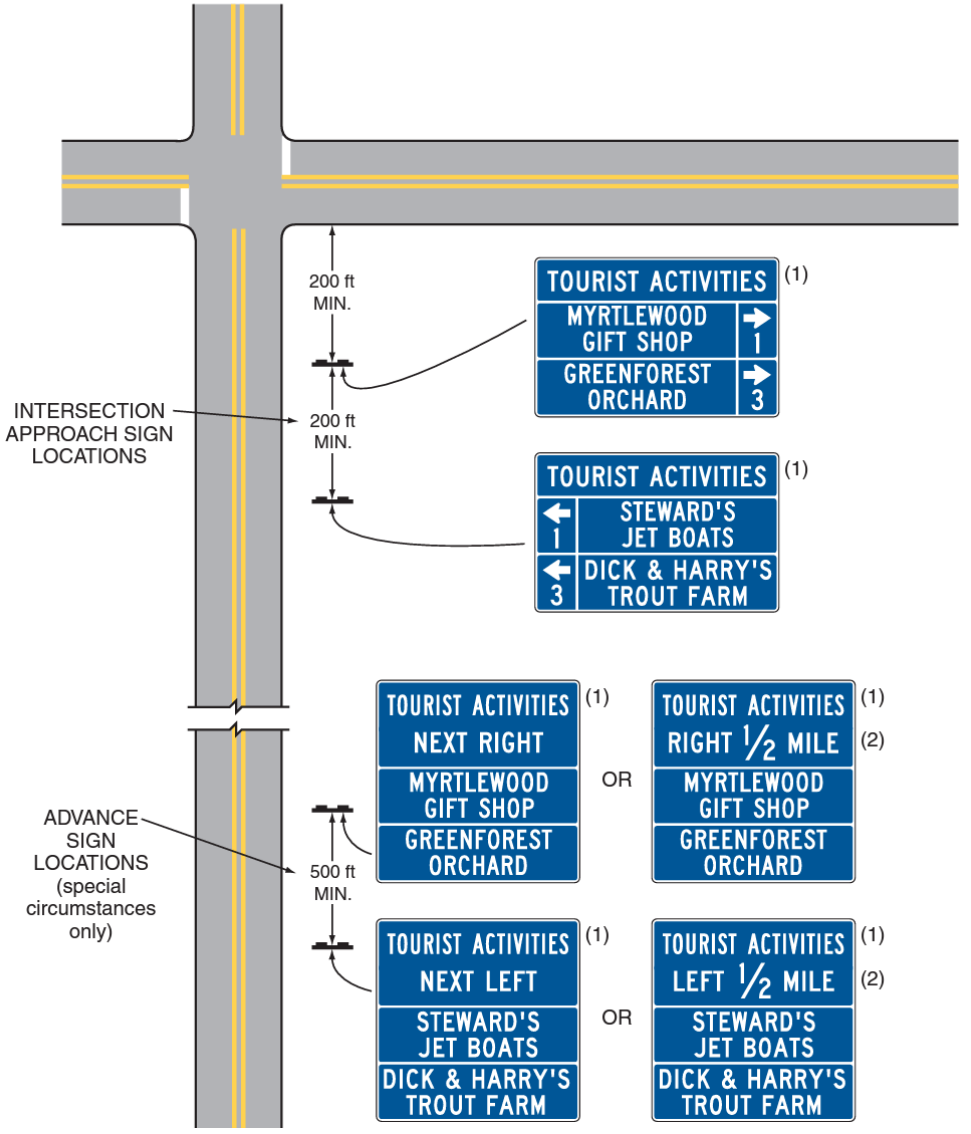
Color:

- Background: Blue
- Symbol: White

Size:

- Maximum height of 6 feet.
- The location of other traffic control devices shall take precedence over the location of tourist-oriented directional signs.

Figure 2K-2. Examples of Intersection Approach Signs and Advance Signs for Tourist-Oriented Directional Signs



Changeable Message Signs

Changeable Message Signs (CMS)

Definition:

- A changeable message sign (CMS) is a traffic control device that is capable of displaying one or more alternative messages.

Purpose:

- Incident management and route diversion
- Warning of adverse weather conditions
- Special event applications
- Control at crossing situations
- Lane, ramp, and roadway control
- Priced or other types of managed lanes
- Travel times
- Warning situations
- Traffic regulations
- Speed control
- Destination guidance

Recreational and Cultural Interest Area Signs

Recreational and Cultural Interest Area Signs

Types:

- Symbol Signs
- Destination Guide Signs

Purpose:

- Recreational or cultural interest areas are attractions or traffic generators that are open to the general public for the purpose of play, amusement, or relaxation.

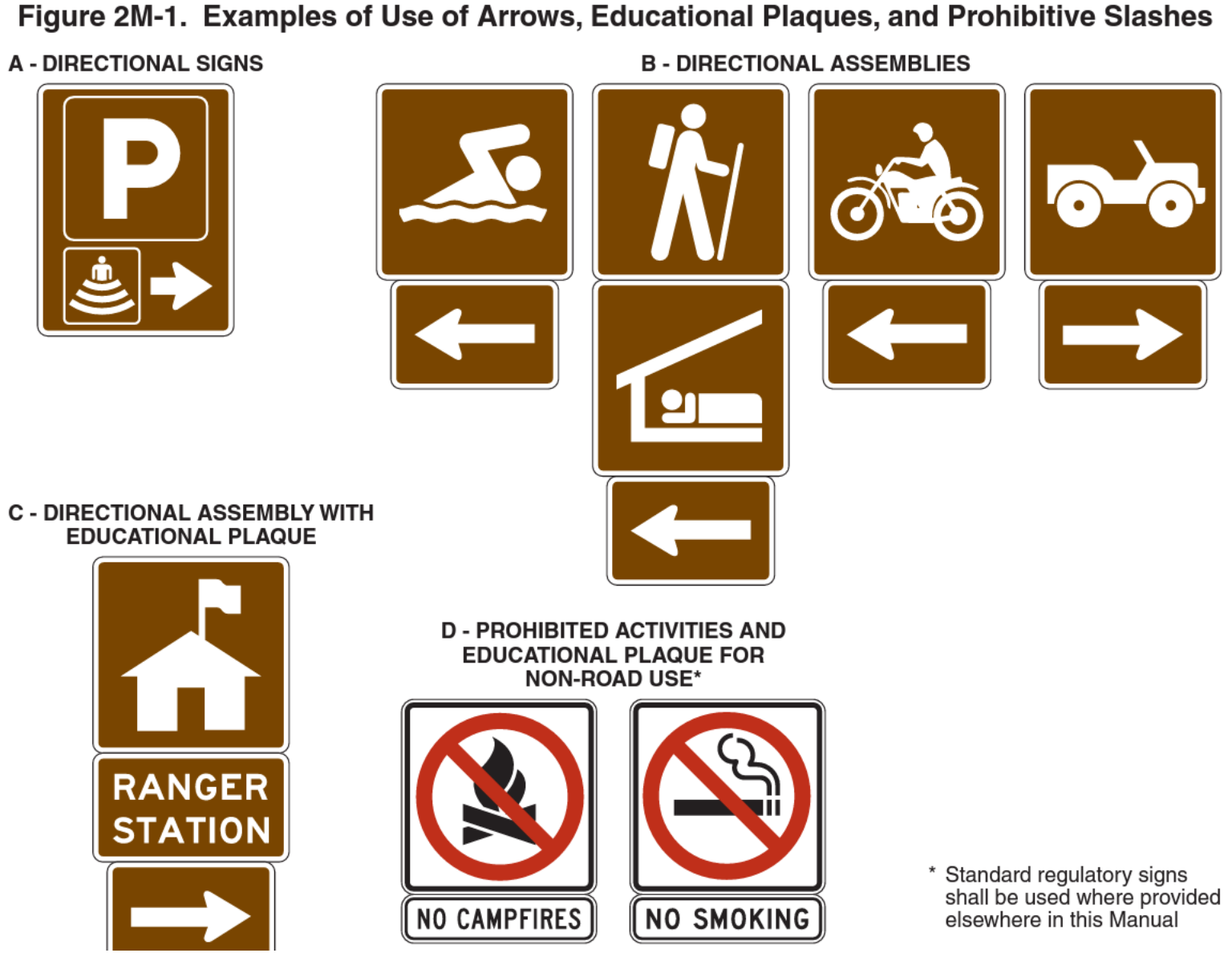
Recreational and Cultural Interest Area Signs Symbol Signs

Purpose:

- General applications
- Accommodations
- Services
- Land recreation
- Water recreation
- Winter recreation

Design:

- Square or rectangular
- White symbol or message and white boarder on a brown background



Recreational and Cultural Interest Area Signs
Destination Guide Signs

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Purpose:

- Identifies recreational or cultural interest areas or facilities.

Design:

- Trapezoidal or rectangular
- White symbol or message and white border on a brown background

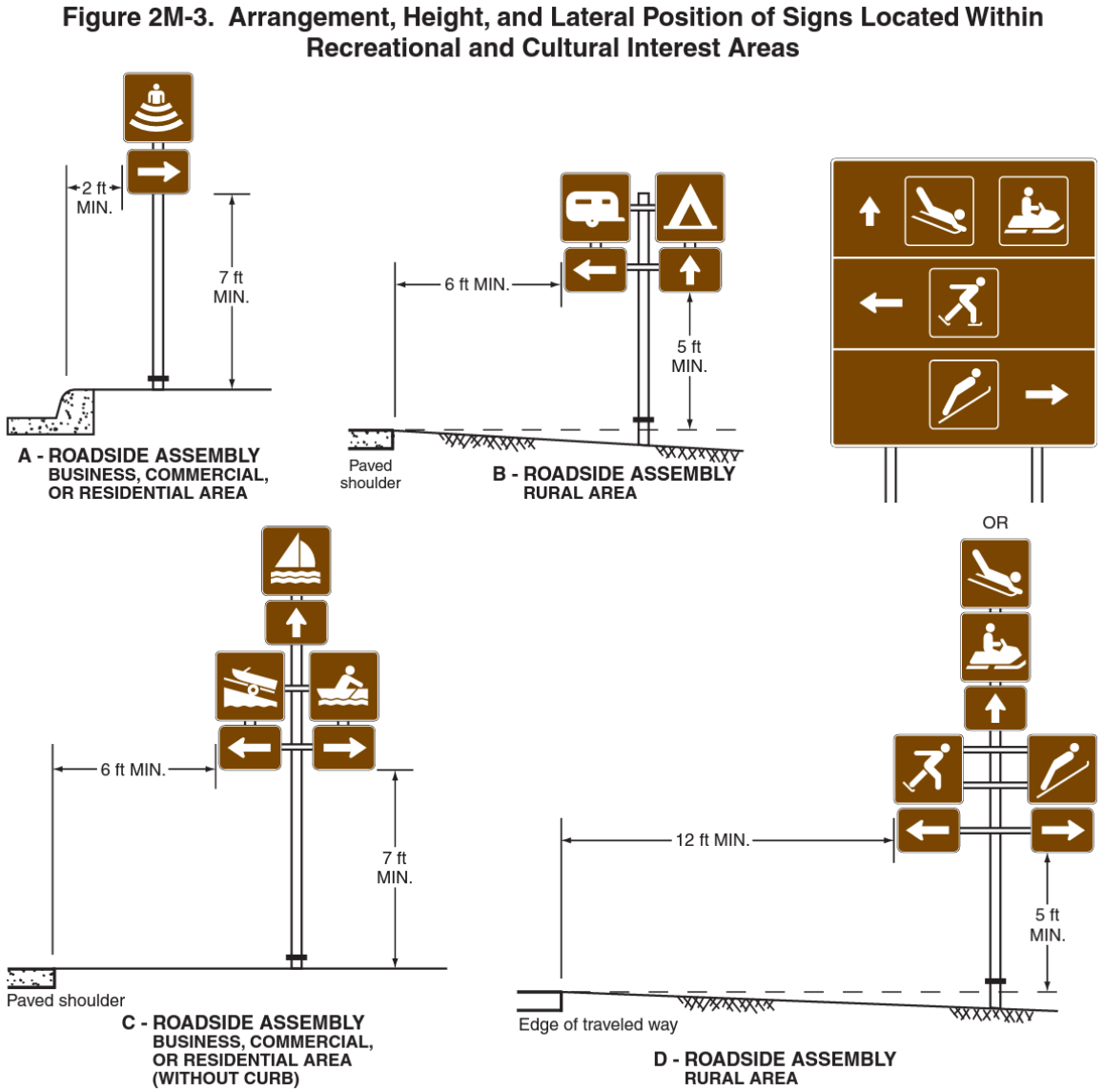

Figure 2M-3. Arrangement, Height, and Lateral Position of Signs Located Within Recreational and Cultural Interest Areas

Use of Educational Plaques

Purpose:

- Educational plaques should accompany all initial installations of recreational and cultural interest area symbol signs.

Design:

- Trapezoidal or rectangular
- White symbol or message and white border on a brown background

Use of Prohibitive Circle and Diagonal Slash for Non-Road Applications

Purpose:

- Indicates a prohibition of an activity or an item within a recreational or cultural interest area.

Design:

- Rectangular
- Black & Red symbol or message on a white background

Emergency Management Signing

Emergency Management Signing

Purpose:

- To guide and control highway traffic during an emergency.

Design:

- Rectangular
- White retroreflective background

EM-7b

Evacuation Route Signs

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Design:

- Rectangular
- Blue circular symbol on a white square sign

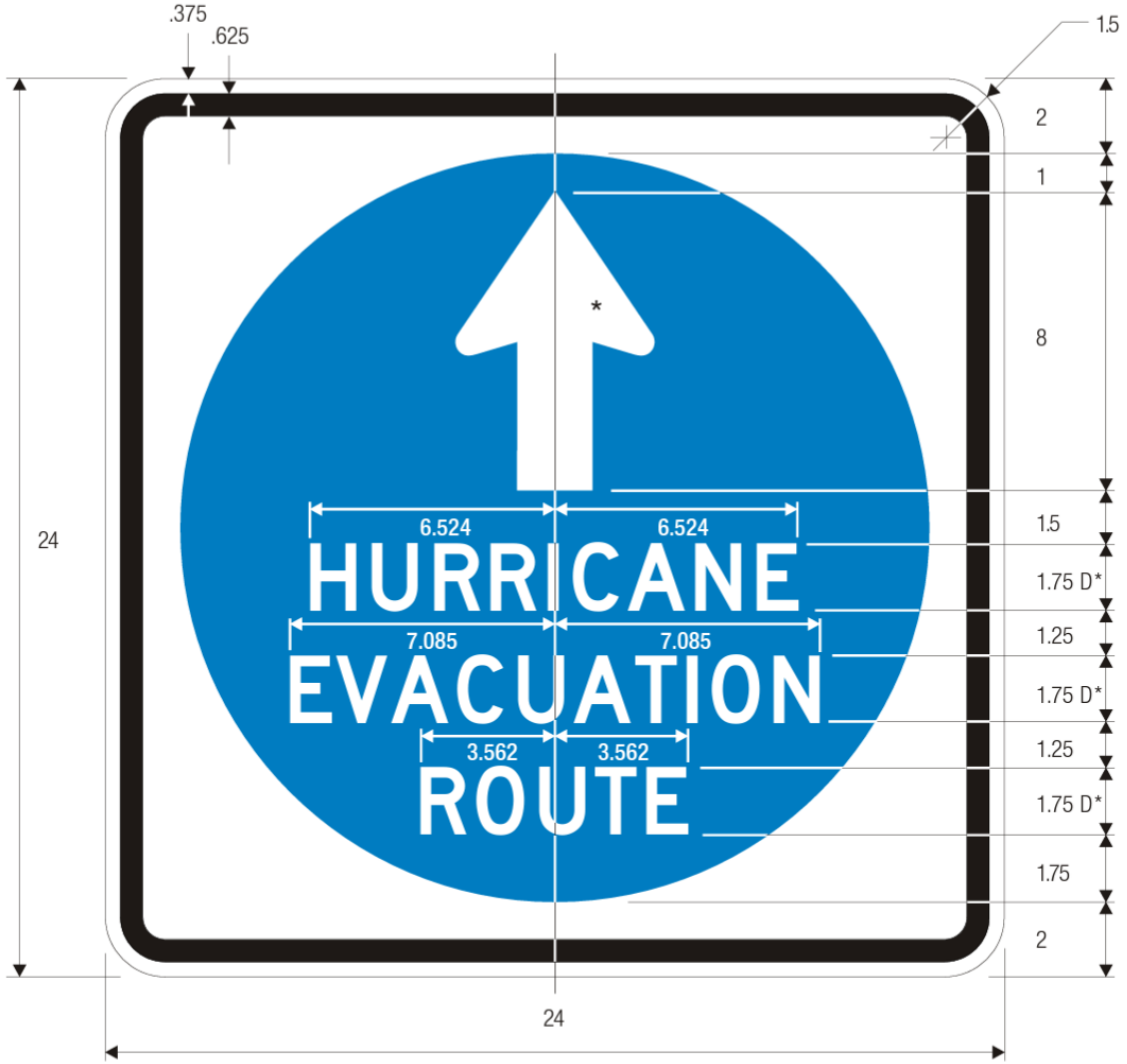
Size:

Table 2N-1. Emergency Management Sign Sizes

Sign or Plaque	Sign Designation	Section	Minimum Size
Evacuation Route	EM-1,EM-1a	2N.03	24 x 24*
Area Closed	EM-2	2N.04	30 x 24
Traffic Control Point	EM-3	2N.05	30 x 24
Maintain Top Safe Speed	EM-4	2N.06	24 x 30
Permit Required	EM-5	2N.07	24 x 30
Emergency Aid Center	EM-6a to EM-6d	2N.08	30 x 24
Shelter Directional	EM-7a to EM-7d	2N.09	30 x 24

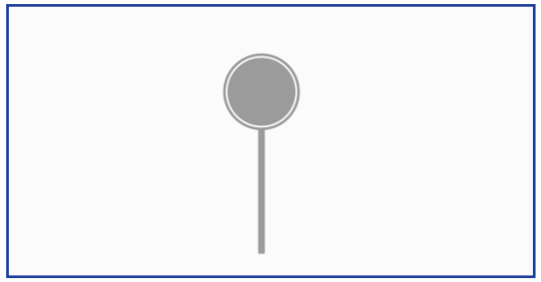
* A minimum size of 18 x 18 may be used on low-volume roadways or roadways with speeds of 25 mph or less

Notes: 1. Larger signs may be used when appropriate
2. Dimensions in inches are shown as width x height



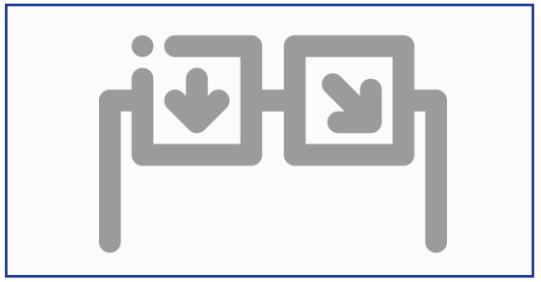
EM-1

Lesson Summary

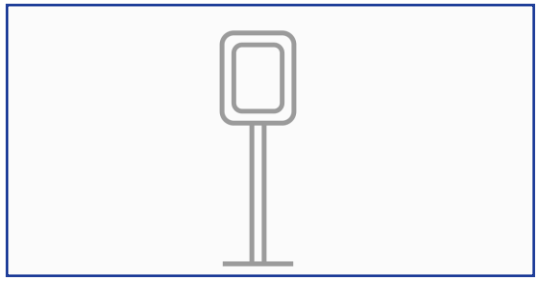


Common Guide Signs

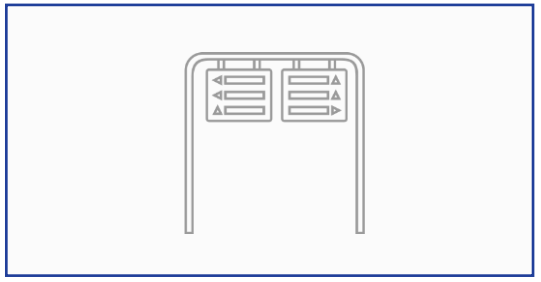
School Signs



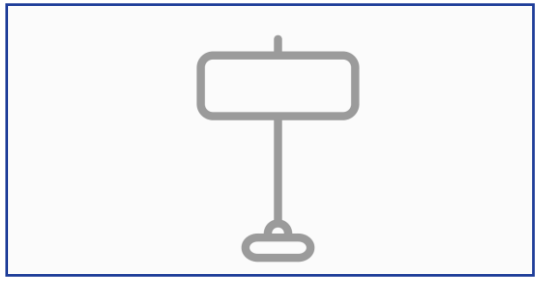
Preferential and Managed Lane Signs



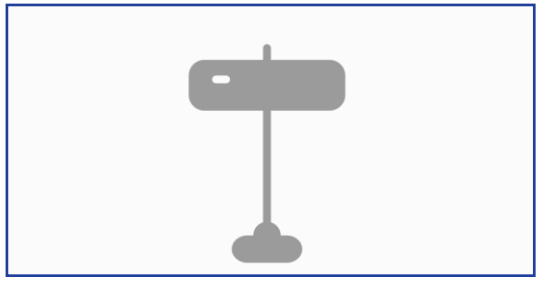
General Information Signs



General Service Signs

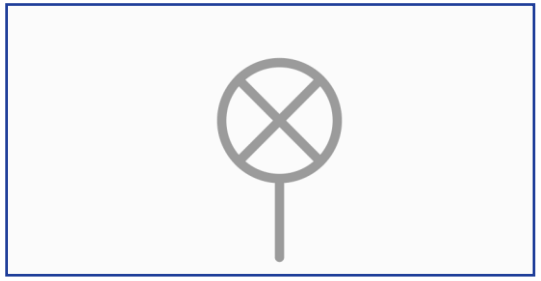


Tourist-Oriented Directional Signs



Changeable Message Signs

Recreational and Cultural Interest Area Signs



Emergency Management Signing

Signs & Markings

Lesson 5: Making a Sign

Advancing the Future of Public Safety

Lesson Introduction

Sign Design

Creating the Sign

Placement & Location

Sign Design

Creating a Sign Overview

Request for a new sign:

- Traffic engineer will conduct a study to see if you should proceed with the sign.
- They may check the jurisdiction's approval or conduct a traffic warrant study to see if the sign is necessary.

Spacing:

- Look at location for the sign.
- Check the spacing - offset & lateral.

Sign fabrication:

- Follow the template for the sign.
- Use the design rules already covered.

Install the sign:

- There are different methods of installation: hydrovac, direct driving, concrete inset (HV), and direct burial (HV). Your agency will have a set of standards to use.
- Make sure the sign is level and to height, the proper distance off of roadway, and oriented correctly for road user.
- Meets MUTCD guidelines & standards, not put up improperly.

Design of Signs

The goal of all signs is:

- High visibility
- High legibility

When designing a sign, you need to consider:

- Retroreflectivity
- Shape
- Color
- Dimensions
- Symbols
- Word messages
- Sign borders

Retroreflectivity and Illumination

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Standards:

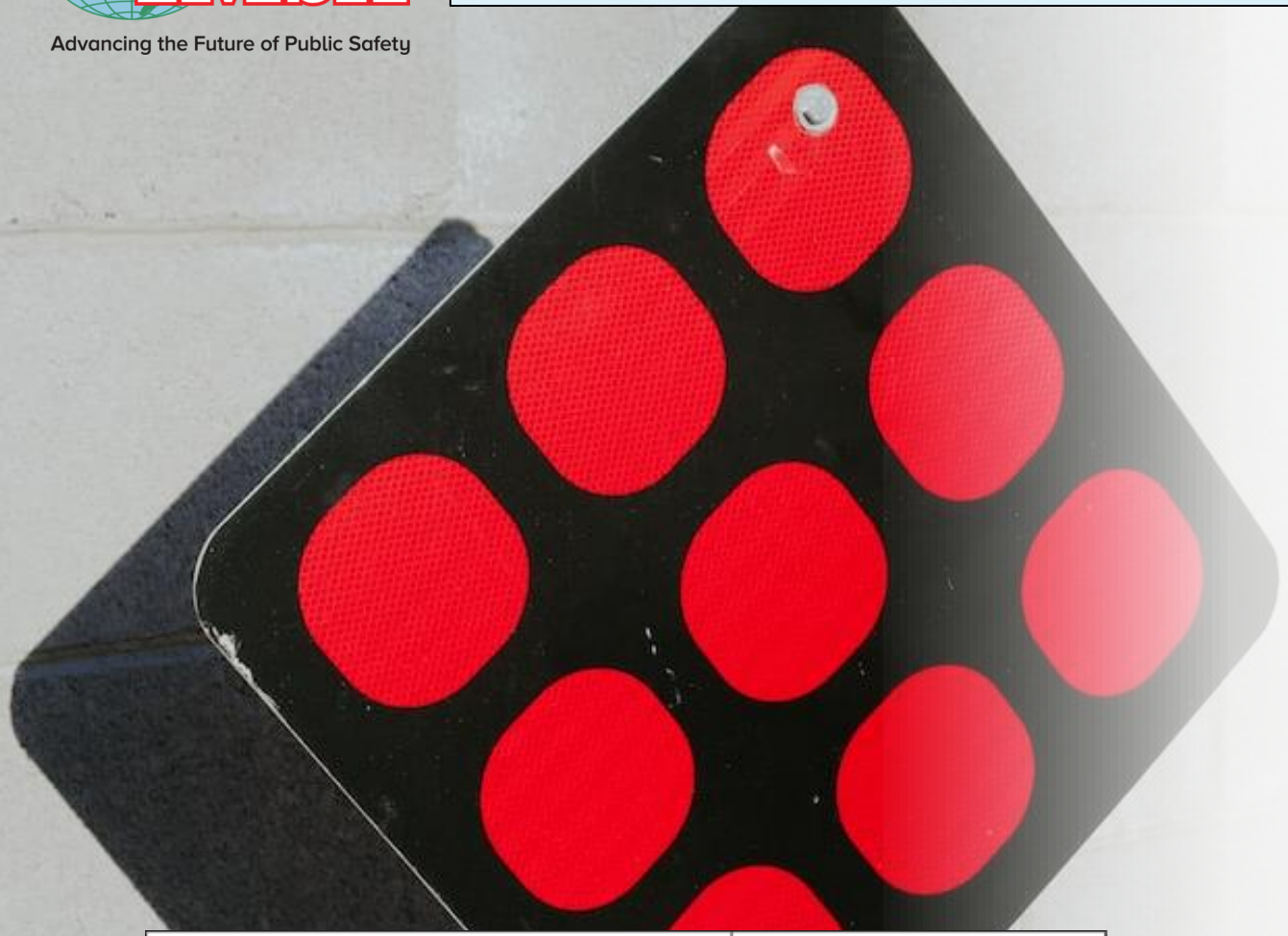
- Regulatory, warning, and guide signs and object markers must be retroreflective or illuminated.
- You must be able to see the same shape and similar color both day and night.

Illumination:

- Street or highway lighting is NOT enough.

Means of Illumination	Sign Element to be Illuminated
Light behind the sign face	• Symbol or word message • Background • Symbol, word message, and background (through a translucent material)
Attached or independently mounted light source designed to direct essentially uniform illumination onto the sign face	• Entire sign face
Light emitting diodes (LEDs)	• Symbol or word message • Portions of the sign border
Other devices, or treatments that highlight the sign shape, color, or message: Luminous tubing Fiber optics Incandescent light bulbs Luminescent panels	• Symbol or word message • Entire sign face

Retroreflectivity



Means of Retroreflection	Sign Element
Reflector “buttons” or similar units	Symbol Word message Border
A material that has a smooth, sealed outer surface over a microstructure that reflects light	Symbol Word message Border Background

Definition:

- Retroreflectivity is the ability of a material to reflect light back to its source, allowing it to be visible at night or low-light conditions.

Purpose:

- Road signs with retroreflective properties provide enhanced visibility and safety to drivers, pedestrians, and other road users.

Maintenance:

- The retroreflective performance of road signs decreases over time due to weathering, dirt, and other factors.

Retroreflective Materials

What determines retroreflectivity:

- The size and refractive index of the glass beads, as well as the thickness and type of reflective sheeting, determine the level of retroreflectivity in the sign.

The two primary materials used to make retroreflective road signs are:

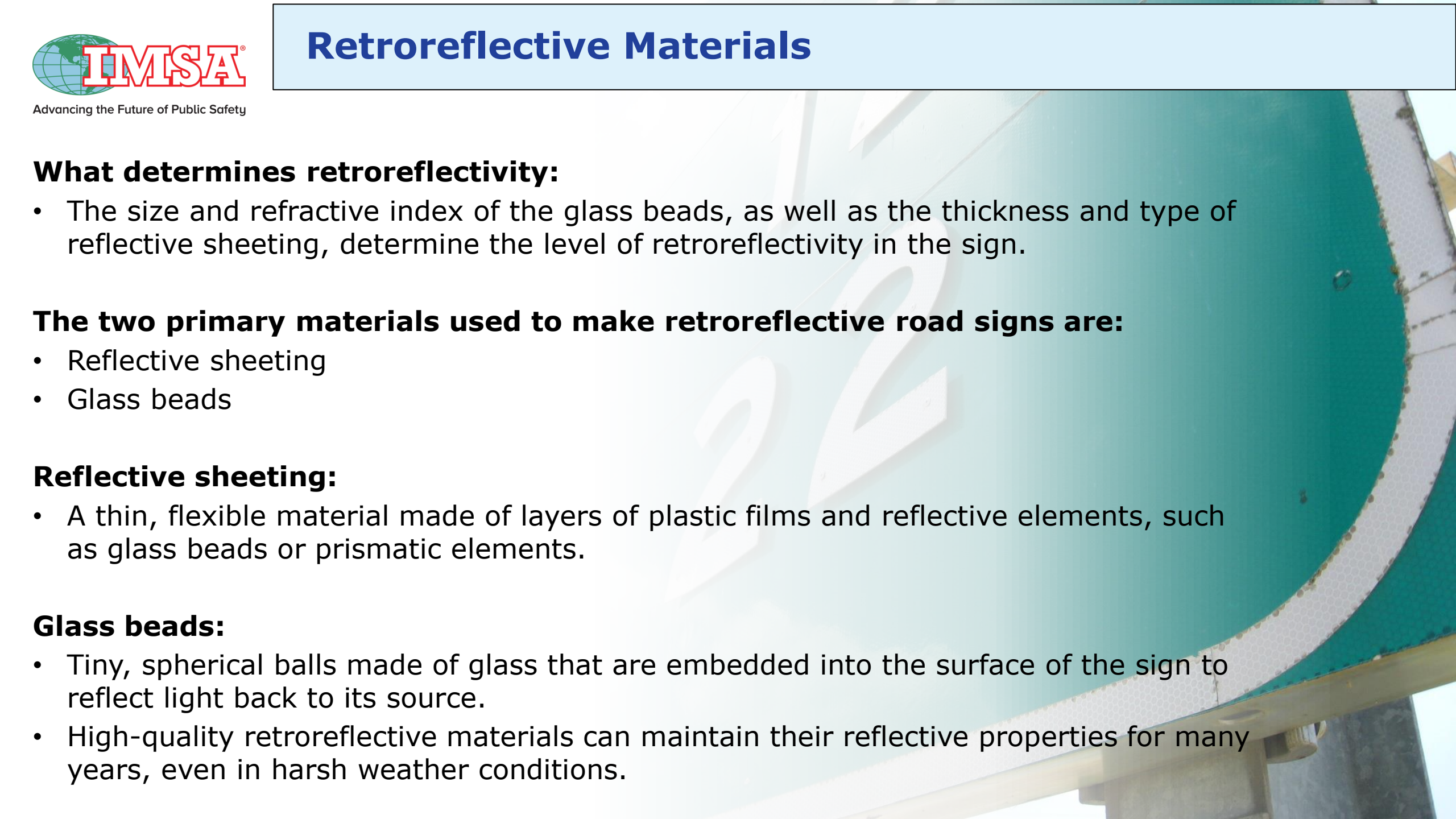
- Reflective sheeting
- Glass beads

Reflective sheeting:

- A thin, flexible material made of layers of plastic films and reflective elements, such as glass beads or prismatic elements.

Glass beads:

- Tiny, spherical balls made of glass that are embedded into the surface of the sign to reflect light back to its source.
- High-quality retroreflective materials can maintain their reflective properties for many years, even in harsh weather conditions.



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Minimum Retroreflectivity

Minimum Retroreflectivity

- The Federal Highway Administration (FHWA) mandates that all traffic signs must meet minimum retroreflectivity standards to ensure adequate visibility.
- See this table to check the sheeting type needed for different sign colors.

Assessing Retroreflectivity:

- Visual nighttime inspection
- Measured sign retroreflectivity
- Expected sign life
- Blanket replacement
- Control signs

Sign Color	Sheeting Type (ASTM D4956-04)				Additional Criteria
	Beaded Sheeting			Prismatic Sheeting	
	I	II	III	III, IV, VI, VII, VIII, IX, X	
White on Green	W*; G ≥ 7	W*; G ≥ 15	W*; G ≥ 25	W ≥ 250; G ≥ 25	Overhead
	W*; G ≥ 7	W ≥ 120; G ≥ 15			Post-mounted
Black on Yellow or Black on Orange	Y*; O*	Y ≥ 50; O ≥ 50			[2]
	Y*; O*	Y ≥ 75; O ≥ 75			[3]
White on Red	W ≥ 35; R ≥ 7				[4]
Black on White	W ≥ 50				–

[1] The minimum maintained retroreflectivity levels shown in this table are in units of cd/lx/m^2 measured at an observation angle of 0.2° and an entrance angle of -4.0°.
[2] For text and fine symbol signs measuring at least 48 inches and for all sizes of bold symbol signs
[3] For text and fine symbol signs measuring less than 48 inches
[4] Minimum sign contrast ratio ≥ 3:1 (white retroreflectivity ÷ red retroreflectivity)
* This sheeting type shall not be used for this color for this application.

Bold Symbol Signs

- W1-1,2 – Turn and Curve
- W1-3,4 – Reverse Turn and Curve
- W1-5 – Winding Road
- W1-6,7 – Large Arrow
- W1-8 – Chevron
- W1-10 – Intersection in Curve
- W1-11 – Hairpin Curve
- W1-15 – 270 Degree Loop
- W2-1 – Cross Road
- W2-2,3 – Side Road
- W2-4,5 – T and Y Intersection
- W2-6 – Circular Intersection
- W2-7,8 – Double Side Roads
- W3-1 – Stop Ahead
- W3-2 – Yield Ahead
- W3-3 – Signal Ahead
- W4-1 – Merge
- W4-2 – Lane Ends
- W4-3 – Added Lane
- W4-5 – Entering Roadway Merge
- W4-6 – Entering Roadway Added Lane
- W6-1,2 – Divided Highway Begins and Ends
- W6-3 – Two-Way Traffic
- W10-1,2,3,4,11,12 – Grade Crossing Advance Warning
- W11-2 – Pedestrian Crossing
- W11-3,4,16-22 – Large Animals
- W11-5 – Farm Equipment
- W11-6 – Snowmobile Crossing
- W11-7 – Equestrian Crossing
- W11-8 – Fire Station
- W11-10 – Truck Crossing
- W12-1 – Double Arrow
- W16-5P,6P,7P – Pointing Arrow Plaques
- W20-7 – Flagger
- W21-1 – Worker

Fine Symbol Signs (symbol signs not listed as bold symbol signs)

Special Cases

- W3-1 – Stop Ahead: Red retroreflectivity ≥ 7
- W3-2 – Yield Ahead: Red retroreflectivity ≥ 7; White retroreflectivity ≥ 35
- W3-3 – Signal Ahead: Red retroreflectivity ≥ 7; Green retroreflectivity ≥ 7
- W3-5 – Speed Reduction: White retroreflectivity ≥ 50
- For non-diamond shaped signs, such as W14-3 (No Passing Zone), W4-4P (Cross Traffic Does Not Stop), or W13-1P,2,3,6,7 (Speed Advisory Plaques), use the largest sign dimension to determine the proper minimum retroreflectivity level.

Knowledge Check: Shapes

Based on the previous lessons, name an example sign for each shape:

Shape	Signs
Octagon	
Equilateral Triangle (1 point down)	
Circle	
Pennant Shape/Isosceles Triangle (longer axis horizontal)	
Pentagon (pointed up)	
Crossbuck (two rectangles in an "X" configuration)	
Diamond	
Rectangle (including square)	
Trapezoid	

Particular shapes, as shown in this table, shall be used exclusively for specific signs or series of signs, unless otherwise provided in the text discussion in the MUTCD for a particular sign or class of signs.

Knowledge Check Answers: Shapes

Based on the previous lessons, name an example sign for each shape:

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

Particular shapes, as shown in this table, shall be used exclusively for specific signs or series of signs, unless otherwise provided in the text discussion in this Manual for a particular sign or class of signs.

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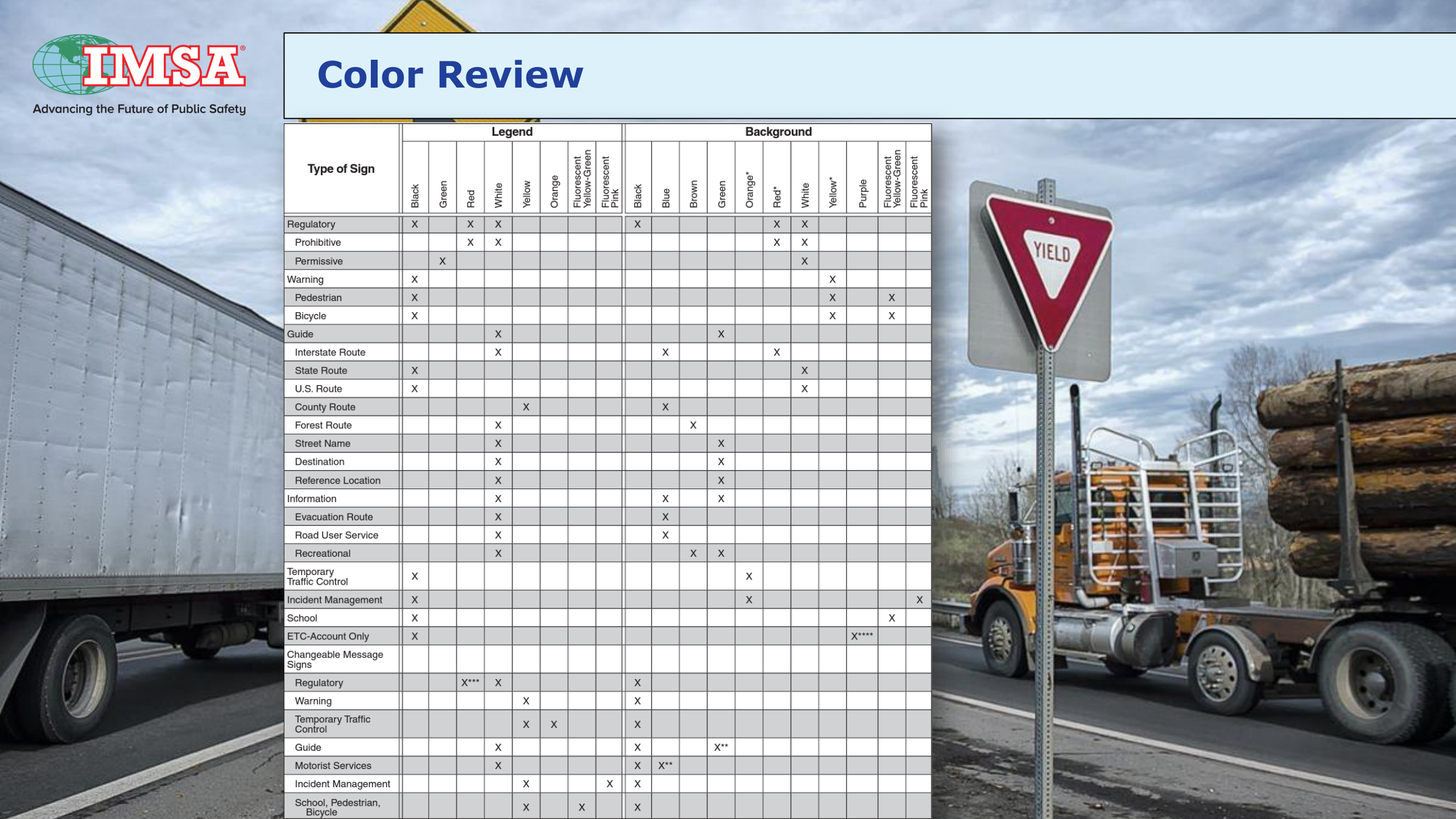
Color Review

Type of Sign	Legend								Background										
	Black	Green	Red	White	Yellow	Orange	Fluorescent Yellow-Green	Fluorescent Pink	Black	Blue	Brown	Green	Orange*	Red*	White	Yellow*	Purple	Fluorescent Yellow-Green	Fluorescent Pink
Regulatory	X		X	X					X					X	X				
Prohibitive			X	X										X	X				
Permissive		X													X				
Warning	X															X			
Pedestrian	X															X		X	
Bicycle	X															X		X	
Guide				X								X							
Interstate Route				X						X				X					
State Route	X														X				
U.S. Route	X														X				
County Route					X					X									
Forest Route				X							X								
Street Name				X								X							
Destination				X								X							
Reference Location				X								X							
Information				X						X		X							
Evacuation Route				X						X									
Road User Service				X						X									
Recreational				X							X	X							
Temporary Traffic Control	X												X						
Incident Management	X												X						X
School	X																	X	
ETC-Account Only	X																X****		
Changeable Message Signs																			
Regulatory			X***	X					X										
Warning					X				X										
Temporary Traffic Control					X	X			X										
Guide				X					X			X**							
Motorist Services				X					X	X**									
Incident Management					X			X	X										
School, Pedestrian, Bicycle					X		X		X										



Dimensions

MUTCD Size Tables:

- Regulatory signs: Page 45
- Warning signs: Page 103
- Guide signs: Page 137
- Preferential & managed lane signs: Page 253
- General information signs: Page 292
- General service signs: Page 299
- TODs: Page 323
- Recreational & cultural interest signs: Page 332
- School signs: Page 733

Sign Borders

Design:

- The border should be of the same color as the legend.
- The corners of all sign borders shall be rounded, except for STOP signs.

Location:

- A dark border on a light background should be set in from the edge.
- A light border on a dark background should extend to the edge of the sign.

Size:

- 30-inch signs with a light background: 1/2 to 3/4 inch in width, 1/2 inch from the edge
- 30-inch signs with a dark background: a width of 1 inch, 1/2 inch from the edge
- For other sizes, the border width should not exceed the stroke-width of the major lettering of the sign
- On signs exceeding 72 x 120 inches in size, the border should be 2 inches wide, or on larger signs, 3 inches wide

Sign Fabrication

Tools of the Trade

Here are some essential tools for weeding out traffic signs:

1. **Weeding Tool**: A weeding tool, also known as a weeder or a weeding hook, is a small handheld tool with a sharp point or hook-like tip. It is used to carefully lift and remove the excess vinyl material from the sign. The tool should have a comfortable grip and a precise tip to navigate around fine details.
2. **Tweezers**: Tweezers can be handy for picking up and removing small vinyl pieces or debris left behind after weeding. They provide more control when handling delicate or intricate parts of the sign.
3. **Magnifying Glass**: For intricate designs or small text, a magnifying glass or a magnifying lamp can be helpful. It allows for better visibility and precision during the weeding process.
4. **Cutting Mat**: A self-healing cutting mat is commonly used as a protective surface while weeding out the sign. It helps prevent damage to the work area and ensures clean cuts without leaving behind unwanted marks.
5. **Transfer Tape**: Masking tape is used to secure the sign design to the cutting mat, making it easier to work with and preventing any movement or misalignment during the weeding process.
6. **Vinyl Release Agen**t: In some cases, especially when working with adhesive vinyl that is difficult to weed, a vinyl release agent can be used. This agent is applied to the vinyl before weeding, making it easier to separate the excess material from the design.

Application Table

A squeeze rolling table, also known as an application table, is a specialized piece of equipment used in traffic sign fabrication for the application of vinyl films onto sign substrates. It is designed to ensure efficient and accurate placement of the vinyl film, creating a smooth and bubble-free surface. The table typically consists of a flat surface with a roller mechanism and may include additional features for improved functionality.

1. Here are some key aspects and benefits of using a squeeze rolling table or application table in traffic sign fabrication:
2. Flat and Stable Surface
3. Roller Mechanism
4. Uniform Pressure Distribution
5. Time and Labor Efficiency
6. Bubble-Free Results
7. Versatility
8. Consistency and Accuracy
9. Ergonomic Design

3 Primary Types of sign sheeting

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Engineer Grade Sheeting (Type I):

- Reflectivity: Engineer grade sheeting provides moderate reflectivity.
- Standards: In the United States, engineer grade sheeting is classified under ASTM D4956 Type I. Its minimum retroreflectivity values are outlined in the Manual on Uniform Traffic Control Devices (MUTCD) published by the FHWA.

High-Intensity Prismatic Sheeting (Type III):

- Reflectivity: High-intensity prismatic sheeting offers increased reflectivity compared to engineer grade sheeting.
- Standards: In the United States, high-intensity prismatic sheeting is classified under ASTM D4956 Type III. Its minimum retroreflectivity values are outlined in the MUTCD.

Diamond Grade Sheeting (Type XI):

- Reflectivity: Diamond grade sheeting provides the highest level of reflectivity among the three types.
- Standards: In the United States, diamond grade sheeting is classified under ASTM D4956 Type XI. Its minimum retroreflectivity values are outlined in the MUTCD.

Engineer Grade Sheeting (Type I)

- **Type 1 traffic sign sheeting refers to a specific classification of retroreflective sheeting used for traffic signs. It is often referred to as Engineer Grade Sheeting. Here are some key characteristics and features of Type 1 traffic sign sheeting:**
- **Reflectivity**: Type 1 sheeting offers moderate reflectivity, providing a basic level of visibility for traffic signs. It reflects light back to the source, enhancing sign visibility during nighttime or low-light conditions.
- **Construction**: Type 1 sheeting is typically composed of a monolayer of acrylic or other polymers with embedded glass beads or microprisms. These reflective elements help to redirect light back to its source, improving sign visibility.
- **Durability**: While Type 1 sheeting offers basic reflectivity, it is generally considered to have a lower durability compared to higher-grade sheeting types. It may be less resistant to fading, cracking, and damage from environmental factors such as UV radiation and weather conditions.
- **Application**: Type 1 sheeting is commonly used for non-critical signs, such as parking lot signs, signs on private property, or in areas with low traffic volume and slower speeds. It may also be suitable for temporary signs or short-term applications.
- **Standards**: In the United States, Type 1 sheeting meets the reflectivity standards outlined in ASTM D4956 Type I and the requirements specified by the Manual on Uniform Traffic Control Devices (MUTCD). The MUTCD provides guidelines for the design and placement of traffic signs to ensure uniformity and consistency across roadways.

High-Intensity Prismatic Sheeting (Type III)

HIP sheeting is constructed using multiple layers of prismatic lenses that enhance the reflection of light. These lenses are designed to reflect light back to its source, making the sign more visible to drivers, particularly during low-light conditions or at night.

Some key features and characteristics of High-Intensity Prismatic (HIP) Sheeting include:

1. **Increased Reflectivity**: HIP sheeting provides a higher level of reflectivity compared to Engineer Grade Sheeting. This increased reflectivity helps improve sign visibility, especially from longer distances.
2. **Durability**: HIP sheeting is designed to withstand the outdoor elements and has excellent resistance to fading, cracking, and weathering. It is often made with durable materials such as acrylic or polycarbonate to ensure long-term performance.
3. **Color Options**: High-Intensity Prismatic sheeting is available in a variety of colors, including white, yellow, red, green, and blue. This allows for the creation of signs with different colors and designs to convey specific messages and comply with traffic regulations.
4. **Compliance Standards**: High-Intensity Prismatic (HIP) Sheeting meets the reflectivity standards specified by transportation authorities and organizations. In the United States, these standards are outlined in the Manual on Uniform Traffic Control Devices (MUTCD) published by the Federal Highway Administration (FHWA).

Diamond Grade Sheeting (Type XI)

Diamond grade sheeting is a type of reflective material commonly used in traffic signs, road markings, and other applications that require high visibility, particularly during nighttime and low-light conditions. It is named for its diamond-shaped microprismatic optical elements that enhance reflectivity. Here are the key aspects of diamond grade sheeting:

1. **Reflectivity**: Diamond grade sheeting offers excellent reflectivity due to its microprismatic design. It reflects light back to the source, enhancing visibility and improving safety on the road.
2. **Visibility and Conspicuity**: The reflective properties of diamond grade sheeting make signs and markings highly visible, even in adverse weather conditions such as rain, fog, or darkness. This helps drivers quickly identify signs and navigate roads more safely.
3. **Performance Grades**: Diamond grade sheeting is available in different performance grades, such as DG3 (highest performance) and DG2. These grades indicate the level of reflectivity and durability. DG3 sheeting provides the highest level of performance and is typically used for critical signs like stop signs and warning signs.
4. **Durability**: Diamond grade sheeting is designed to be durable and resistant to environmental factors, such as UV radiation, humidity, and temperature fluctuations. It has a longer lifespan compared to lower-grade reflective materials.
5. **Compliance with Standards**: Diamond grade sheeting typically meets or exceeds various national and international standards, such as the ASTM D4956 Type XI specification in the United States and the EN 12899-1 standard in Europe. Compliance with these standards ensures consistent performance and quality.
6. **Application Versatility**: Diamond grade sheeting is suitable for a wide range of applications, including traffic signs, pavement markings, vehicle markings, barricades, and work zone signage. It can be used on various substrates, such as metal, plastic, and concrete.

Sign Fabrication Methods

Silk screening

- High volume of the same type of sign
- Needs a dedicated area & chemicals
- Needs time to dry

Cut and plot

- Medium to low qualities
- Flexible on design
- Relatively inexpensive

Digital printing

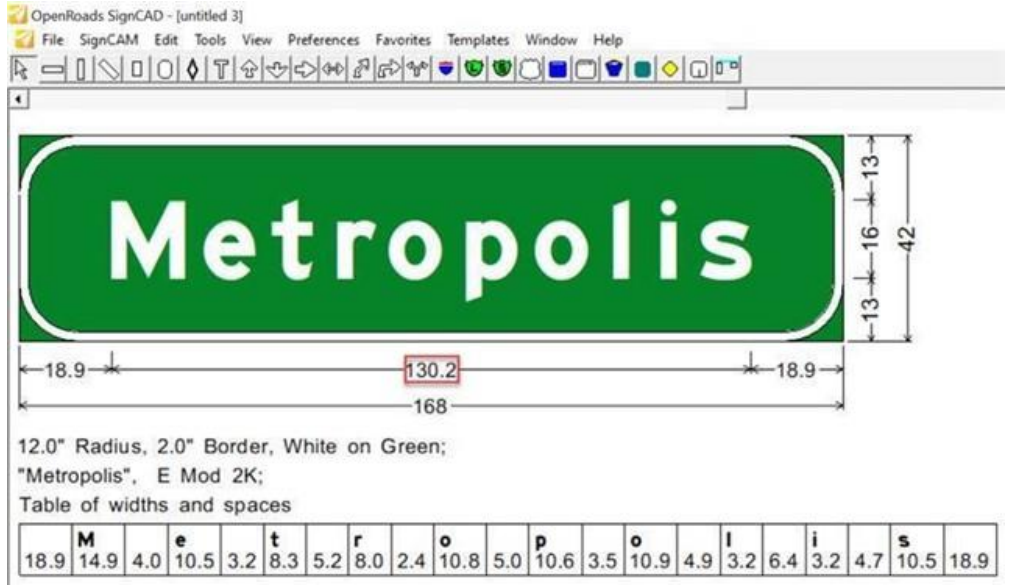
- Medium/high quantities
- Flexible on design
- More expensive than cut & plot
- Most efficient

Silk Screening

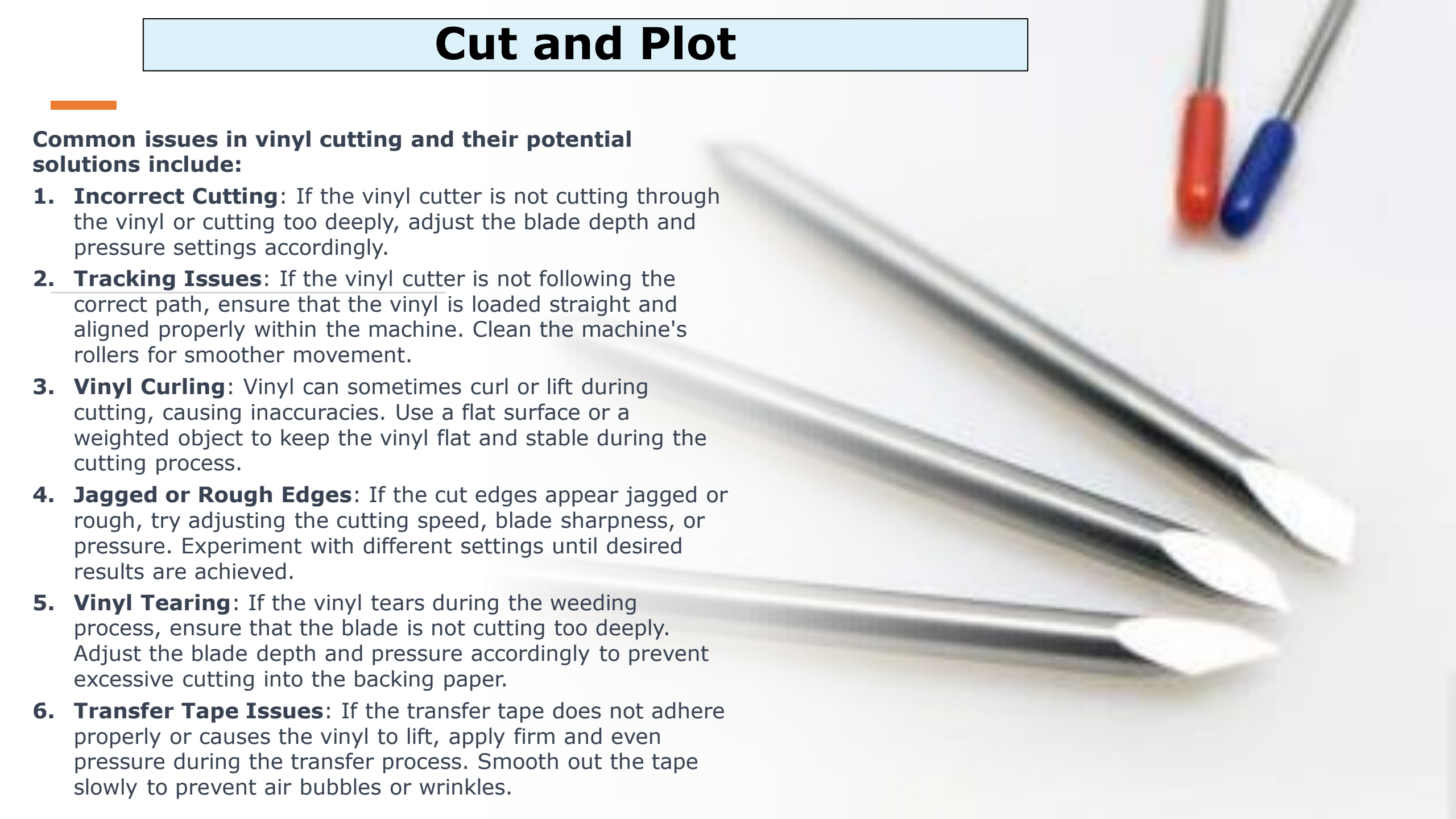
- **Steps To Silk Screening**
  - Design / obtain design of sign
  - Prepare the screen
  - Apply Emulsion
  - Create a film Positive
  - Prepare the exposure setup
  - Wash out the design
  - Dry the screen
  - Setup print station
  - Apply ink
  - Print the sign
  - Cure the Ink
  - Inspect and finish

Cut and Plot

- **Steps To Cut and Plot**
  - Design / obtain design of sign
  - Load the proper Material in your plotter.
  - Send the file from the computer program (SignCAD, TrafficCAD, COCUT, Flexi, ETC) to the plotter and let it cut the proper lines.
  - Remove material from plotter and transfer to a flat surface
  - Weed out the material that is not needed.
  - Use Transfer Tape to hold the little pieces in place
  - Line up the face of the sign on the substrate making sure it was centered.
  - Apply with Rolling apparatus
  - Use **<u>utility knife</u>** to trim off the excess around the edge of the substrate.



Cut and Plot



Common issues in vinyl cutting and their potential solutions include:

1. **Incorrect Cutting**: If the vinyl cutter is not cutting through the vinyl or cutting too deeply, adjust the blade depth and pressure settings accordingly.
2. **Tracking Issues**: If the vinyl cutter is not following the correct path, ensure that the vinyl is loaded straight and aligned properly within the machine. Clean the machine's rollers for smoother movement.
3. **Vinyl Curling**: Vinyl can sometimes curl or lift during cutting, causing inaccuracies. Use a flat surface or a weighted object to keep the vinyl flat and stable during the cutting process.
4. **Jagged or Rough Edges**: If the cut edges appear jagged or rough, try adjusting the cutting speed, blade sharpness, or pressure. Experiment with different settings until desired results are achieved.
5. **Vinyl Tearing**: If the vinyl tears during the weeding process, ensure that the blade is not cutting too deeply. Adjust the blade depth and pressure accordingly to prevent excessive cutting into the backing paper.
6. **Transfer Tape Issues**: If the transfer tape does not adhere properly or causes the vinyl to lift, apply firm and even pressure during the transfer process. Smooth out the tape slowly to prevent air bubbles or wrinkles.

Cut and Plot

- **Maintaining the Plotter and Tools**
- A plotter is not a difficult machine to maintain. It is always best to keep some spare blades on hand if you need to replace a dull blade. Wiping it down regularly will keep the machine free of dust and debris and be sure to clean out your material catching system.

Digital Printing

- **Steps For Digital Printing**
  - Design / obtain design of sign
  - Load the proper Material in your Printer
  - Send the file from computer using Flexi or other application
  - While it is printing you can cut your laminate to fit the sign.
  - Remove from Printer and lay on flat surface.
  - Use a rolling Apparatus to apply the laminate to the printed sign.
  - Lay the material onto a substrate like a metal blank and use the roller to apply.
  - Use **Utility Knife** to trim off the excess material from around the substrate.

Digital Printing

- **Steps To Digital Printing**
  - Design / obtain design of sign
  - Load the proper Material in your Printer
  - Send the file from computer using Flexi or other application
  - While it is printing you can cut your laminate to fit the sign.
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  - Lay the material onto a substrate like a metal blank and use the roller to apply.
  - Use **Utility Knife** to trim off the excess material from around the substrate.

Digital Printing

Common Issues in Digital Printing for Traffic Signs and Solutions:

1. Color inconsistencies: Ensure that the color profile and settings on the printer match the design file. Regularly calibrate the printer to maintain color accuracy.
2. Banding or streaking: Clean the printheads regularly and ensure they are properly aligned. If the issue persists, consider replacing or servicing the printheads.
3. Print quality issues: Check the print heads, ink levels, and media settings. Perform test prints and adjust print settings as needed. If necessary, replace or repair faulty components.
4. Adhesion problems: Ensure the sign substrate is clean and properly prepared before printing. Consider using adhesion promoters or specialized inks for better ink adhesion to the substrate.
5. Media jams or misfeeds: Regularly clean the media feed rollers and ensure they are in good condition. Adjust the media settings and avoid overloading the printer with heavy or stiff materials.

Signs & Markings

Lesson 6: Before Sign Installation

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Lateral Offset

Definition:

- Lateral offset is the distance between the edge of the sign and the edge of the roadway or curb.

Purpose:

- Proper lateral offset is crucial for ensuring road signs are visible and do not obstruct the roadway or sidewalk.
- Lateral offset requirements depend on the type of roadway, speed limit, and other factors that affect traffic flow.

Installation:

- Signs with lateral offset too close to the roadway can cause accidents or collisions, while signs too far away may not be visible to drivers.
- Signs should be installed at a consistent lateral offset throughout the roadway to avoid confusion and improve safety.
- Factors such as landscaping, terrain, and other obstacles may affect the proper lateral offset and should be considered during installation.

Vertical Offset

Definition:

- Vertical offset is the distance between the bottom of the sign and the ground or sidewalk.

Purpose:

- Proper vertical offset is essential for ensuring road signs are visible and do not pose a hazard to pedestrians or vehicles.
- Vertical offset requirements depend on the type of roadway, speed limit, and other factors that affect traffic flow and pedestrian safety.

Installation:

- Signs with vertical offset too low can pose a hazard to pedestrians or obstruct the roadway, while signs too high may not be visible to drivers.
- Signs should be installed at a consistent vertical offset throughout the roadway to avoid confusion and improve safety.
- Factors such as landscaping, terrain, and other obstacles may affect the proper vertical offset and should be considered during installation.

Standardization of Location

Purpose:

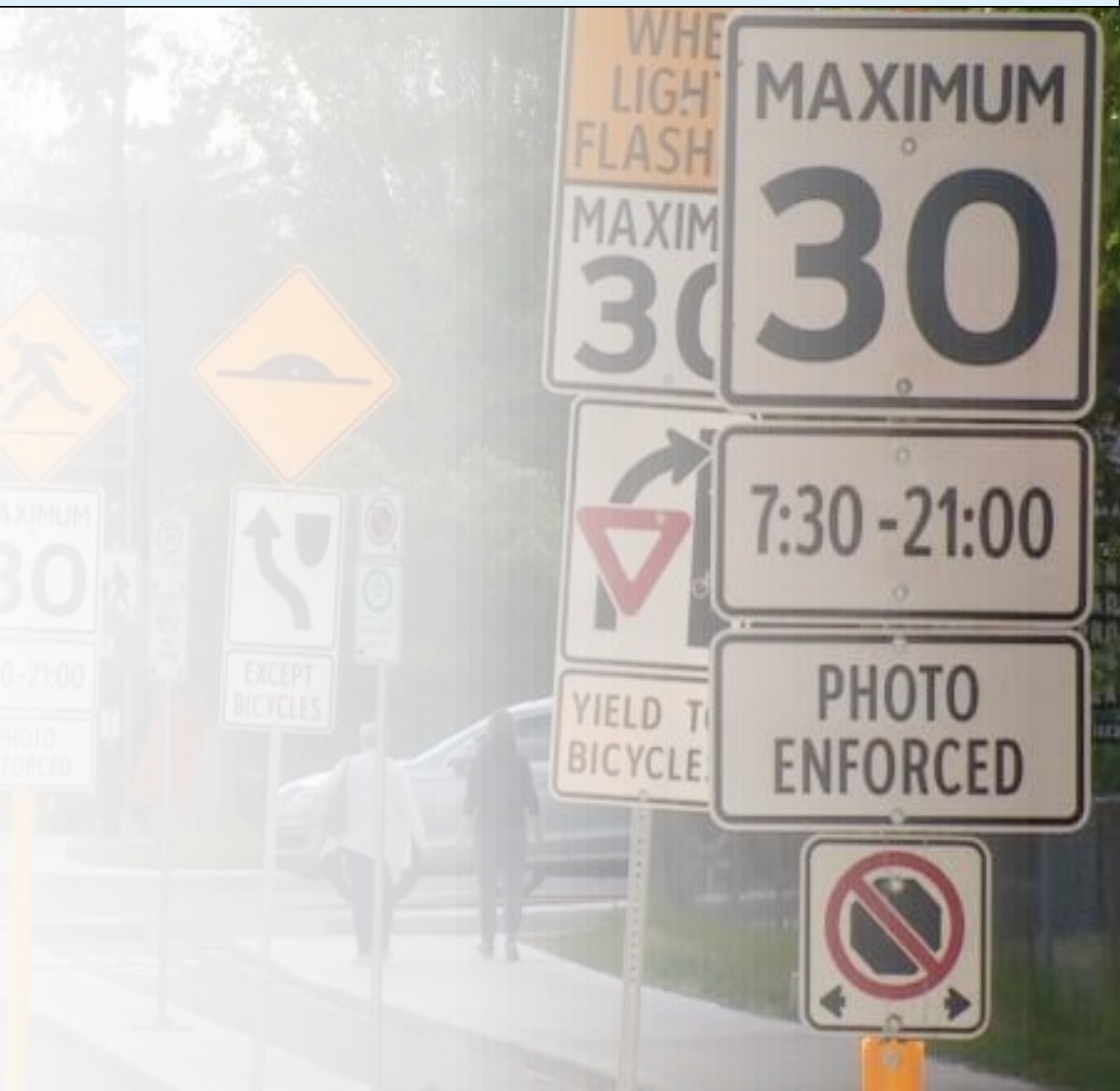
- Sign location should be as standardized as possible so that road users know what to expect.

Location:

- Signs should be located on the right-hand side of the roadway where they are easily recognized and understood by road users.

Spacing:

- Signs requiring separate decisions by the road user shall be spaced sufficiently far apart for the appropriate decisions to be made.



Orientation

Placement:

- Signs should be vertically mounted at right angles to the direction of, and facing, the traffic that they are intended to serve.
- Signs that are placed 30 feet or more from the pavement edge should be turned toward the road.

Reflection:

- Where mirror reflection from the sign face is encountered to such a degree as to reduce legibility, the sign should be turned slightly away from the road.

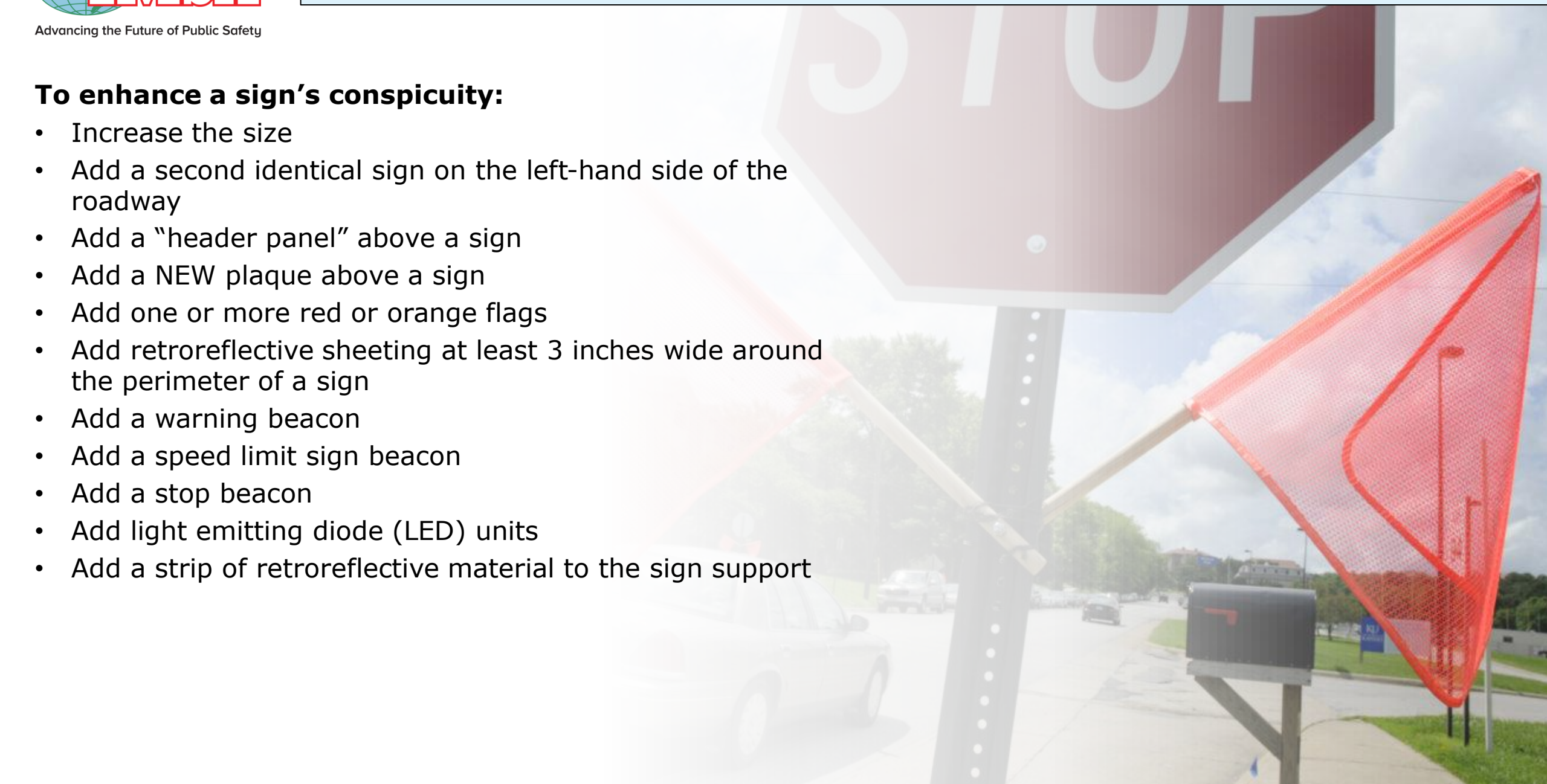
Curves & Grades:

- On curved alignments, the angle of placement should be determined by the direction of approaching traffic rather than by the roadway edge at the point where the sign is located.
- On grades, sign faces may be tilted forward or back from the vertical position to improve the viewing angle.

Enhanced Conspicuity for Standard Signs

To enhance a sign's conspicuity:

- Increase the size
- Add a second identical sign on the left-hand side of the roadway
- Add a "header panel" above a sign
- Add a NEW plaque above a sign
- Add one or more red or orange flags
- Add retroreflective sheeting at least 3 inches wide around the perimeter of a sign
- Add a warning beacon
- Add a speed limit sign beacon
- Add a stop beacon
- Add light emitting diode (LED) units
- Add a strip of retroreflective material to the sign support



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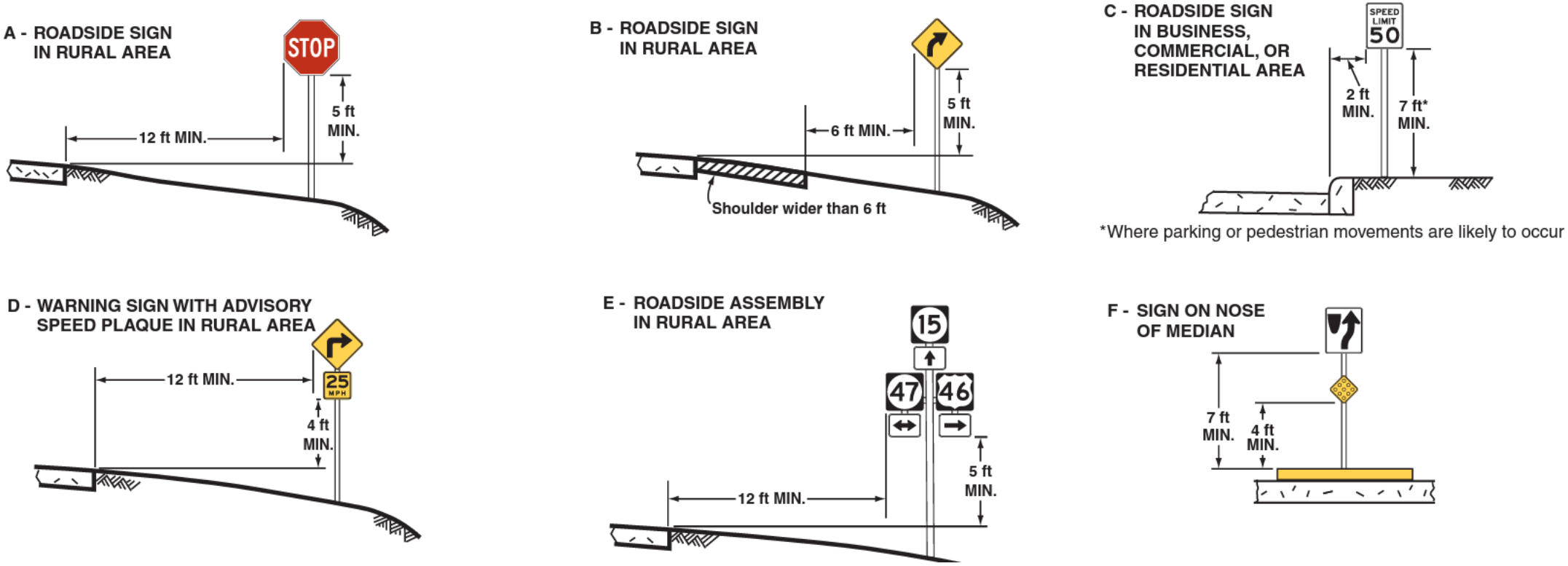
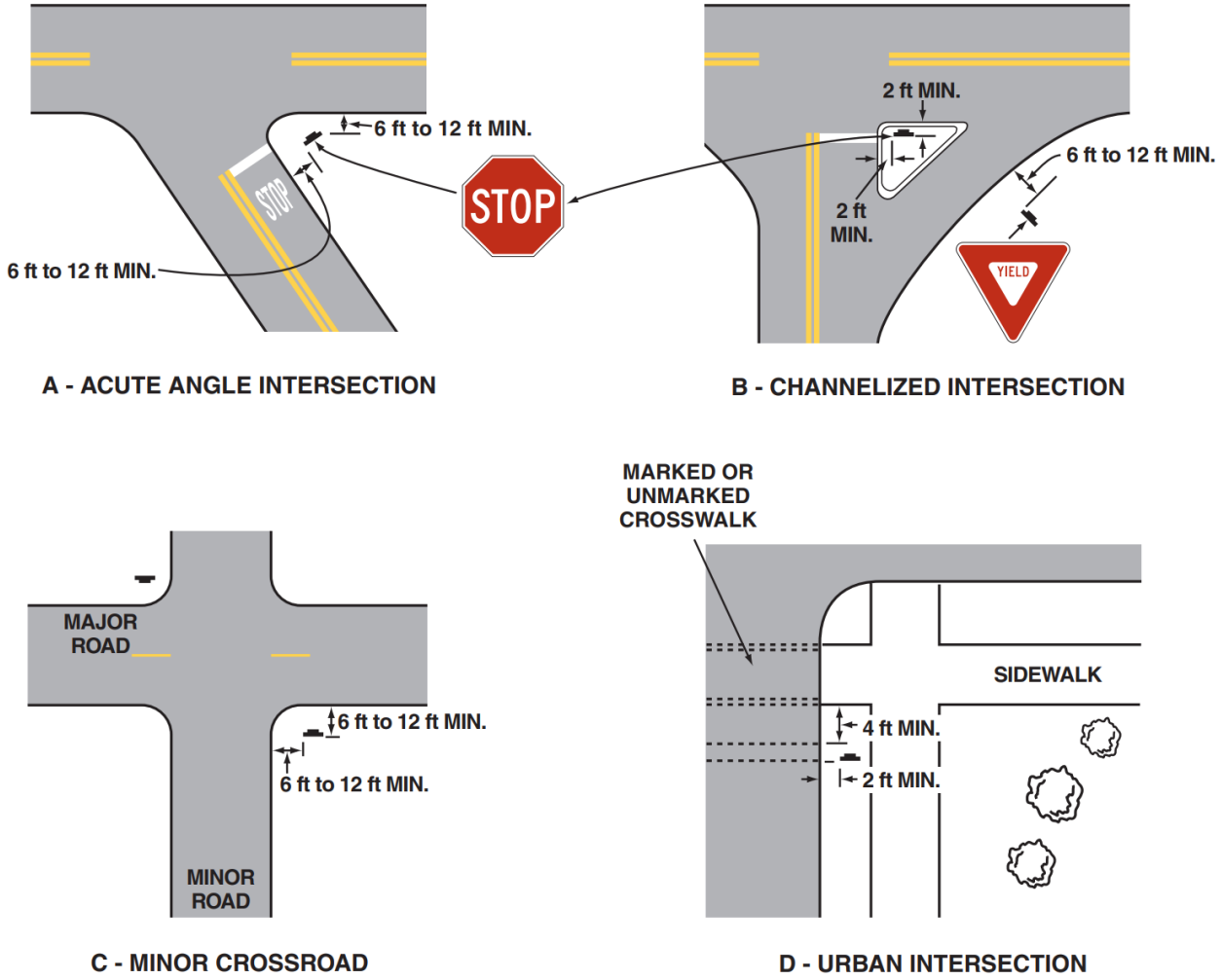
Standardization of Location: Offset

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



Intersections

Figure 2A-3. Examples of Locations for Some Typical Signs at Intersections



A - ACUTE ANGLE INTERSECTION

B - CHANNELIZED INTERSECTION

C - MINOR CROSSROAD

D - URBAN INTERSECTION

Overhead Sign Installations

Use:

Overhead signs should be used on freeways and expressways, at locations where some degree of lane-use control is desirable, and at locations where space is not available at the roadside.

Mounting height:

The minimum vertical clearance for an overhead sign often depends on local regulations, the type of roadway, and the expected types of vehicles. In the United States, according to the Manual on Uniform Traffic Control Devices (MUTCD) by the Federal Highway Administration, the following minimum clearances are recommended:

- On freeways and expressways, the minimum clearance from the bottom of the sign to the road surface is 17 feet (approximately 5.2 meters).
- On other roads, the minimum clearance from the bottom of the sign to the road surface is 15 feet (approximately 4.6 meters).

These measurements ensure that the signs don't interfere with the passage of high-profile vehicles such as trucks and buses. However, local requirements may differ, so it's always important to check with local transportation or highway authorities when installing overhead signs.

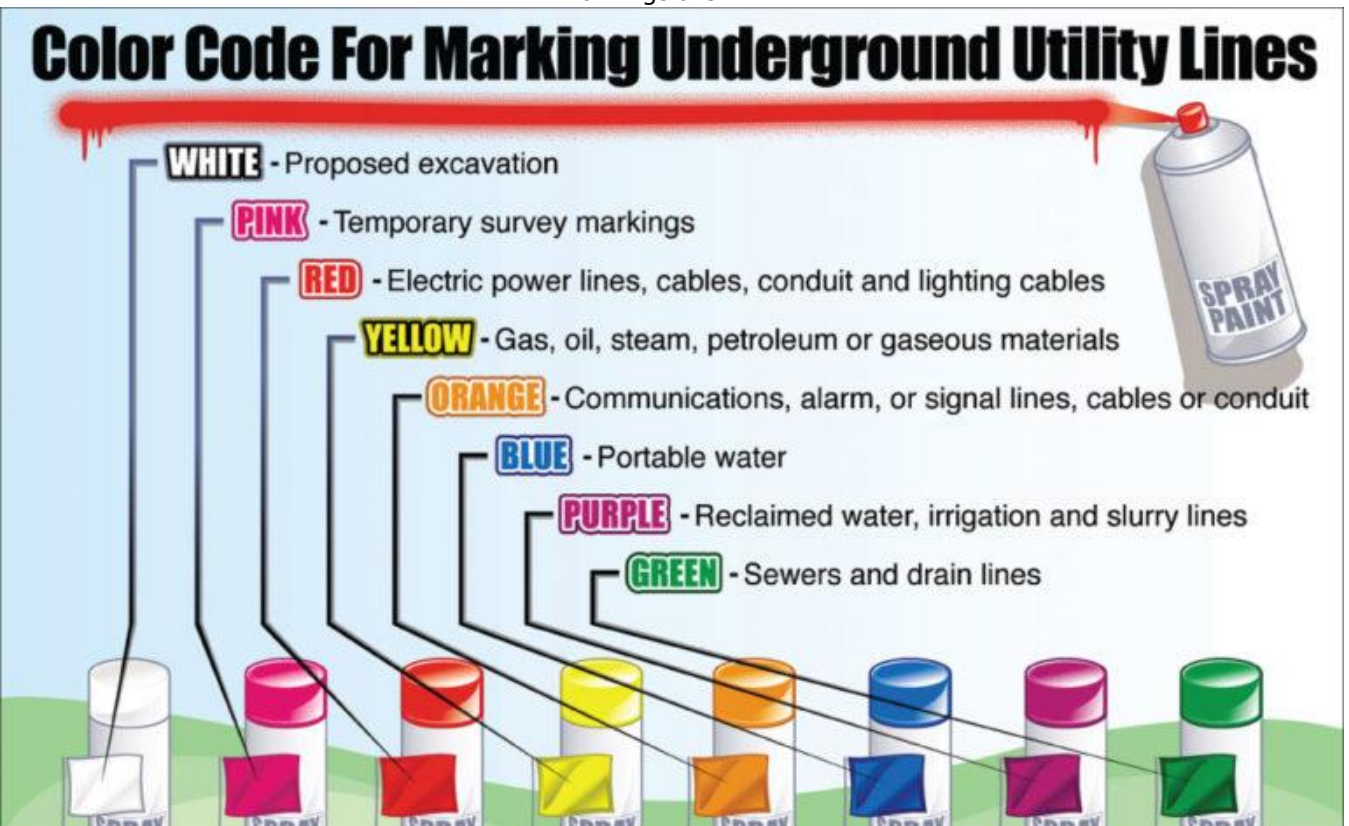
Before any Installation – Line Locates

Underground utilities should be located before installing signs or conducting any excavation work to prevent accidental damage to the utilities. The primary reasons for locating underground utilities are:

- **Safety**: Hitting underground utilities can lead to severe accidents, injuries, or even fatalities. Locating them beforehand ensures the safety of workers and the public.
- **Cost and Time Efficiency**: Damaging underground utilities can result in costly repairs, project delays, and disruptions to essential services. Locating utilities in advance helps avoid these issues and ensures efficient project execution.

The length of time for line locates can vary depending on the locality and the specific requirements of the project. Typically, line locates are valid for a certain period, usually ranging from a few weeks to a couple of months. It is essential to check with the local utility providers or the responsible authorities to determine the exact validity period in your area.

When utility lines are located, they are marked with specific colors to indicate the type of utility. While color codes may vary slightly between regions, the general color codes for utility markings are:



Before any Installation – Line Locate Contact Info

For line locates in the states of Texas, Oklahoma, Arkansas, and Louisiana, you would typically contact the appropriate regional or state-level agency responsible for utility locating. Here are the relevant agencies for each state:

- **Texas**: In Texas, you would contact the Texas811 service. It is a one-call notification center that helps coordinate utility line locates across the state. You can reach them by dialing 811 or visiting their website at https://www.texas811.org/.
- **Oklahoma**: In Oklahoma, you would contact the Oklahoma One-Call System. They are responsible for coordinating utility line locates in the state. You can reach them by dialing 811 or visiting their website at https://www.okie811.org/.
- **Arkansas**: In Arkansas, you would contact the Arkansas One Call. They provide a central point of contact for utility line locates in the state. You can reach them by dialing 811 or visiting their website at https://www.arkonecall.com/.
- **Louisiana**: In Louisiana, you would contact the Louisiana One Call System. They are responsible for coordinating utility line locates in the state. You can reach them by dialing 811 or visiting their website at https://www.laonecall.com/.

Signs & Markings

Lesson 6.1: Methods to Establish the base of your sign

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Setting the base for a sign

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Hydrovac

- Non-destructive, vacuum-based process.
- Uses high-pressure water and an industrial vacuum to excavate soil around the hole.
- Good for digging in areas with underground utilities.

Direct driven

- Involves using a Gas Powered post driver to install the base directly into the ground.
- generally does not need concrete and is very fast to install

Auger excavation

- Involves the use of a rotating helical screw to remove soil from the hole.
- Can be performed with different types of augers, such as hand-held or truck-mounted.
- Good for digging deep holes in soft soil.

Direct Bury

- Direct bury sign installation refers to a method of installing signs directly into the ground without the use of any additional support structures or mounting systems.

Line Locates

- If you dig past 18 inches, ensure you don’t disrupt utilities.
- If you line locate and hit something you are NOT liable; if you don’t line locate, you ARE liable.

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Standard size of hole needed

The standard specifications for a hole for sign installation can vary based on factors such as the size and weight of the sign, the height of the pole, wind load considerations, and the type of soil where the installation is taking place. It's always important to check local codes and regulations, as there may be specific guidelines to follow in your area.

However, a general rule of thumb often followed is that the hole should be about one-third to one-half the length of the post in depth, and approximately three times the width of the post in diameter. For instance, if you're installing a standard 4x4 wooden post (which is actually 3.5 inches x 3.5 inches), you might dig a hole that is around 24 to 32 inches deep and approximately 10 to 12 inches in diameter.

The depth of the hole and amount of concrete needed does change based on the height of the pole and also the size and weight of the sign. A taller pole or a heavier sign will need a deeper hole and more concrete to ensure stability. For example, a small yard sign may only need a few feet of post depth, while a large, heavy commercial sign may require several feet of depth and a substantial concrete footing.

As for the amount of concrete needed, this will depend on the size of the hole. Concrete is usually sold in 40, 60, or 80 pound bags. If you're installing a 4x4 post in a hole 10 inches wide and 24 inches deep, you'll need approximately 1.5 cubic feet of concrete. One 80 pound bag of concrete mix will typically yield about 0.6 cubic feet of concrete, so you'd likely need about 3 bags for this size of hole.

Hydrovac

Using a hydrovac, also known as a hydro excavation truck or vacuum excavator, involves the use of high-pressure water and a vacuum system to excavate and remove soil or debris. Here are the pros and cons of using a hydrovac:

Pros:

- Precise Excavation
- Non-Destructive
- Reduced Risk of Accidents
- Faster and More Efficient
- Minimizes Disruption

Cons:

- Cost:
- Limited Reach
- Dependency on Water Source
- Weather Conditions
- Potential for Water Damage

- Overall, hydrovac excavation provides numerous advantages, such as precise and non-destructive excavation, increased efficiency, and enhanced safety. However, the costs, potential limitations, and requirements of water supply need to be carefully considered when deciding on the suitability of hydrovac excavation for a particular project.

Direct Driven

Direct drive sign installation refers to a method where signposts are driven directly into the ground using a hydraulic or pneumatic hammer without the need for digging holes or using additional support structures. Here's an overview of the pros and cons of direct drive sign installation:

Pros:

- Efficiency and Time-Saving
- Cost-Effective
- Versatility
- Flexibility and Adjustability
- Reduced Environmental Impact

Cons:

- Limited Depth
- Soil Compatibility
- Potential for Damage
- Limited Load Capacity
- Noise and Disruption

When considering direct drive installation, it's important to assess factors such as soil conditions, sign size and weight, desired depth, and local regulations. Professional expertise and appropriate equipment are crucial for ensuring the proper installation and long-term stability of the signpost.

Auger Excavation

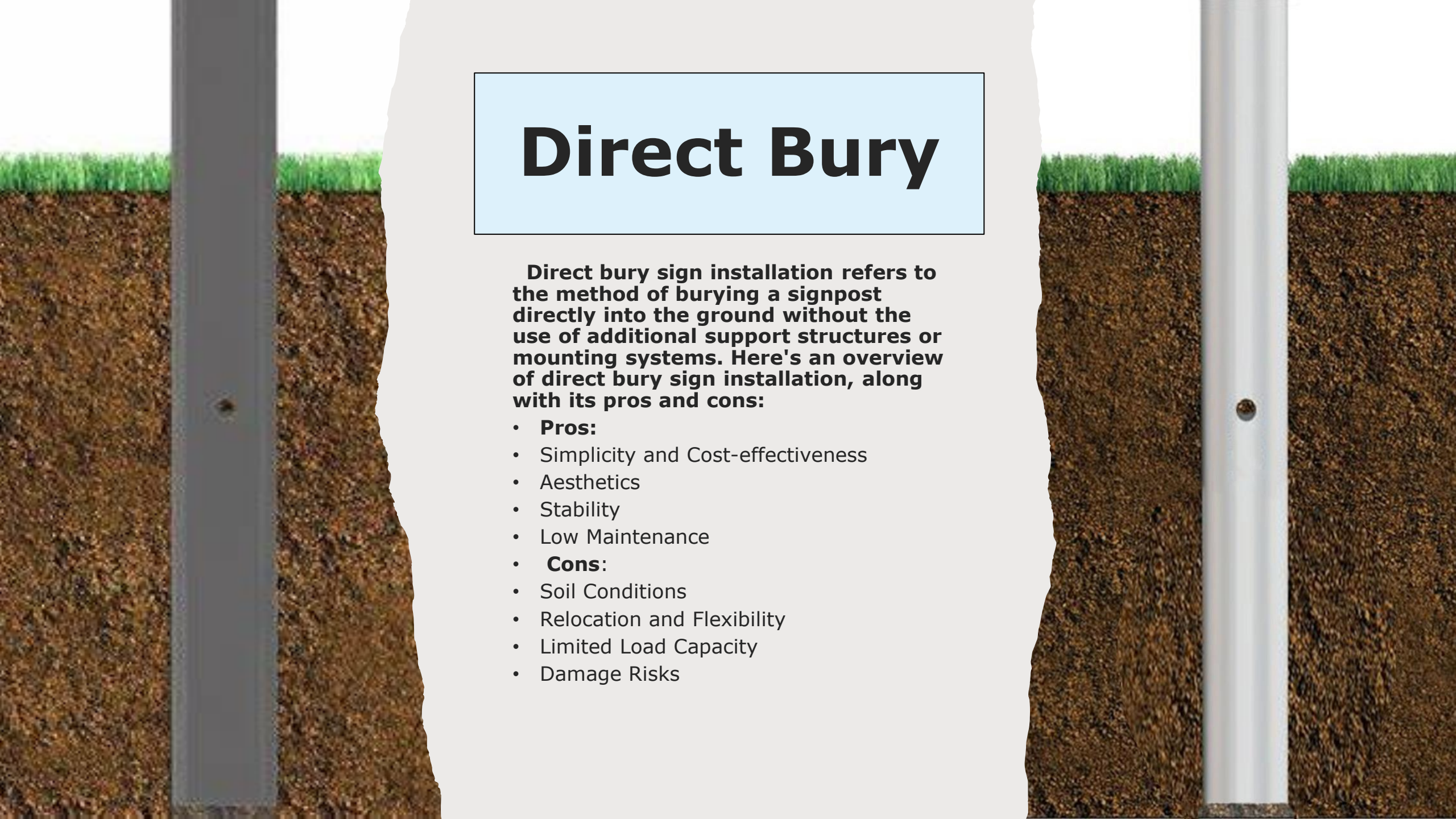
Using an auger for sign installation involves using a power tool with a rotating helical screw-like blade to dig holes in the ground. The auger is commonly used to create holes for installing signposts or support structures. Here's an overview of using an auger for sign installation, along with its pros and cons:

Pros:

1. Efficiency and Time-Saving
2. Accuracy and Precision
3. Reduced Physical Effort
4. Versatility

Cons:

1. Equipment Requirement
2. Limited Application
3. Soil Displacement
4. Operator Skill



Direct Bury

Direct bury sign installation refers to the method of burying a signpost directly into the ground without the use of additional support structures or mounting systems. Here's an overview of direct bury sign installation, along with its pros and cons:

- **Pros:**
- Simplicity and Cost-effectiveness
- Aesthetics
- Stability
- Low Maintenance
- **Cons**:
- Soil Conditions
- Relocation and Flexibility
- Limited Load Capacity
- Damage Risks

Signs & Markings

Lesson 6.2: Common Installation Types

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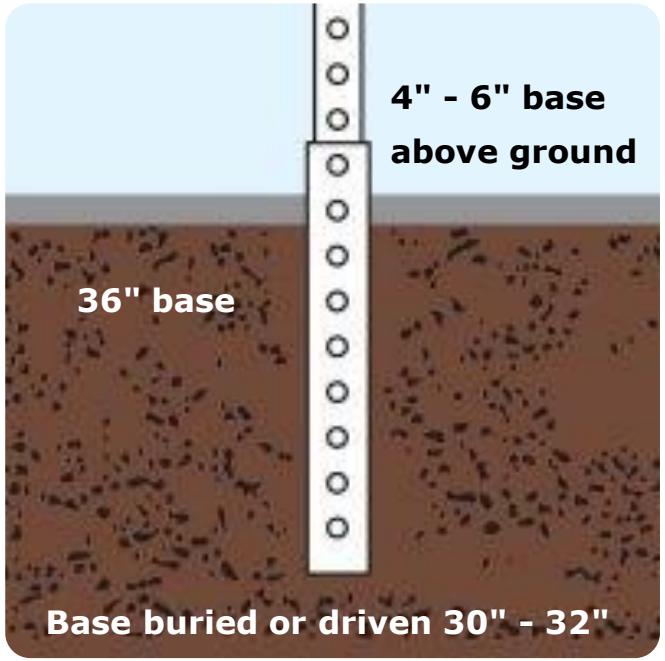


Telspar

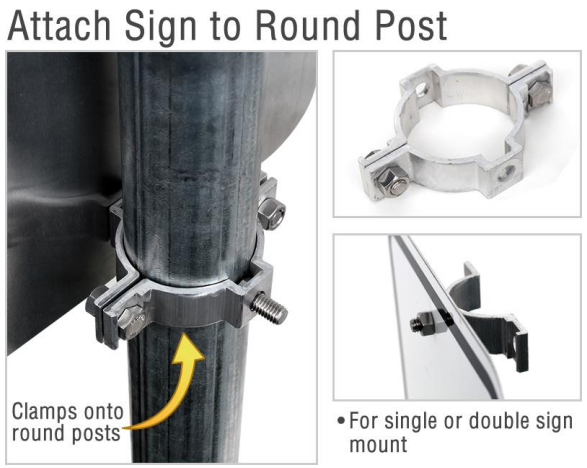
Telspar is a brand of square tubular sign support system widely used in sign installation. It consists of square-shaped metal tubes that are used to create posts and structures for mounting signs. Here are the pros and cons of using Telspar for sign installation:

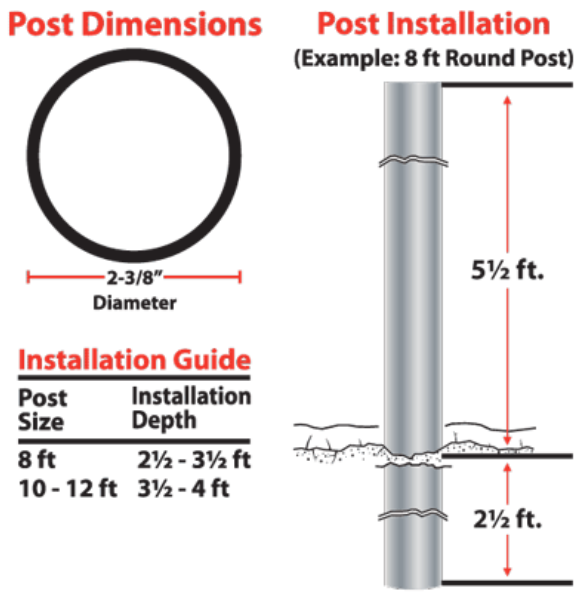
Pros:

- Versatility
- Strength and Durability
- Easy Installation
- Adjustable Heights
- Compatibility

Cons:

- Weight
- Corrosion Potential
- Limited Aesthetic Options
- Cost





Round Post

Using a round post for sign installation involves utilizing a cylindrical post, typically made of metal or wood, to support and display signs. Here's an overview of using a round post for sign installation, along with its pros and cons:

Pros:

- Versatility
- Stability and Durability
- Easy Maintenance
- Cost-Effective

Cons:

- Time-Consuming Installation
- Limited Adjustability
- Vulnerability to vehicle collisions

U-Channel

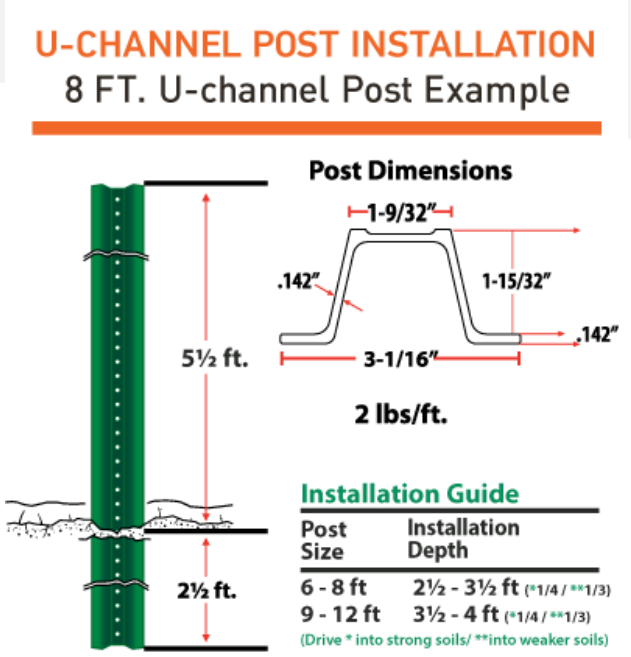
U-channel sign installation refers to a method of mounting signs using U-shaped metal channels. These channels are typically made of galvanized steel or aluminum and provide a secure and durable framework for mounting signs. Here are the pros and cons of using U-channel sign installation:

Pros:

- Cost-effective
- Easy Installation
- Versatility
- Accessibility for Maintenance
- Durability

Cons:

- Limited Aesthetic Options
- Structural Integrity
- Difficulty with Uneven Surfaces
- Potential for Vandalism



The depth of the post installation depends on the soil type at installation time, the percentages above are recommendations (*1/4 = 25% of the post / **1/3" = 33% of the post)

I-Beam Steel Post

This post type is used when it is necessary to support large sign panels, which is common for roadside post-mounted guide signs.

All large steel posts use a breakaway feature, unless protected by barrier or placed out of the clear zone. This is usually accomplished by using a slip base that connects the post to the foundation. When struck, the post slips off the foundation at the bottom, and rotates around the hinge plate below the sign panel. This allows the vehicle to safely pass under the sign after impact.

Wooden Post

Wood posts are frequently used, especially in regions where wood is economical compared to metal type supports. These posts usually come in sizes of 4 x 4 inches to 6 x 8 inches. All posts above 4 x 4 inch nominal size must be drilled perpendicular to traffic flow to allow the post to break away if struck by a motor vehicle.

- ***Small supports*** have a cross section of approximately 16 square inches. This type of post should be buried about 30 to 36 inches deep depending upon the type of soil and backfill; check State specifications or with LTAP for embedment depth and backfill material. The post may need to be buried even deeper to reduce vandalism and reduce dislodging by heavy winds. One or two posts may be used to make up the sign support, but adding posts too close together can affect crashworthiness.

- ***Large supports*** should be drilled to provide the breakaway characteristic. For example, a 6 x 8 inch wood post can be used if the cross section is weakened by drilling two 3-inch holes (drill perpendicular to roadway). A 4 x 4 inch wood post is the largest undrilled wood post recommended to act as a breakaway support.

Two Post Sign Installation

A two-post sign installation method is typically used when installing larger and heavier signs that require additional support and stability. Here are some situations where a two-post installation method is commonly employed:

- **Large Signs**: Signs that are larger in size, such as those used on highways or major roadways, often require a two-post installation method. The added support of two posts helps prevent the sign from sagging or bending under its own weight and provides better resistance against wind loads.
- **Overhead Signs**: Overhead signs, such as those mounted on gantries or spanning across multiple lanes, often require a two-post installation method for stability and to ensure proper clearance for vehicles passing beneath.
- **High Wind Areas**: In areas prone to high winds or severe weather conditions, a two-post installation method can provide increased stability and resistance against strong gusts.
- **Signs with Dynamic Loads**: Signs that may experience dynamic loads, such as those near high-speed intersections or areas with heavy traffic, can benefit from the additional support of a two-post installation.
- **Irregular or Uneven Ground**: If the installation site has uneven terrain or ground conditions, a two-post installation can help provide better stability and compensate for any unevenness.

When using a two-post installation method, it's important to ensure that the posts are properly spaced, aligned, and securely anchored. The specific installation requirements, such as post height, spacing, and foundation size, may vary depending on local regulations and the specifics of the sign. Consulting local codes and guidelines, as well as seeking professional advice, is recommended for proper installation of larger or heavier signs using a two-post method.

Sign Installation Structures – Breakaway Structures

No matter which type of sign post you use, it must be a break away structure. In the case of a Wooden post you would drill holes through the post to make it breakaway.

Breakaway sign supports are engineered to break away or deform upon impact, diverting the vehicle's energy and reducing the risk of severe damage or injury. The design incorporates specific weak points or connections that allow the sign support to separate from its base or break apart when sufficient force is applied.

The most common type of breakaway sign support is a breakaway post. It typically consists of a post or pole that is installed into the ground using a breakaway base. The base is engineered to fail under impact, allowing the post to detach or collapse.

Benefits and Advantages:

- Enhanced Safety: Breakaway sign supports are designed to minimize the impact forces transferred to the vehicle and its occupants during a collision. This helps reduce the severity of injuries and damage.
- Compliance with Regulations: Many transportation authorities and road agencies require the use of breakaway sign supports in certain locations or for specific types of signs. Compliance with these regulations ensures safety standards are met.
- Cost Savings: In the event of a collision, breakaway sign supports can reduce the need for costly repairs or replacements of signs and support structures. Instead of requiring complete reconstruction, only the damaged components need to be replaced.

Signs & Markings

Lesson 6.3: Installation Removal

Advancing the Future of Public Safety

The Removal of a Post

Safely removing a sign post requires proper techniques and precautions to prevent injury or damage. Here are some general guidelines for safely removing a sign post:

1. **Prepare the Work Area**: Clear the area around the sign post of any obstructions, such as vegetation, debris, or nearby objects. Make sure there is enough space to safely maneuver and work around the post.
2. **Safety Gear**: Wear appropriate personal protective equipment (PPE) such as gloves, safety glasses, and sturdy footwear to protect yourself during the removal process.
3. **Inspect the Post**: Check the condition of the post for any signs of damage, corrosion, or structural weakness. Avoid removing posts that are damaged or compromised, as they may require specialized techniques or equipment for safe removal.
4. **Loosen the Soil**: Use a shovel or post hole digger to loosen the soil around the base of the post. This will make it easier to remove the post from the ground.
5. **Apply Lubrication**: If the post seems stuck or difficult to remove, applying a lubricant (such as penetrating oil) to the joint between the post and the ground can help loosen it.
6. **Rocking Motion**: Once the soil around the post is loosened, apply gradual pressure to the post in a rocking motion. Gently push the post back and forth, alternating between the sides. This helps break the suction between the post and the soil.
7. **Pulling or Levering**: Depending on the size and weight of the post, you can use a pry bar or a mechanical pulling device (such as a come-along) to assist in pulling the post out of the ground. Be cautious not to apply excessive force that could cause injury or damage.
8. **Stabilization and Disposal**: Once the post is removed, stabilize it to prevent it from falling or causing harm. Dispose of the post and any associated hardware or debris properly, following local regulations and guidelines.

Some of the tools you can use to assist in the removal of a sign post and foundation include:

Pole Puller / Chain and hooks

- **A post puller is a specialized tool designed to remove sign posts from the ground. It typically consists of a hydraulic or manual mechanism that provides the necessary force to extract the post.**

Trenching or Digging tools

•In some cases, it may be necessary to dig around the base of the sign post to expose its connection or to access any anchor points. Trenching tools such as shovels, spades, or post hole diggers can be used for this purpose.

Personal Protective Equipment (PPE)

- Safety should always be a top priority. A sign technician should wear appropriate PPE, including safety glasses, gloves, hard hat, and high-visibility clothing, to protect against any potential hazards during the removal process.

Safety Barricades

- If the removal process poses any risks to nearby traffic or pedestrians, safety barricades, cones, or signs should be used to establish a safe work zone and alert others of the ongoing work.

Signs & Markings

Lesson 6.5: Sign Installation Hardware and Tools

Advancing the Future of Public Safety

Banding Tool

A banding tool, also known as a banding tensioner or strapping tool, is a device used for securely fastening signs or other objects to posts or structures. It is commonly used in sign installation to secure signs to posts, especially for larger or heavier signs that require additional support. The banding tool is specifically designed to tighten and secure metal bands or straps around the sign and post, providing a durable and reliable attachment.

Here are the main parts and components typically found in a banding tool:

- Handle
- Tensioning Mechanism
- Cutter
- Clamp or Sealer
- Hardware

Fastening Hardware

The most common type of hardware used in sign installations is typically metal hardware, specifically stainless steel or galvanized steel. These materials offer durability, strength, and resistance to rust and corrosion, making them suitable for outdoor applications. The specific types of hardware commonly used in sign installations include:

1. **Bolts**: Bolts are commonly used to secure signs to posts or mounting brackets. They come in various lengths, diameters, and head types (such as hex head or carriage bolts) to accommodate different sign and mounting configurations.
2. **Tamper Resistant Bolts**: A special Bolt and Nut system that requires a specific key in order to tighten or loosen, decreasing the chances of theft.
3. **Nuts and Washers**: Nuts and washers are used in conjunction with bolts to secure the sign in place. They provide additional stability and prevent loosening over time. Nylon lock nuts can be used to further enhance the locking capability.
4. **Screws**: Screws are often used to attach smaller signs or sign components, such as plaques or faceplates, to mounting brackets or posts. Self-tapping screws or wood screws may be used, depending on the material being mounted to.
5. **Brackets and Clips**: Brackets and clips are hardware components used to connect the sign to the support structure. They provide stability and ensure the sign remains securely in place. Various bracket designs are available to accommodate different types of signs, including U-channel brackets, channel post brackets, or custom-designed brackets for specific sign types.
6. **Anchors and Fasteners**: Anchors and fasteners are used to secure the sign post into the ground or onto a surface. Concrete anchors or expansion anchors may be used for solid surfaces, while ground anchors or post anchors are suitable for soil or gravel installations.

Advancing the F

Fastening Hardware

Sign Installation Tools

The tools used in traffic sign installation can vary depending on the type of sign, the type of post, and the specific installation procedures. However, some of the most commonly used tools include:

1. **Post Hole Digger or Auger**: These tools are used to dig the hole where the sign post will be installed. An auger, which can be manually or power-operated, is often used for larger installations or when multiple holes need to be dug.
2. **Shovel**: A shovel is useful for removing dirt from the hole and backfilling it once the post is in place.
3. **Level**: A level is used to ensure that the post is straight and level in the hole before it's secured.
4. **Measuring Tape**: A measuring tape is used to ensure the hole is of the correct depth and that the sign is installed at the correct height.
5. **Wrenches and Screwdrivers**: These tools are used to secure the sign to the post and may also be used to install any hardware needed to secure the post in the hole.
6. **Hammer or Sledgehammer**: A hammer or sledgehammer might be used to drive the post into the ground, particularly for metal U-channel posts.
7. **Bucket or Wheelbarrow and Hoe**: These are used for mixing concrete if it's being used to secure the post in the hole.
8. **Safety Equipment**: Safety vests, gloves, safety glasses, and hard hats are essential to ensure the safety of the installation crew.
9. **Ladder**: For taller signs, a ladder may be necessary to attach the sign to the post and ensure it's secure.
10. **Drill**: A power drill can be used to make pilot holes in the post and to secure the sign to the post with screws.

Signs & Markings

Lesson 6: Sign Inspections

Advancing the Future of Public Safety

How weather affects signs

Traffic signs are subject to various environmental conditions, including weather, which can affect their effectiveness and longevity. The effects of weather on traffic signs can include:

1. **Fading**: Extended exposure to the sun's UV rays can cause the colors on traffic signs to fade. Fading reduces the sign's visibility and its effectiveness. Signs with bright colors, like stop signs (red) or warning signs (yellow), tend to be more affected as any fading can decrease their ability to grab attention.
2. **Wind Damage**: Strong winds, hurricanes, or tornadoes can cause physical damage to traffic signs. This could lead to the sign becoming dislodged from its post, bent, or even broken. Larger signs or those with a broad surface area can be more affected as they present more resistance to wind.
3. **Snow and Ice**: In colder climates, snow and ice can cover signs, making them unreadable. The weight of accumulated ice or snow could potentially cause a sign to bend or fall.
4. **Corrosion**: In coastal areas or regions with heavy snowfall (where de-icing salts are often used on roads), the metal components of traffic signs can corrode over time. Corrosion can weaken the sign post and fasteners, leading to potential failure.
5. **Temperature Effects**: Extreme temperatures, both hot and cold, can affect the materials of traffic signs. In hot weather, signs can warp or buckle, while in cold temperatures, they may become brittle and more prone to cracking or breaking.

These are just a few reasons why a Sign Inspection Plan is important

Sign Inspections

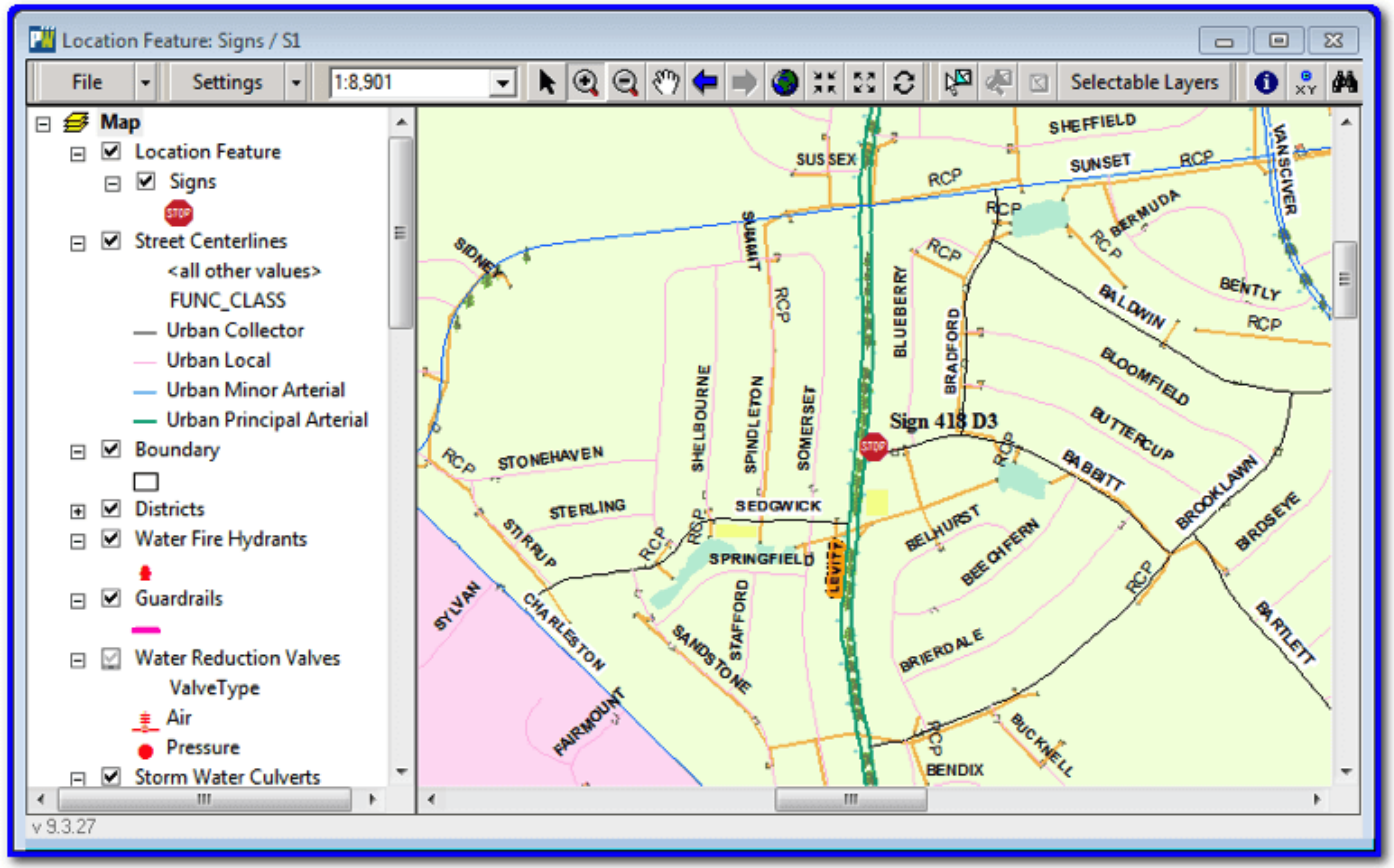
Traffic sign inspections are a crucial part of maintaining a safe and efficient transportation system. They help ensure that all signs are in good condition, clearly visible, and providing accurate information. Inspections typically focus on several key aspects:

1. **Visibility**: Signs should be easily visible to drivers. This includes both daytime and nighttime visibility. For instance, inspectors may use a retroreflectometer, a device that measures the level of retroreflectivity (how much light the sign reflects back to its source), to ensure that the sign still meets the required standards for nighttime visibility.
2. **Physical Condition**: This includes checking for any physical damage to the sign, such as bends, dents, or cracks, as well as any damage to the post or mounting. Any graffiti or stickers that could obscure the sign's message would also be noted.
3. **Position and Height**: The sign's height and position should be checked to ensure it's mounted at the correct height and angle, facing the oncoming traffic for maximum visibility.

Sign Inspections

4. **Corrosion**: In coastal areas or regions with heavy snowfall (where de-icing salts are often used on roads), the metal components of traffic signs can corrode over time. Corrosion can weaken the sign post and fasteners, leading to potential failure.
5. **Legibility**: Over time, a sign's message can fade or become obscured due to weather, UV radiation, or other factors. The sign's legibility should be checked to ensure drivers can easily read and understand the sign's message.
6. **Compliance with Standards**: The sign should be checked for compliance with local and national standards regarding size, color, design, and reflectivity.
7. **Surrounding Environment**: The surrounding environment should also be inspected to ensure that the sign is not obscured by things like overgrown vegetation, dirt, or other structures.

Sign Inspections - GPS



- Many departments have now started to use sign management systems to help manage this process. These systems use GPS and database technology to create a record of every sign, its installation date, condition, and date of last inspection. It helps automate the process and ensures that no sign is overlooked.

Sign Inspections

Inspections for traffic signs are crucial for maintaining roadway safety and ensuring signs meet local and national standards. Here are some common types of inspections:

- **Nighttime Inspections**: These inspections are conducted at night to evaluate the retroreflectivity of the sign, which is the ability of the sign to reflect light back to the source, making it visible in the dark. For this, a vehicle with headlights on is driven on the road to check if the signs are clearly visible and legible.
- **Daytime Inspections**: During the day, signs are inspected for general visibility, legibility, correct positioning, physical condition (checking for damage, rust, or wear), and if they are obscured by overgrown vegetation or other obstructions.
- **Scheduled Inspections**: Regularly scheduled inspections are conducted at predetermined intervals, which could be annually, biannually, or based on some other timeline. These inspections might include both daytime and nighttime checks.
- **In-Depth Inspections**: These could involve a detailed evaluation of each sign to assess its condition, including factors like sign sheeting (the material the sign face is made of), post integrity, and hardware (bolts, brackets, etc.). These are generally more time-consuming and might be conducted on a rotating schedule, with different sections of the roadway being inspected each time.

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Common Tools for Sign Inspections

- **Retroreflectometer**: This device measures the retroreflective properties of the sign. It's used to ensure that the sign meets the minimum retroreflectivity levels set by standards like the Manual on Uniform Traffic Control Devices (MUTCD) in the United States.

Sign Management Software

- Some jurisdictions use sign management software systems, which help in tracking the condition, maintenance, and replacement of signs. These systems can schedule inspections, store photos and conditions of the signs, and help in planning budgets for sign replacement or repair.

Reasons for Inspection

A sign inspection program is crucial for a few key reasons:

- **Safety**: Traffic signs play a vital role in road safety, providing necessary information and guidance to drivers and pedestrians. Faded, damaged, or obscured signs can lead to confusion or misinterpretation, potentially causing accidents.
- **Legal Compliance**: Regular inspections ensure that all signs are in compliance with local and national regulations, which may change over time.
- **Maintenance and Budget Planning**: Regular inspections allow for identification of signs that need maintenance or replacement, helping to budget and plan for these expenses effectively.
- **Aesthetics and Community Image**: Well-maintained signs contribute to a positive community image and show attention to public safety.

As for the frequency of inspections, it can depend on a number of factors including local regulations, the type of sign, the environment, and the amount of wear and tear they typically experience. However, the Manual on Uniform Traffic Control Devices (MUTCD) suggests an inspection at least once a year for regulatory and warning signs, and once every two years for guide signs.

Signs & Markings

Lesson 7: Markings and Striping

Advancing the Future of Public Safety

General

Marking Types Include:

- Pavement and curb markings, delineators, colored pavements, channelizing devices, and islands.

Purpose:

- Used to supplement other traffic control devices such as signs, signals, and other markings.
- Used alone to effectively convey regulations, guidance, or warnings in ways not obtainable by the use of other devices.

Limitations:

- Visibility of the markings can be limited by snow, debris, and water on or adjacent to the markings.
- Durability is affected by material characteristics, traffic volumes, weather, and location.

Before Application

Before applying road marking, it is important to ensure that the road surface is properly prepared and that weather conditions are suitable. Here are the key considerations:

Road Surface Preparation

- Cleanliness
- Dryness
- Smoothness

Weather Conditions

- Temperature
- Humidity
- Rain
- Wind

In addition to the road surface preparation and weather conditions, it is crucial to consider the type of road marking material being used, as different materials may have specific requirements or recommendations for application. It is always advisable to follow the manufacturer's guidelines and consult with experienced professionals to ensure proper road marking application

Retroreflectivity

Retroreflectivity:

- Markings that must be visible at night shall be retroreflective unless ambient illumination assures that the markings are adequately visible.
- All markings on Interstate highways shall be retroreflective.

Signs & Markings

Lesson 7.1: Marking Materials

Advancing the Future of Public Safety

Materials

Various materials are used to create durable and highly visible road markings.

Materials Include:

- Paint
- Preform Thermo tape
- Self-adhesive tapes
- Thermoplastics

Choosing a Material:

- Choosing the appropriate material depends on factors such as durability requirements, visibility needs, and budget constraints.

Paint

Description:

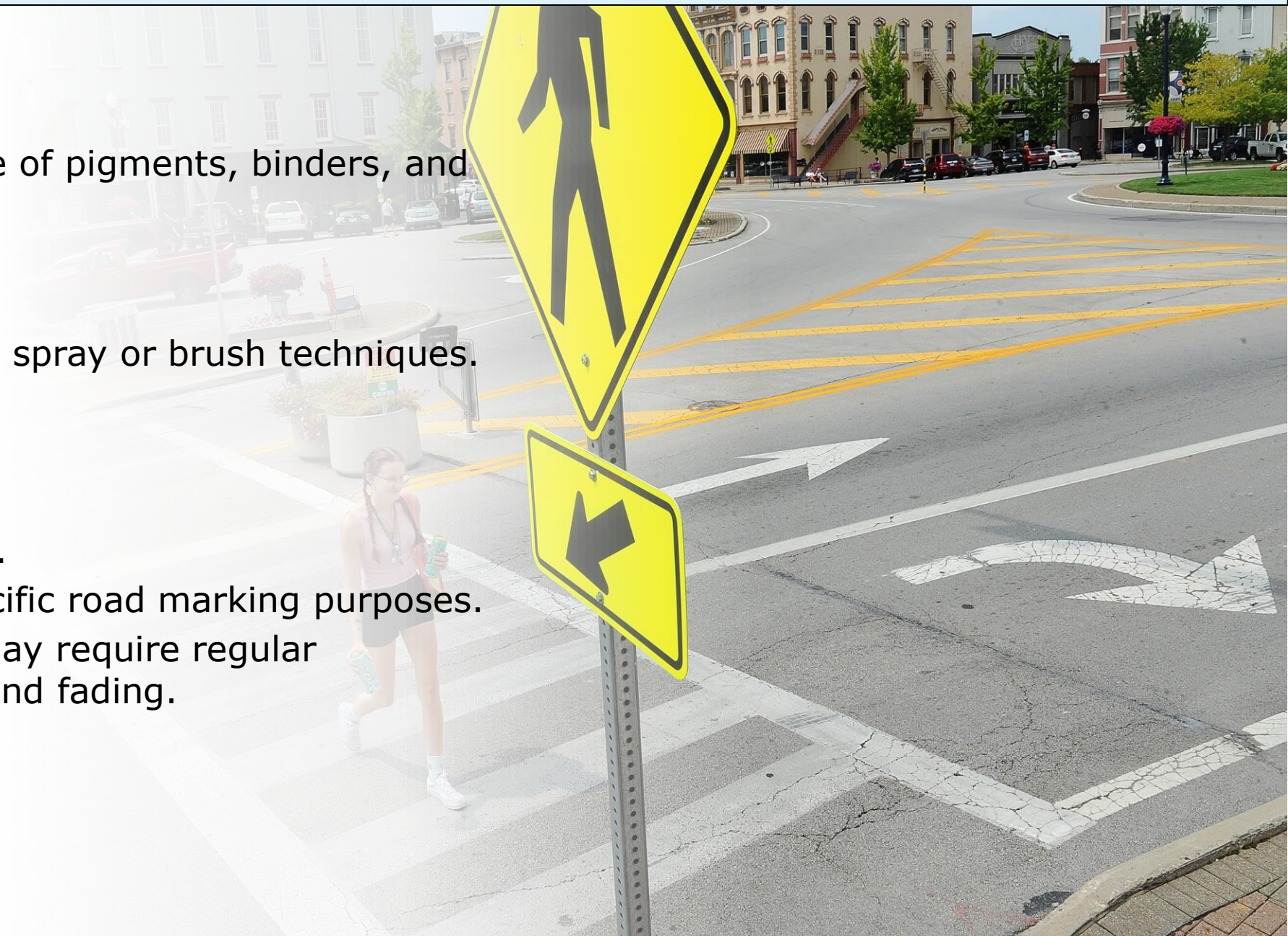
- Typically made of a mixture of pigments, binders, and solvents.

Application:

- Can be easily applied using spray or brush techniques.

Pros & Cons:

- Cost-effective.
- It comes in different colors.
- Can be customized for specific road marking purposes.
- However, paint markings may require regular maintenance due to wear and fading.



Paint

The common types of paint used for roadway markings include:

1. **Water-Based Paint**: Water-based paints are widely used for roadway markings due to their low VOC (volatile organic compounds) content and environmental friendliness. They are typically used for temporary markings or in areas with low traffic volume. Good Adhesion to concrete and asphalt.
2. **Thermoplastic Paint**: Thermoplastic paint is a durable option for roadway markings. It is a molten material that is applied to the road surface and then cools and solidifies. Thermoplastic markings have excellent durability and visibility, making them suitable for high-traffic areas.
3. **Epoxy Paint**: Epoxy-based paints provide exceptional durability and adhesion to road surfaces. They are resistant to wear, weathering, and chemicals. Epoxy paint is commonly used for long-lasting roadway markings, such as centerlines and stop bars.
4. **Chlorinated Rubber Paint**: Chlorinated rubber paint is a type of solvent-based paint that is resistant to water, oils, and chemicals. It offers good adhesion and durability on various road surfaces. Chlorinated rubber paint is often used for high-traffic areas or in locations where durability is a priority.
5. **Acrylic Paint**: Acrylic-based paints are commonly used for both roadway markings and signage. They provide good durability and visibility. Acrylic paint is available in various grades, including regular and high-build, depending on the desired thickness of the markings.
6. **Methyl Methacrylate (MMA) Paint**: MMA paint is a specialized type of road marking paint known for its fast drying time and excellent durability. It can be applied in a wide range of weather conditions, including low temperatures. MMA paint is commonly used for highway markings and in areas with heavy traffic.

Paint Acrylic / Solvent-Based

Acrylic paint is a common method for roadway markings

Here are the advantages and disadvantages of using acrylic paint for this purpose:

Advantages:

1. **Cost-effective**
2. **Quick Drying**
3. **Good Visibility**
4. **Ease of Application**
5. **Good Adhesion**

Disadvantages

1. **Limited Durability**
2. **Weather-Dependent**
3. **Reduced Reflectivity**
4. **Maintenance Requirements**

Chlorinated rubber paint is a type of solvent-based paint that is used for roadway markings.

Here are the advantages and disadvantages of using chlorinated rubber paint:

Advantages:

1. **Durability**
2. **Chemical Resistance**
3. **Adhesion**
4. **Fast Drying**
5. **Versatility**

Disadvantages

1. **VOC Content**
2. **Application Challenges**
3. **Limited Colors**
4. **Longevity**

Paint Applicator

A paint applicator for traffic markings is a specialized machine used to apply paint or thermoplastic materials on roads and highways to create clear and durable traffic markings, such as lane lines, crosswalks, arrows, and symbols. It is commonly used by road maintenance crews, highway departments, and contractors involved in road striping and marking operations.

- **Paint Tank or Material Hopper**: It is a large container that holds the paint or thermoplastic material used for creating the traffic markings. The tank may have various capacities depending on the size and type of the applicator.
- **Pumping System**: The pumping system is responsible for drawing the paint or thermoplastic material from the tank and transferring it to the marking head or spray nozzles. It usually consists of a pump, hoses, valves, and filters.
- **Marking Head or Spray Nozzles**: The marking head or spray nozzles are the components that disperse the paint or thermoplastic material onto the road surface. They are typically positioned underneath the machine and can be adjusted to control the width and thickness of the markings.
- **Control System**: The control system includes various switches, buttons, and levers that allow the operator to control the flow of paint or thermoplastic material, adjust the width and thickness of the markings, and start or stop the applicator.
- **Power Source**: Paint applicators can be powered by different sources, including gasoline engines, diesel engines, or electric motors. The power source provides the necessary energy to operate the pumping system and other components.

Paint Applicator Maintenance

Common types of maintenance on a paint applicator for traffic markings include:

- **Cleaning and Flushing**: Regular cleaning and flushing of the paint applicator are essential to prevent clogs and maintain optimal performance. This involves removing any remaining paint or thermoplastic material from the tank, hoses, and spray nozzles.
- **Inspection and Repair**: Routine inspections are conducted to identify any worn-out or damaged components that need repair or replacement. This includes checking hoses, valves, filters, pumps, and spray nozzles for any signs of wear or malfunction.
- **Calibration**: Calibration ensures the accurate flow and consistency of paint or thermoplastic material. The applicator's settings, such as pressure and flow rate, need to be periodically checked and adjusted if necessary to ensure the markings meet the required standards.
- **Lubrication**: Lubrication of moving parts, such as pumps and valves, is necessary to reduce friction and maintain smooth operation. This helps prevent premature wear and extends the lifespan of the applicator.
- **Storage and Winterization**: Proper storage and winterization are essential when the paint applicator is not in use for an extended period or during cold weather. This includes draining fluids, protecting components from freezing, and ensuring the machine is stored in a clean and dry environment.

MMA Paint

Description:

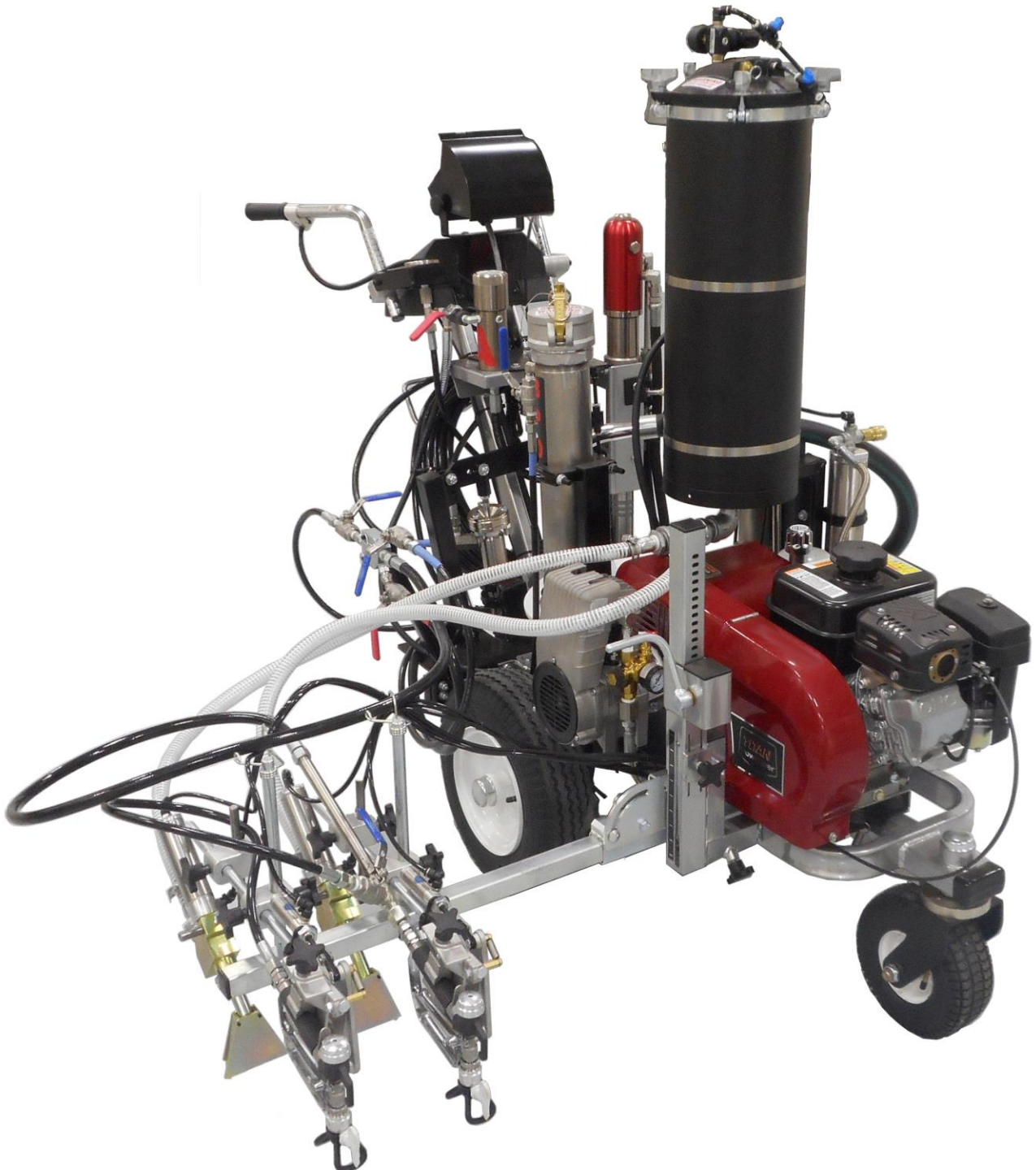
- MMA (Methyl Methacrylate) markings are a type of durable and high-performance surface coating.

Application:

- Can be easily applied using a spray applicator.

Pros & Cons:

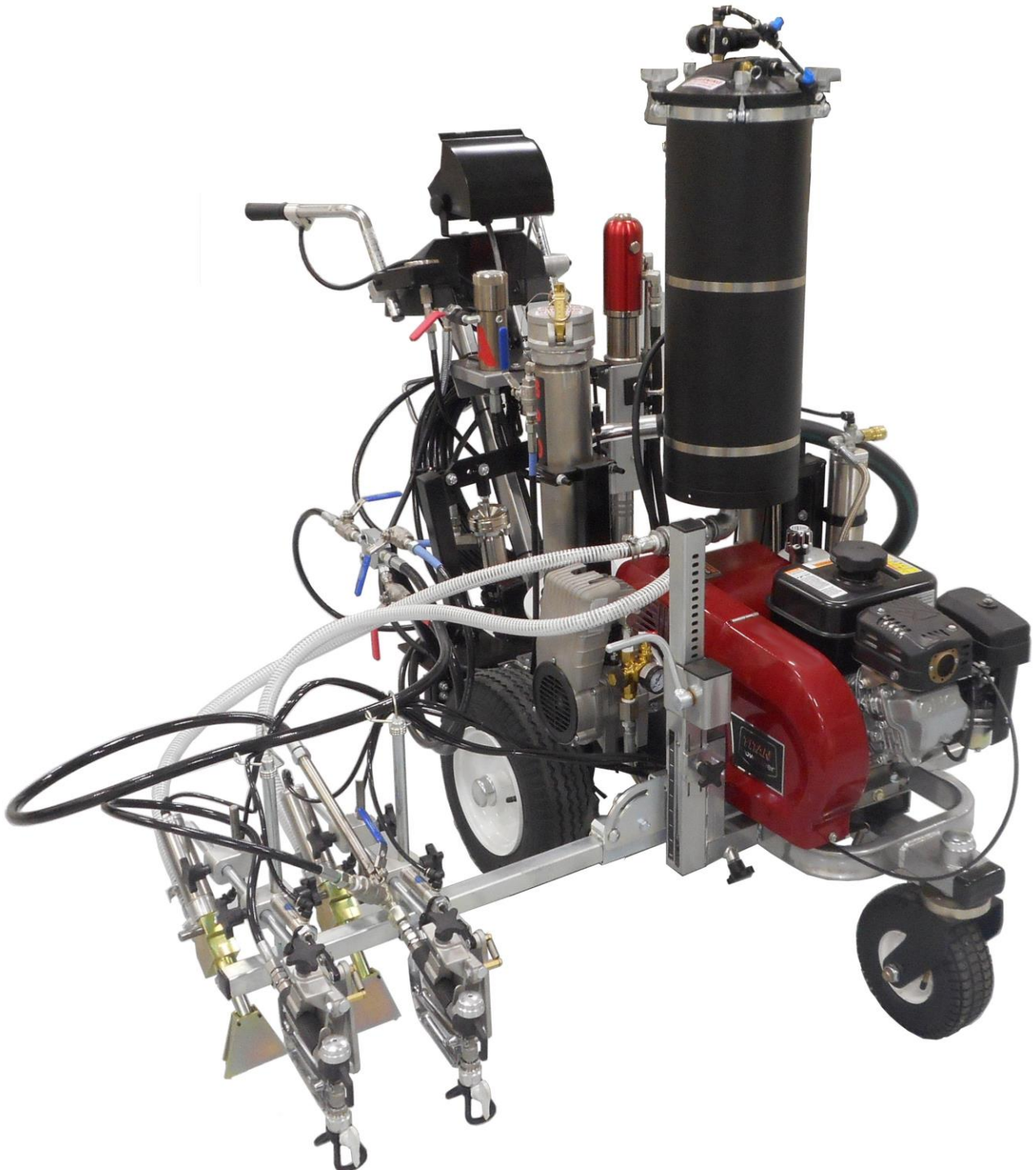
- High Durability and quick installation
- Chemical Resistance
- Excellent Adhesion and UV Stability
- Cost and Professional Installation
- Odor and Ventilation
- Limited Repair Options



MMA Applicator

An MMA (Methyl Methacrylate) applicator for traffic markings is a specialized machine used in road marking and pavement maintenance. MMA is a durable and highly reflective material commonly used for creating road markings such as lines, symbols, and other traffic signs.

- **Tank**: It holds the MMA material, which is a two-component liquid consisting of resin and hardener. The tank should be designed to mix the components properly and maintain the appropriate temperature.
- **Pumping System**: The applicator is equipped with a pumping system that pressurizes and transports the MMA material from the tank to the application nozzle. The pump must provide consistent flow and pressure for accurate and uniform markings.
- **Spray Nozzles**: These are responsible for evenly distributing the MMA material onto the road surface. The applicator usually has multiple spray nozzles arranged in a specific pattern to create the desired marking design.
- **Heating System**: Since MMA material requires specific temperatures for proper curing, the applicator often incorporates a heating system to regulate the temperature of the material during application. This ensures the markings cure quickly and adhere well to the road surface.
- **Control Panel**: The control panel allows the operator to manage and adjust various parameters, such as temperature, pressure, flow rate, and pattern of the markings. It provides control and monitoring functionalities for efficient application.

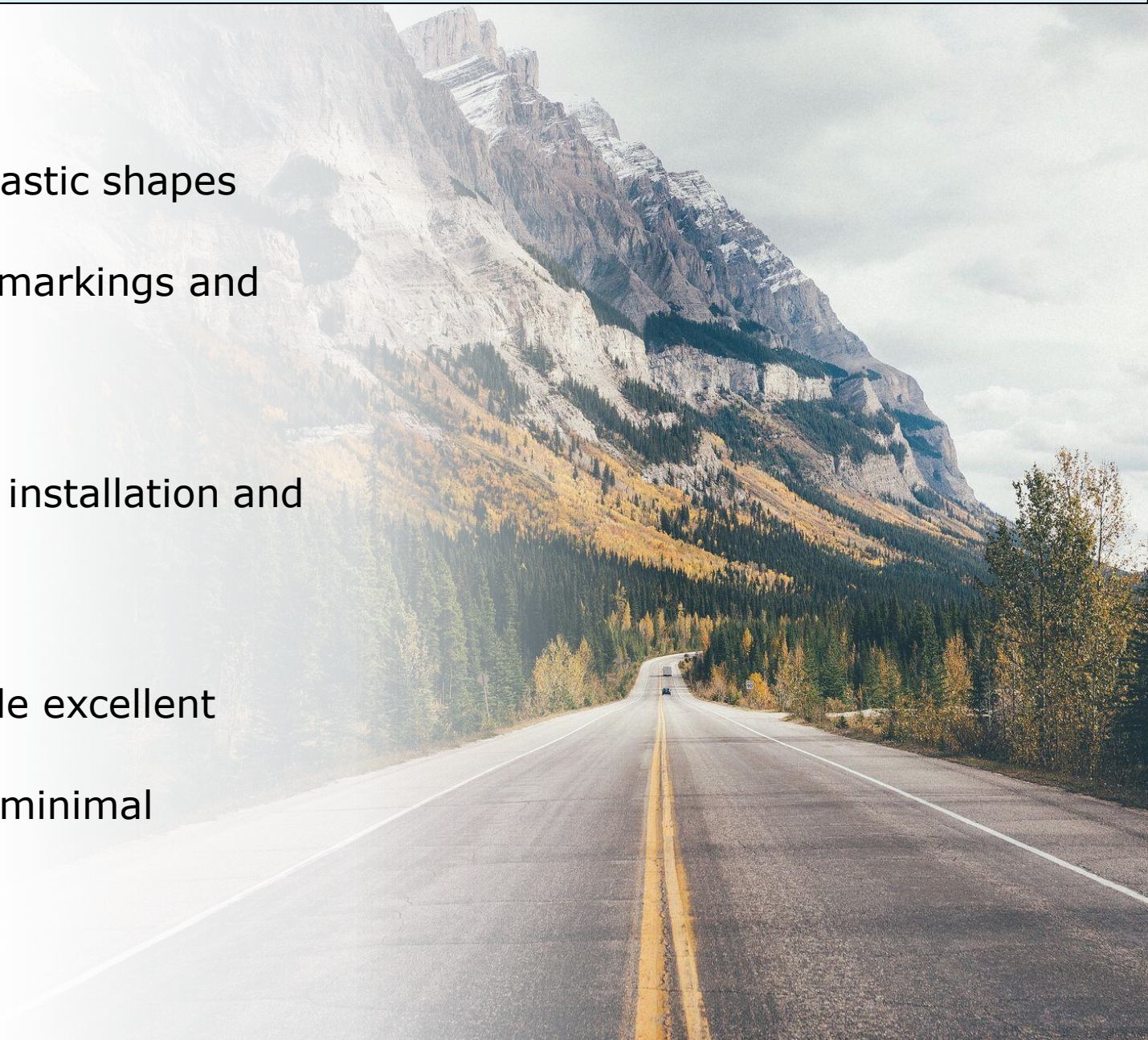


MMA Applicator Maintenance

Common types of maintenance performed on an MMA applicator include:

- **Cleaning**: Regular cleaning is necessary to prevent buildup and clogging of the spraying system. Proper cleaning ensures consistent flow and prevents blockages that may affect the quality of the markings.
- **Cleaning**: Regular cleaning is necessary to prevent buildup and clogging of the spraying system. Proper cleaning ensures consistent flow and prevents blockages that may affect the quality of the markings.
- **Calibration**: The applicator may require calibration to ensure accurate and precise application of the MMA material. This involves adjusting settings and parameters to achieve the desired line thickness, width, and pattern.
- **Material Storage and Handling**: Proper storage and handling of the MMA material are crucial for maintaining its quality. Appropriate storage conditions, such as temperature control, are necessary to prevent degradation or premature hardening of the material.
- **System Testing**: Regular system testing helps identify any potential issues or inefficiencies in the applicator. This may include testing the flow rate, pressure, temperature control, and overall performance of the machine.

Preform Thermoplastic Roll



Description:

- Preform tapes consist of pre-cut thermoplastic shapes adhered to a backing material.
- They are commonly used for longitudinal markings and symbols on roadways.

Application:

- Their peel-and-stick nature ensures quick installation and reduces traffic disruptions.

Pros & Cons:

- These tapes are highly durable and provide excellent retroreflectivity for enhanced visibility.
- Preform tapes offer easy application with minimal equipment and labor requirements.

Preformed thermoplastic Rolls - Storage

To ensure the proper storage of traffic preform tape, you should follow these guidelines:

- **Temperature**: Store the tape in a cool, dry place away from direct sunlight and extreme temperature fluctuations. Ideally, the temperature should be between 10°C and 30°C (50°F to 86°F).
- **Humidity**: Keep the tape in a low-humidity environment to prevent moisture absorption. High humidity can damage the adhesive and affect the tape's performance. Aim for a relative humidity level of around 40% to 50%.
- **Vertical Storage**: Store the traffic preform tape in a vertical position, either on its side or upright. This helps prevent warping or deformation of the tape. If you need to store it horizontally, ensure that it is on a flat surface and not under heavy objects that can cause pressure damage.
- **Protective Packaging**: If the tape comes in its original packaging, keep it intact. The packaging provides additional protection against dust, dirt, and moisture. If the packaging is damaged or removed, consider using a suitable alternative, such as a plastic bag or airtight container, to keep the tape clean and protected.
- **Avoid Chemical Exposure**: Keep the tape away from chemicals, solvents, oils, and other substances that can degrade or stain it. Chemical exposure can affect the tape's adhesive properties and overall performance.
- **Handling**: Handle the tape with clean hands to avoid transferring dirt, oils, or moisture onto the surface. Avoid excessive bending, twisting, or folding, as this can damage the tape or cause creases that affect its functionality.

By following these storage guidelines, you can help prolong the lifespan and maintain the quality of your traffic preform tape.

Preformed thermoplastic - Installation

To install preformed thermoplastic pavement markings, follow these general steps:

- **Surface Preparation**: Prepare the surface by cleaning it thoroughly to remove dirt, debris, and loose material. The surface should be dry and free from any contaminants that may affect the adhesion of the preformed thermoplastic.
- **Measure and Layout**: Measure the area where the markings will be installed and plan the layout accordingly. Use marking tape or chalk lines to mark the desired positions of the preformed thermoplastic markings. This step ensures accurate placement and alignment.
- **Heat the Thermoplastic**: Preformed thermoplastic markings require heat to become pliable and adhere to the pavement. Use a propane torch or a specialized heating apparatus designed for thermoplastic application to heat the markings. Follow the manufacturer's instructions for heating time and temperature.
- **Position and Apply**: Once the preformed thermoplastic is sufficiently heated and flexible, carefully position it on the marked area. Press it firmly onto the pavement, ensuring proper adhesion. Use a roller or a hand tool to smooth out any air bubbles or wrinkles, ensuring a flat and uniform appearance.
- **Cool and Cure**: Allow the installed preformed thermoplastic to cool and cure as per the manufacturer's instructions. Avoid any foot or vehicle traffic during this curing period to ensure proper bonding and durability.
- **Clean-Up**: Clean up any excess or spilled thermoplastic material immediately, using a suitable solvent if necessary. Dispose of waste materials following local regulations and guidelines.

Preformed thermoplastic - Installation

Self-Adhesive Tapes

Description:

- Self-adhesive tapes are made of durable materials such as vinyl or polyester.
- They are commonly used for temporary road markings or to highlight hazards or construction zones.

Application:

- These tapes have a pressure-sensitive adhesive backing for easy application.

Pros and Cons:

- Self-adhesive tapes are removable and can be repositioned when necessary.
- They provide good visibility, but their lifespan may be shorter compared to other materials.

Self-Adhesive Tape – storage

- **To properly store self-adhesive traffic markings, you should adhere to the following guidelines:**
  - **Temperature and Humidity**: Store the self-adhesive traffic markings in a controlled environment similar to the guidelines provided for traffic preform tape. Keep them in a cool, dry place with temperatures between 10°C and 30°C (50°F to 86°F) and relative humidity levels of around 40% to 50%.
  - **Protective Packaging**: If the markings are in their original packaging, maintain the packaging's integrity and keep them in it until they are ready to be used. The packaging provides protection against dust, dirt, and moisture. If the packaging is damaged or removed, use an alternative such as a plastic bag or airtight container to store the markings.
  - **Vertical Storage**: Store the markings in a vertical position to prevent warping or deformation. If storing horizontally, ensure they are on a flat surface and not under heavy objects that could cause pressure damage.
  - **Avoid Chemical Exposure**: Keep the markings away from chemicals, solvents, oils, or any substances that could degrade the adhesive or affect the markings' integrity. Chemical exposure can compromise their adhesive properties and durability.
  - **Handling**: When handling the markings, use clean hands to avoid transferring dirt, oils, or moisture onto the adhesive surface. Avoid excessive bending, folding, or twisting, as this can damage the markings.

- Following these storage recommendations will help maintain the quality and adhesive properties of self-adhesive traffic markings, ensuring they are ready for effective use when needed.

Self-Adhesive Tape – Installation (1)

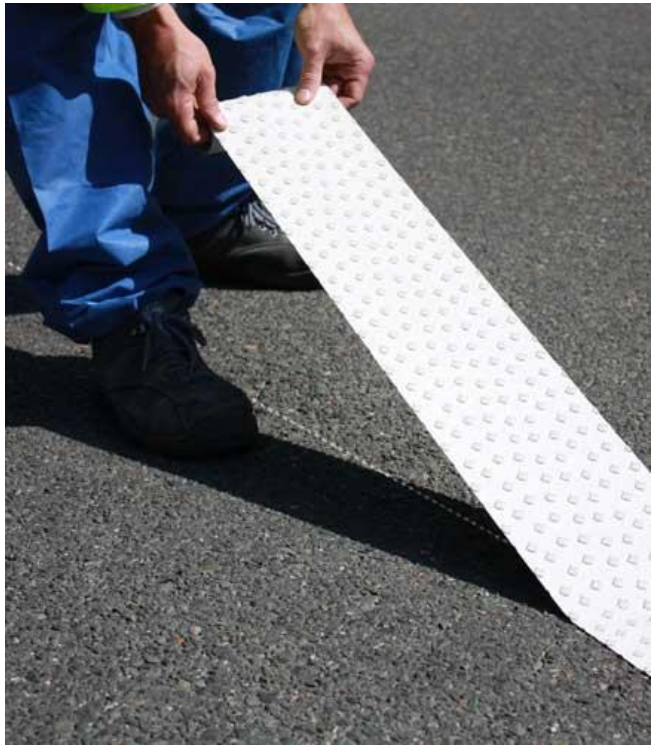
Installing pavement marking tape involves several steps and requires specific equipment. Here's a general overview of the process:

- **Prepare the Surface**: The pavement surface must be clean and free from dirt, debris, and loose material. Use a broom or a blower to remove any loose particles and ensure a clean working area.
- **Measure and Plan**: Determine the layout and placement of the pavement marking tape. Measure the distance and mark the positions where the tape will be installed. Use chalk or marking paint to make these markings.
- **Temperature Considerations**: Pavement marking tape installation typically requires specific temperature conditions. The tape manufacturer will provide guidelines regarding the optimal temperature range for installation. It is crucial to follow these guidelines for proper adhesion and longevity of the markings. Generally, the pavement surface temperature should be above the minimum specified temperature for the tape to bond effectively.

Self-Adhesive Tape – Installation (2)

Equipment Required:

- **Pavement Cleaner**: Use a high-pressure water jet or a pavement cleaner to thoroughly clean the surface and remove any remaining dirt or contaminants.
- **Heat Gun or Torch**: A heat gun or torch is used to warm the pavement surface and activate the adhesive on the marking tape. The heat source should be adjustable to control the temperature.
- **Tape Applicator**: A tape applicator is used to apply the pavement marking tape accurately and evenly. It typically consists of a roller or squeegee mechanism to press the tape firmly onto the pavement.
- **Safety Equipment**: It's essential to wear appropriate safety gear, including gloves, goggles, and high-visibility clothing, to protect against potential hazards during the installation process.



Self-Adhesive Tape – Installation (3)

Install the Tape:

- **Position the Tape**: Align the pavement marking tape with the markings made earlier and place it on the prepared surface. Ensure that the tape is straight and properly aligned with the desired markings.
- **Apply Heat**: Use the heat gun or torch to warm the pavement surface beneath the tape. Move the heat source evenly across the tape, following the manufacturer's instructions, to activate the adhesive.
- **Press and Roll**: Once the adhesive is activated, use the tape applicator to press and roll the tape firmly onto the pavement. Apply consistent pressure to ensure proper adhesion and eliminate any air bubbles or wrinkles. Work from one end to the other, gradually securing the tape onto the surface.

Trim and Finish: After the tape is installed, trim any excess tape using a sharp utility knife. Ensure clean and neat edges. If necessary, reheat the trimmed edges to ensure proper sealing.

Self-Adhesive Tape – Butt Splicing

"Butt splicing" in the context of traffic marking tapes refers to the method of applying the tapes end-to-end without any overlap. This is done to ensure a smooth and even surface, which is crucial for effective visibility and longevity of the markings. This method is preferred to overlapping the tapes, which could create a bump or ridge at the overlap point, potentially causing the tape to peel, crack, or degrade prematurely. Furthermore, any overlaps could also affect the retroreflectivity of the marking, which is essential for night-time visibility.

Overlapping traffic marking tapes is generally discouraged for several reasons:

1. **Confusion and Misinterpretation**: Overlapping can cause confusion for drivers, pedestrians, and other road users. It can obscure the original meaning of the markings and potentially lead to misinterpretations.
2. **Poor Adhesion**: Overlapping tapes can create uneven surfaces that may lead to poor adhesion, and consequently, the tape might peel or wear off more quickly. The tape is designed to adhere directly to the surface of the road, and overlapping can compromise this.
3. **Reduced Visibility**: If the tapes overlap, it can reduce their visibility, especially in adverse weather conditions or at night. This could potentially lead to accidents or unsafe situations.
4. **Waste of Resources**: Overlapping tapes might also be seen as a waste of resources. Traffic marking tapes are typically designed to last for a certain period of time and to cover a specific area. Overlapping them could mean using more tape than necessary, leading to unnecessary costs.
5. **Standards Compliance**: Traffic marking standards and guidelines set by regulatory bodies (like the Department of Transportation in the US, or equivalent organizations in other countries) often specify how these markings should be used. Overlapping them might violate these guidelines, potentially leading to penalties or other enforcement actions.

Temporary VS Long-Term Marking Tape

Temporary Markings Tape: Temporary markings tape is designed for short-term applications where a temporary marking or visual indication is needed. It is typically made of materials like vinyl or cloth and has a moderate adhesive backing that allows it to be easily applied and removed without leaving behind residue or causing damage to surfaces. Temporary markings tape is commonly used for activities such as temporary floor marking for events, construction or renovation projects, marking off areas for maintenance or repairs, and temporary signage.

Long-Term Markings Tape: Long-term markings tape, on the other hand, is designed to provide durable and permanent markings that can withstand regular wear and tear over an extended period. It is usually made of more robust materials like heavy-duty vinyl or thermoplastic and has a stronger adhesive backing for long-lasting adhesion. Long-term markings tape is intended for applications that require durable markings, such as warehouse floor marking, parking lot striping, safety markings in industrial settings, and traffic control markings on roads and highways.

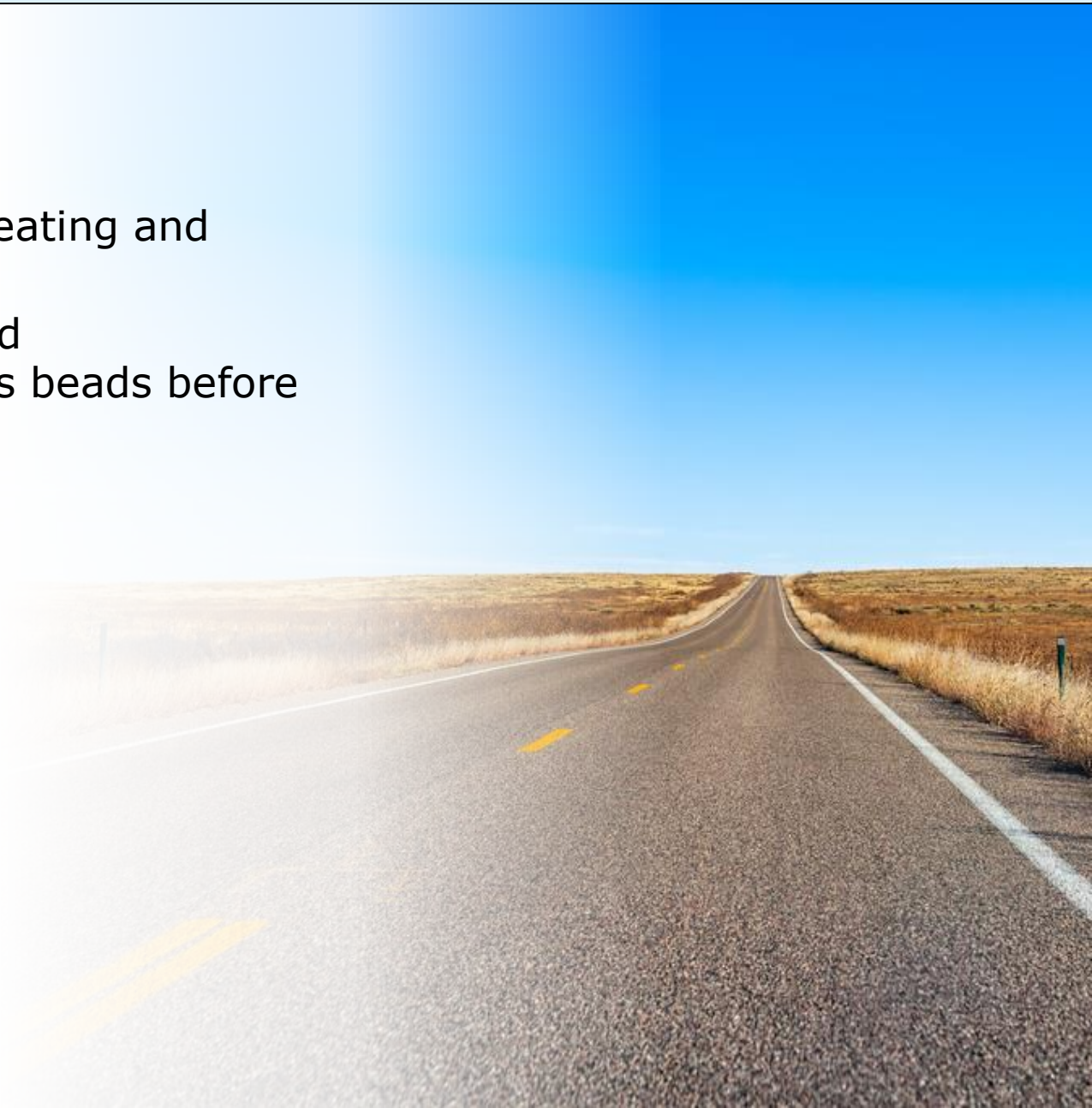
Thermoplastic Paint

Description & Application:

- Thermoplastic road markings are created by heating and melting a mixture of resins and pigments.
- This molten material is then applied to the road surface. This is where you would add the glass beads before the material cools and hardens.

Pros and Cons:

- Durability and Visibility
- Quick Drying Time
- Longevity
- Cost – More expensive
- Equipment and skill requirements
- Limited flexibility
- Enviornmental Concerns



Thermoplastic – storage

To store thermoplastic pavement marking material properly, you should adhere to the following guidelines:

- **Temperature**: Thermoplastic pavement marking material should be stored in a temperature-controlled environment. Ideally, the storage temperature should be between 15°C and 25°C (59°F to 77°F). Avoid exposing the material to extreme temperatures, as it can affect its consistency and performance.
- **Ventilation**: Ensure proper ventilation in the storage area to prevent the accumulation of heat and moisture. Good air circulation helps maintain the quality of the material and prevents moisture-related issues.
- **Protection from Moisture**: Moisture can adversely affect thermoplastic pavement marking material. Store it in a dry area away from water sources, leaks, and excessive humidity. Moisture can cause the material to clump or degrade, reducing its effectiveness during application.

Thermoplastic – storage

To store thermoplastic pavement marking material properly – Cont.

- **Protection from Sunlight**: Direct exposure to sunlight can lead to premature aging and degradation of thermoplastic pavement marking material. Store it away from windows or any other direct light sources to minimize UV exposure.
- **Stacking and Handling**: If storing multiple containers of the material, stack them carefully, ensuring that the weight is evenly distributed. Avoid stacking them too high, as excessive weight can cause deformation or damage to the containers. When handling the material, use proper lifting techniques and equipment to prevent injuries and spills.

By following these storage guidelines, you can help maintain the quality and effectiveness of thermoplastic pavement marking material, ensuring optimal results during application.

Thermoplastic Paint Installation

When installing thermoplastic preformed markings, it is important to consider the air and pavement temperatures to ensure proper application and adherence of the markings. While the specific temperature requirements may vary depending on the manufacturer and product specifications, typically, the minimum air and pavement temperatures should be above 50°F (10°C).

Thermoplastic preformed markings require a certain level of heat to melt and adhere to the pavement surface effectively. If the temperatures are too low, the thermoplastic material may not bond properly, leading to reduced durability and premature failure of the markings. Additionally, colder temperatures can also affect the overall quality of the application, resulting in a subpar finish.

It is important to consult the manufacturer's guidelines or product datasheet for the specific temperature recommendations for the thermoplastic preformed markings you are using. Following the manufacturer's instructions will help ensure a successful installation and maximize the longevity of the markings.

Thermoplastic Paint Installation

The minimum temperature required for heating thermoplastic extrusion products before application can vary depending on the specific product and manufacturer's recommendations. However, as a general guideline, the typical minimum heating temperature for thermoplastic striping materials is around 400 to 450 degrees Fahrenheit (204 to 232 degrees Celsius). This temperature range allows the material to melt and become sufficiently fluid for application.

It's important to note that different thermoplastic materials may have different melting points and heating requirements, so it's crucial to follow the manufacturer's instructions and guidelines for the specific product you are using. The manufacturer should provide detailed information on the recommended heating temperature, application techniques, and any other specific requirements for successful and durable striping installation.

Thermoplastic Handliner Applicator

A thermoplastic handliner applicator is a specialized tool used in road marking applications. It is designed to melt and apply thermoplastic materials to create durable and long-lasting road markings.

The thermoplastic handliner applicator consists of several key parts, each serving a specific function in the application process. Here are the main components typically found in a thermoplastic handliner applicator:

- Material Hopper
- Heating System
- Melting Chamber
- Application Shoe
- Control Panel
- Propane or Gas Tank (optional)
- Wheels and Handles

Thermoplastic Handliner Maintenance

To ensure optimal performance and longevity of a thermoplastic hardliner applicator, regular maintenance is crucial. Here are some general maintenance practices:

- **Cleaning:** After each use, it is important to clean the applicator thoroughly. Remove any remaining thermoplastic material and debris from the hopper, melting chamber, and application shoe. Use appropriate cleaning agents or solvents as recommended by the manufacturer.
- **Inspection**: Regularly inspect the applicator for any signs of wear, damage, or leaks. Check the hoses, connections, and heating elements for any abnormalities. Replace or repair any faulty parts promptly.
- **Lubrication**: Some applicators may require lubrication at specific points to ensure smooth movement. Consult the manufacturer's guidelines for the recommended lubricants and intervals.
- **Calibration**: Periodically check the temperature controls and flow rate settings to ensure they are accurate. Recalibrate if necessary to maintain consistent application performance.
- **Storage**: Store the applicator in a clean and dry environment when not in use. Protect it from extreme temperatures, moisture, and direct sunlight.
- **Training and Operator Knowledge**: Ensure that operators are properly trained in the use and maintenance of the applicator. Familiarize them with the manufacturer's instructions and safety guidelines.

Thermoplastic Dies and Screed Boxes Applying Thermo to the Pavement

Although very similar, the main difference between a screed box and a die lies in their function and the type of pavement markings they are used for in the application of thermoplastic materials. Here's a breakdown of the key distinctions:

Screed Box:

- **Function**: A screed box is used for the application of continuous and long-line thermoplastic pavement markings, such as traffic lane lines, crosswalks, or bike lanes.
- **Application**: The screed box dispenses molten thermoplastic material in a controlled manner onto the pavement surface. It typically has a slot or opening at the bottom through which the thermoplastic is poured and distributed.
- **Leveling and Thickness Control**: The screed box is equipped with a screed shoe or plate that helps level and control the thickness of the applied thermoplastic material. This ensures uniformity and consistency in the pavement marking.
- **Movement**: The screed box is moved along the desired path or marking line, guided by handles or other guiding mechanisms, to create a continuous and uninterrupted pavement marking.
- **Shapes and Patterns**: Screed boxes are not designed to create intricate shapes or patterns. They are primarily used for straight and continuous line markings.

Die:

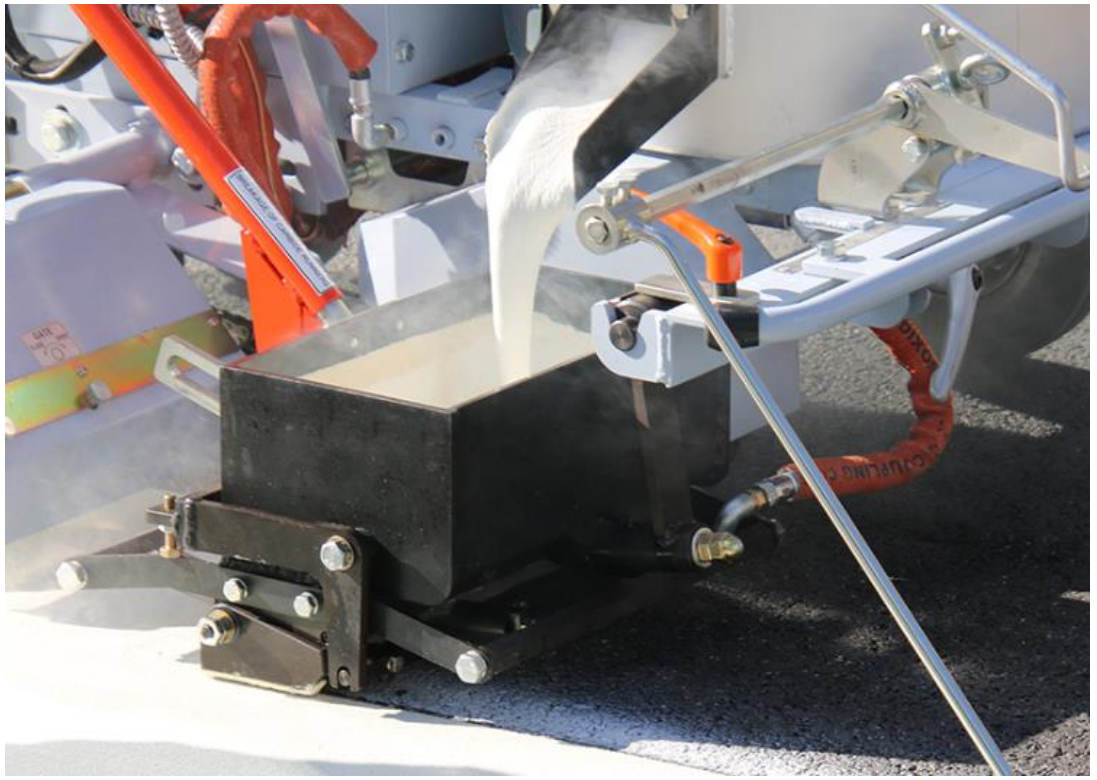
- **Function**: A die is used for the application of individual shapes, symbols, arrows, or letters as thermoplastic pavement markings.
- **Application**: The die is pressed into the molten thermoplastic material, leaving an impression and creating a specific shape or pattern. It is typically handheld or attached to a specialized applicator machine.
- **Precision and Detail**: Dies are designed with intricate details and specific shapes to create precise markings. They allow for greater customization and versatility in pavement marking designs.
- **Individual Markings**: Dies are used to create individual markings, such as arrows, symbols, letters, or numbers, rather than continuous line markings.
- **Size and Variety**: Dies come in various sizes and shapes to accommodate different pavement marking requirements, allowing for flexibility in design options.

Thermoplastic Dies and Screed Boxes Applying Thermo to the Pavement

Although very similar, the main difference between a screed box and a die lies in their function and the type of pavement markings they are used for in the application of thermoplastic materials. Here's a breakdown of the key distinctions:

Screed Box:

Die:



Thermoplastic Screed Boxes Applying Thermo to the Pavement

Screed boxes used for thermoplastic pavement marking application may encounter various maintenance issues over time. Here are some common maintenance issues associated with screed boxes:

1. **Wear and Tear:** thermoplastic material die screed box might leak is due to a damaged or worn-out sealing gasket or o-ring.
2. **Clogging**: If the screed box is not properly cleaned after use, thermoplastic residue can build up inside the box, particularly in the dispensing slot or opening. This residue can harden and clog the box, obstructing the smooth flow of molten thermoplastic during future applications.
3. **Deformation or Damage**: Screed boxes can become damaged or deformed due to mishandling, accidental impacts, or exposure to excessive heat. This can affect the alignment of the box and its ability to dispense thermoplastic evenly, resulting in irregular markings.
4. **Rust or Corrosion**: If the screed box is made of metal, it can be susceptible to rust or corrosion if not properly cleaned and stored. Exposure to moisture or harsh environmental conditions can accelerate corrosion, compromising the box's functionality and appearance.
5. **Loose or Worn Components**: Screed boxes often have movable parts or fasteners that may loosen or wear out over time. Loose bolts, screws, or hinges can affect the stability and performance of the box during application.

Thermoplastic Dies Applying Thermo to the Pavement

Thermoplastic marking dies, like any tool, may encounter certain maintenance issues over time. Here are some common maintenance issues that can occur with thermoplastic marking dies:

1. **Wear and Tear**: With repeated use, marking dies can experience wear and tear. The constant contact with hot thermoplastic material and the pavement surface can cause the die's edges to wear down or become blunt. This can affect the quality and sharpness of the markings produced.
2. **Build-up of Residue**: Over time, thermoplastic residue can accumulate on the marking die. This build-up can occur when the die is not adequately cleaned after each use. The residue can affect the die's performance, resulting in uneven or distorted markings.
3. **Damage or Deformation**: Marking dies can sustain damage or deformation due to accidental impacts, mishandling, or exposure to extreme temperatures. Cracks, chips, or bent edges can affect the die's ability to create precise markings.
4. **Clogging**: If the die has intricate details or small openings, it can be susceptible to clogging. Bits of solidified thermoplastic or debris can get lodged in the die, obstructing the flow of molten material and leading to inconsistent or incomplete markings.
5. **Rust or Corrosion**: If the marking die is made of metal, it can be susceptible to rust or corrosion if not properly cleaned and stored. Exposure to moisture or harsh environmental conditions can accelerate the corrosion process, affecting the die's surface and functionality.
6. **Loss of Alignment**: Over time, the positioning and alignment of the die's components may shift or become misaligned. This can impact the accuracy and consistency of the markings produced.

Glass Beads

Glass beads for traffic markings are small, spherical beads made from high-index, lead-free glass. These beads are primarily used for road markings and signage, including crosswalks, lane markings, and directional signs. The purpose of these beads is to provide retroreflectivity, which makes the markings more visible, especially in low-light or night-time conditions.

Glass beads can range in size but are generally about the size of a grain of sand. These are classified into several types based on their size and reflective properties. Commonly used types include Type I, Type III, and Type IV.

- **Type I**: These are smaller glass beads commonly used for regular traffic paint.
- **Type III**: These are larger and more reflective than Type I beads, often used for high-performance markings.
- **Type IV**: These are the most reflective and are typically used in long-lasting thermoplastic or durable tape markings.

- The installation of glass beads in traffic markings is typically done in two main ways:

- **Drop-on beads**: These are spread or "dropped" onto the still-wet paint immediately after the paint is applied to the roadway. As the paint dries, the beads become embedded in the paint, but enough of the bead remains exposed to reflect light back to the driver's eyes.
- **Premixed beads**: These are mixed into the paint before application. Once the paint is applied to the roadway, these beads provide retroreflectivity as the paint wears away.

The application rate of glass beads can vary depending on the specific regulations of a region or the requirements of a particular project. However, a common range for drop-on beads is around 6 lbs/gallon of paint. For premixed beads, the ratio can be around 25 lbs of beads to every 100 lbs of paint.

Mil Thickness gauge

- A mil thickness gauge, also known as a mil gauge or a paint thickness gauge, is a device used to measure the thickness of a coating or paint film on a surface. It is commonly used in industries such as automotive, manufacturing, and construction to ensure that coatings are applied within specified tolerances.
- The term "mil" refers to one thousandth of an inch (0.001 inch or 0.0254 millimeters). A mil gauge typically consists of a small, handheld instrument with a probe or sensor that is placed on the coated surface. The gauge then provides a reading or measurement of the coating thickness in mils.
- The mil thickness for paint, MMA (Methyl Methacrylate), and thermoplastic for traffic markings can vary depending on specific requirements and local regulations. However, here are some general guidelines:
- **Paint:** The mil thickness for traffic paint typically ranges from 3 to 15 mils (0.003 to 0.015 inches). The specific mil thickness may depend on factors such as the type of paint, surface conditions, and durability requirements.
- **MMA (Methyl Methacrylate)**: MMA is a durable type of pavement marking material. The mil thickness for MMA markings can range from 20 to 60 mils (0.02 to 0.06 inches) or even more. MMA is known for its high visibility and long-lasting performance.
- **Thermoplastic**: Thermoplastic materials are commonly used for traffic markings due to their durability. The mil thickness for thermoplastic markings can range from 60 to 120 mils (0.06 to 0.12 inches) or more. Thermoplastic markings are heated and applied to the pavement, creating a thick, highly visible layer.

- It's important to note that local regulations and standards can dictate specific mil thickness requirements for traffic markings. It is recommended to consult local transportation authorities or industry guidelines to determine the appropriate mil thickness for your specific project.

Removing Pavement Markings

Pavement markings can be removed through several methods, each with its own benefits and drawbacks.

- **Grinding**: This involves using a grinding machine to wear down the marking. The biggest benefit of grinding is that it's fast and efficient, but the downside is that it can damage the surface of the pavement if not done carefully.
- **Water Blasting**: Also known as hydroblasting or water jetting, this method uses pressurized water to remove the markings. Water blasting is considered more gentle on the pavement surface than grinding, but it can be more time-consuming and might not fully remove the markings, particularly if they are very thick or deeply ingrained.
- **Sandblasting**: Sandblasting uses small particles, usually sand, to remove the pavement markings. This method is effective, but it can be messy and may damage the pavement surface.
- **Chemical Removal**: Some companies use chemicals to break down and remove the markings. However, this method has environmental concerns and can be harmful if the chemicals are not managed properly.
- **Thermal Lance/Heat**: This method uses high temperatures to burn off or evaporate the markings. It can be effective, but it also has a high risk of damaging the pavement and may result in an uneven surface.
- **Shot Blasting**: Shot blasting propels small steel balls at high speed towards the surface, thereby removing the markings. This method is quick and effective but can cause damage to the surface if not done correctly.
- **Scraping**: Scraping uses blades to scrape off the pavement marking. This is a slower method, and like grinding, it has the potential to damage the surface if not done carefully.

Removing Pavement Markings

The two most common methods for Markings removal are:

Grinding:

Water Blasting:

Signs & Markings

Lesson 7.2: Longitudinal Lines

Advancing the Future of Public Safety

Colors

Use:

- Road markings use different colors to convey important information and improve traffic safety.
- Each color has a specific meaning and is selected based on its visibility and recognition characteristics.

White:

- White is the most commonly used color for road markings.
- It signifies separation between lanes and the edge of the roadway.
- White lines are used for lane markings, crosswalks, stop lines, and symbols.
- They provide high visibility, especially at night, due to their contrast with the road surface.

Yellow:

- Yellow is used for road markings that indicate caution or warnings.
- It is commonly used for centerline markings on two-lane roads with no separation.
- Yellow lines may also indicate no-passing zones or areas with restricted access.
- These markings provide enhanced visibility and help alert drivers to potential hazards.

Colors (continued)

Red:

- Red markings generally are reserved for Fire Lane Markings.

Blue:

- Blue is occasionally used for road markings, particularly for parking spaces reserved for disabled individuals.
- Blue markings help designate accessible parking areas and provide visual cues for drivers.

Other Colors:

- Other colors such as green and orange may be used for specific purposes or in special circumstances.
- Green may indicate bike lanes or areas where pedestrians have the right of way.
- Orange markings are often used in work zones to delineate temporary traffic patterns.

Functions, Widths, and Patterns of Longitudinal Pavement Markings

A double line indicates maximum or special restrictions.

- 4 to 6 inches wide
- Two parallel lines separated by a discernible space

A solid line discourages or prohibits crossing.

- 4 to 6 inches wide
- Wide line: at least twice the width of a normal line

A broken line indicates a permissive condition.

- Normal line segments separated by gaps

A dotted line provides guidance or warning of a change in lane function.

- Noticeably shorter line segments separated by shorter gaps than used for a broken line
- The width of a dotted line extension shall be at least the same as the width of the line it extends

Yellow Center Line Pavement Markings and Warrants

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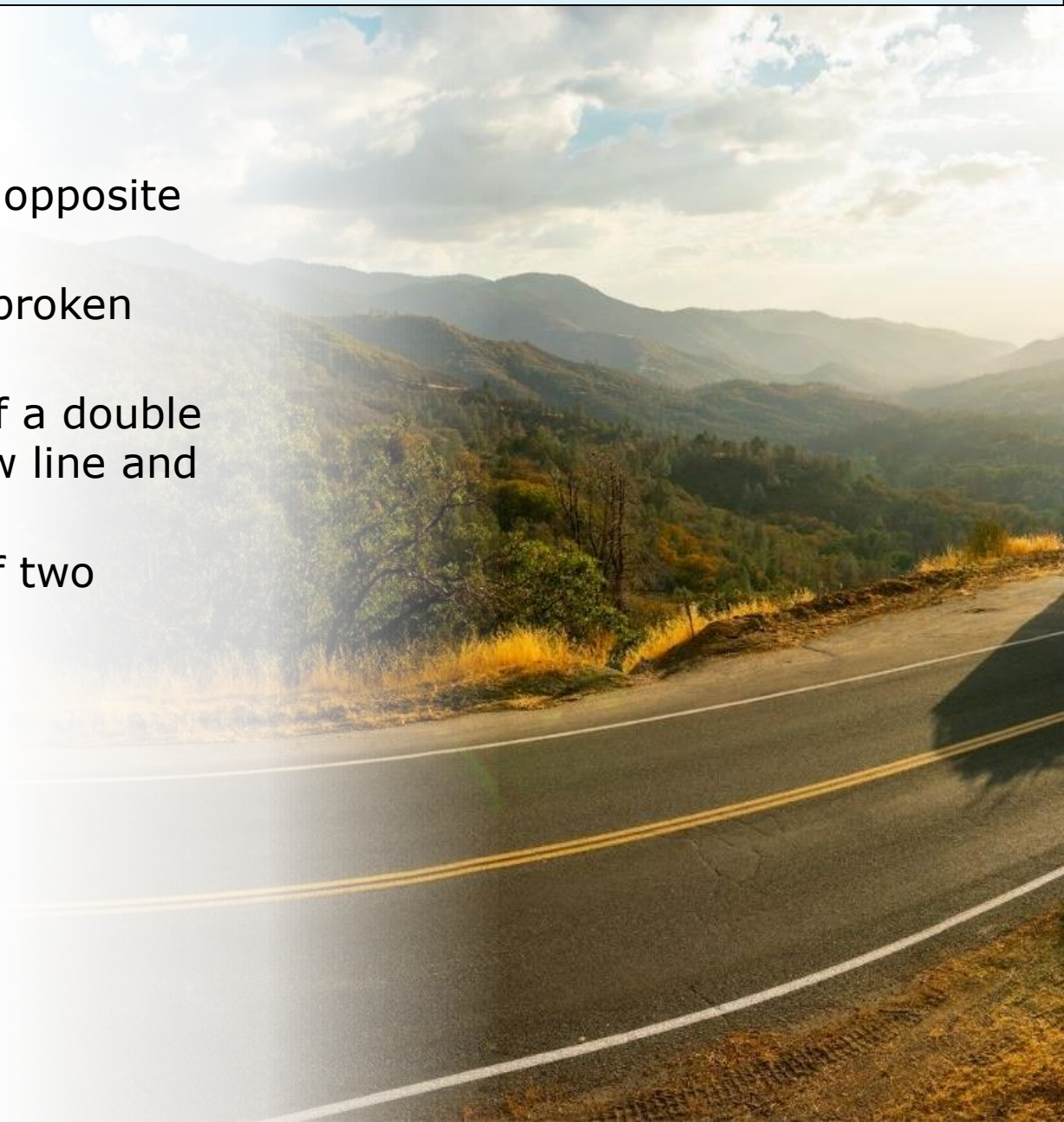
Use:

- Delineate the separation of traffic lanes that have opposite directions of travel on a roadway.
- Two-direction passing zone markings consist of a broken yellow line.
- One-direction no-passing zone markings consist of a double yellow line, one of which is a normal broken yellow line and the other is a normal solid yellow line.
- Two-direction no-passing zone markings consist of two normal solid yellow lines.



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Yellow Center Line Pavement Markings and Warrants

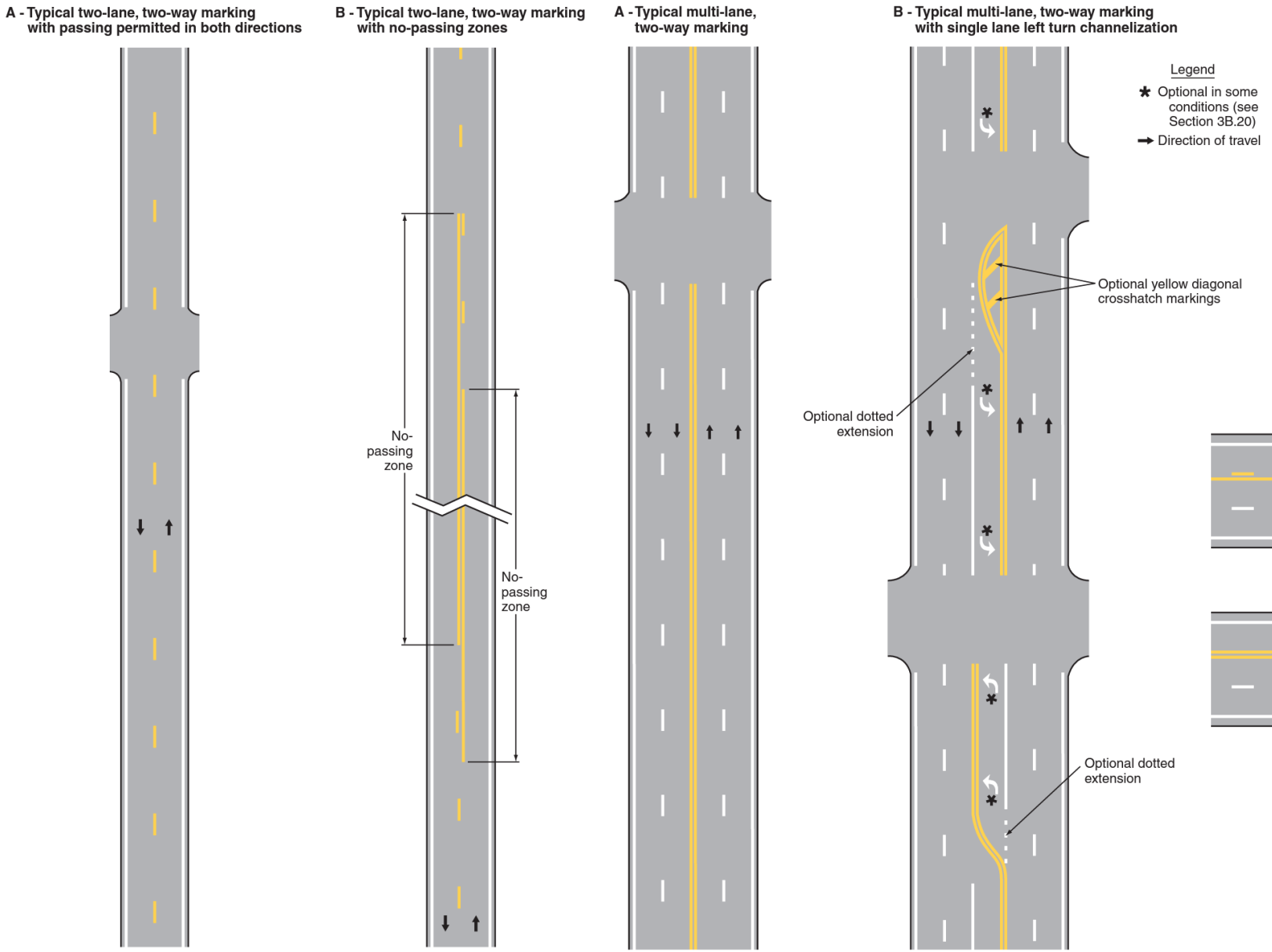
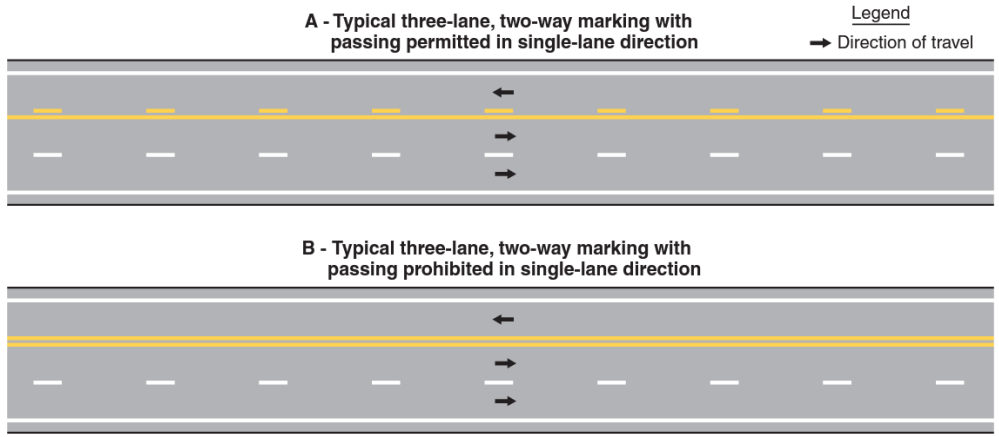


Figure 3B-3. Examples of Three-Lane, Two-Way Marking Applications



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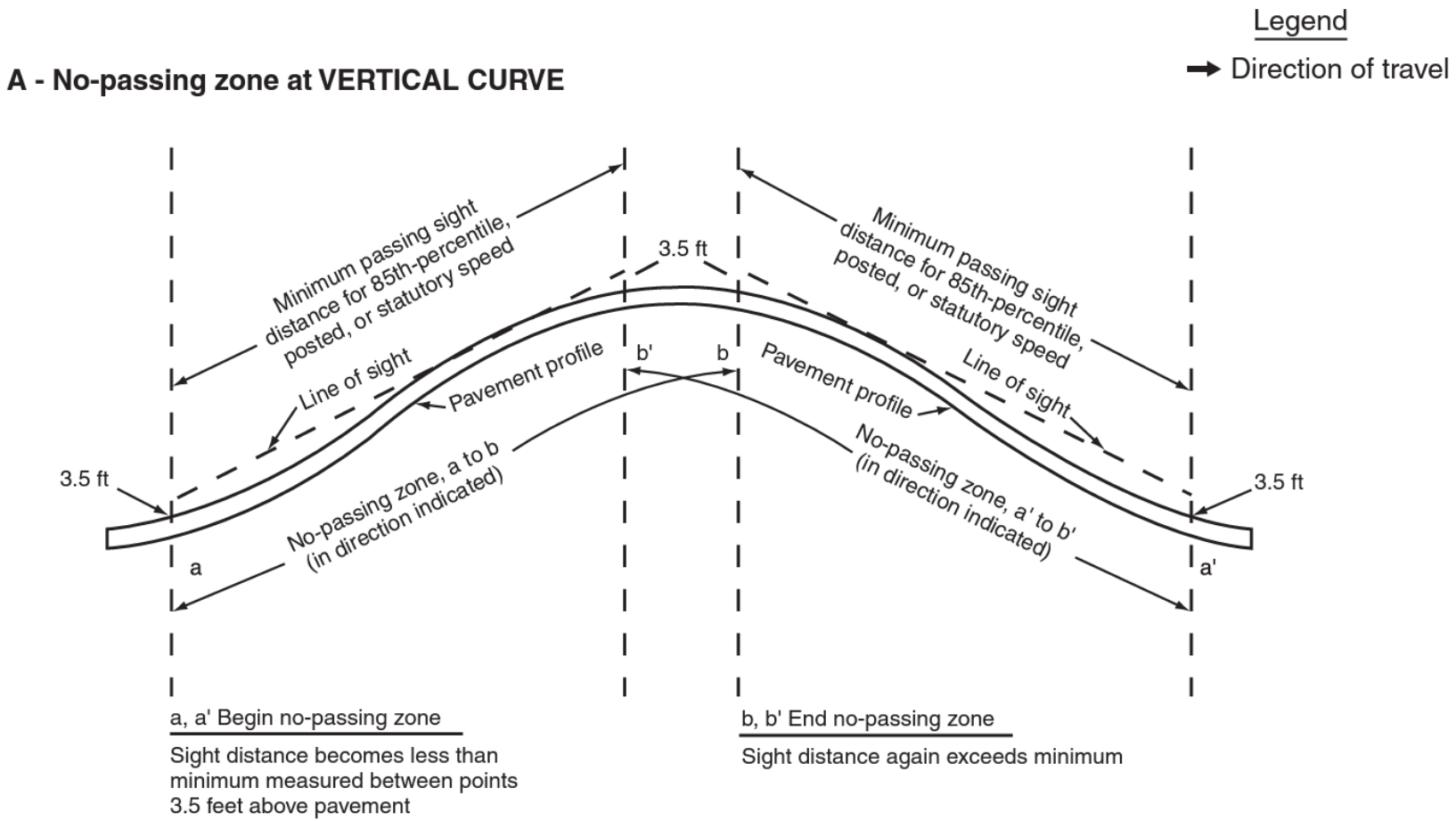
Yellow Center Line Pavement Markings and Warrants

Figure 3B-4. Method of Locating and Determining the Limits of No-Passing Zones at Curves

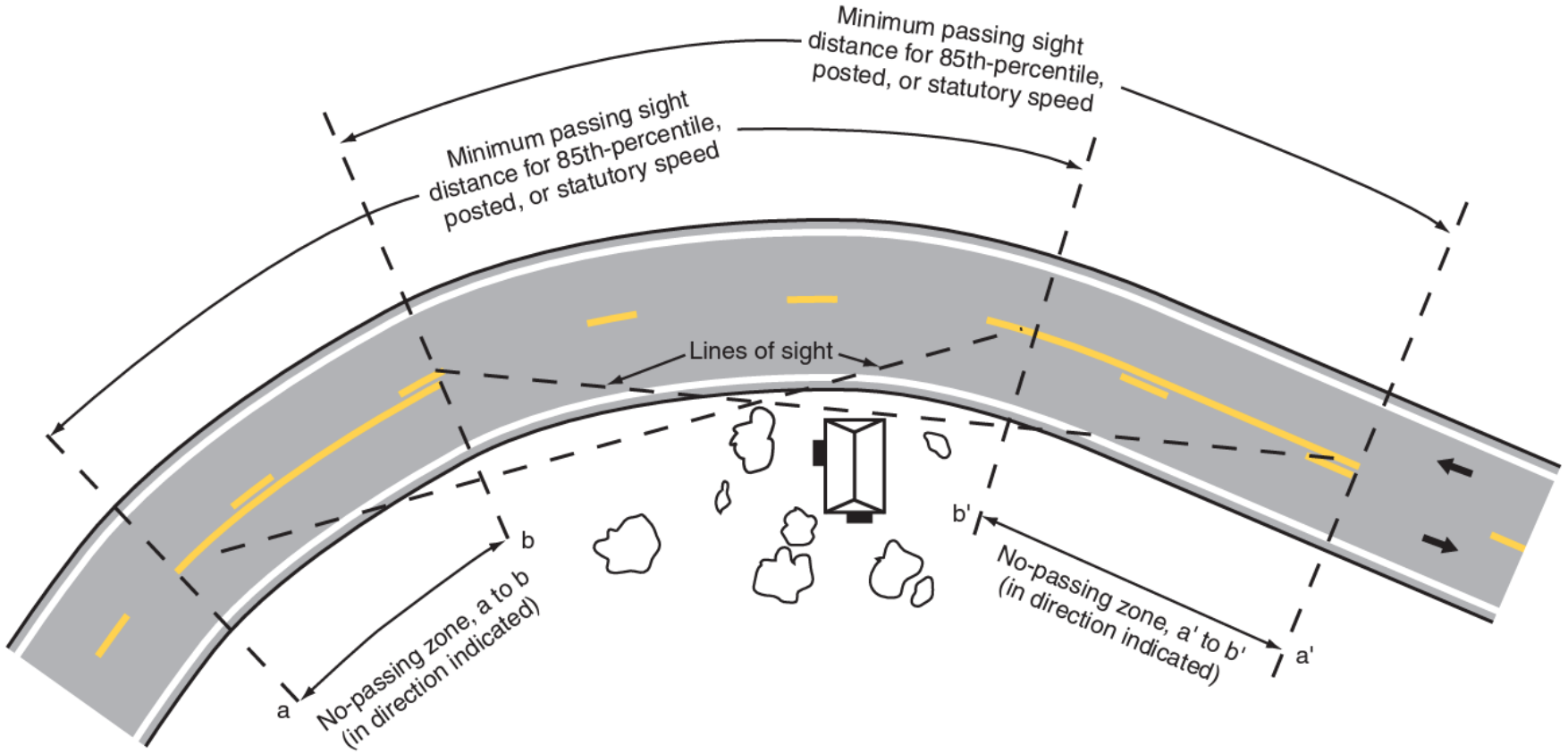


Profile View

Note: No-passing zones in opposite directions may or may not overlap, depending on alignment

Yellow Center Line Pavement Markings and Warrants

B - No-passing zone at HORIZONTAL CURVE



a, a' Begin no-passing zone

Sight distance becomes less than minimum measured between points 3.5 feet above pavement

b, b' End no-passing zone

Sight distance again exceeds minimum

Plan View

Note: No-passing zones in opposite directions may or may not overlap, depending on alignment

White Lane Line Pavements Markings and Warrants

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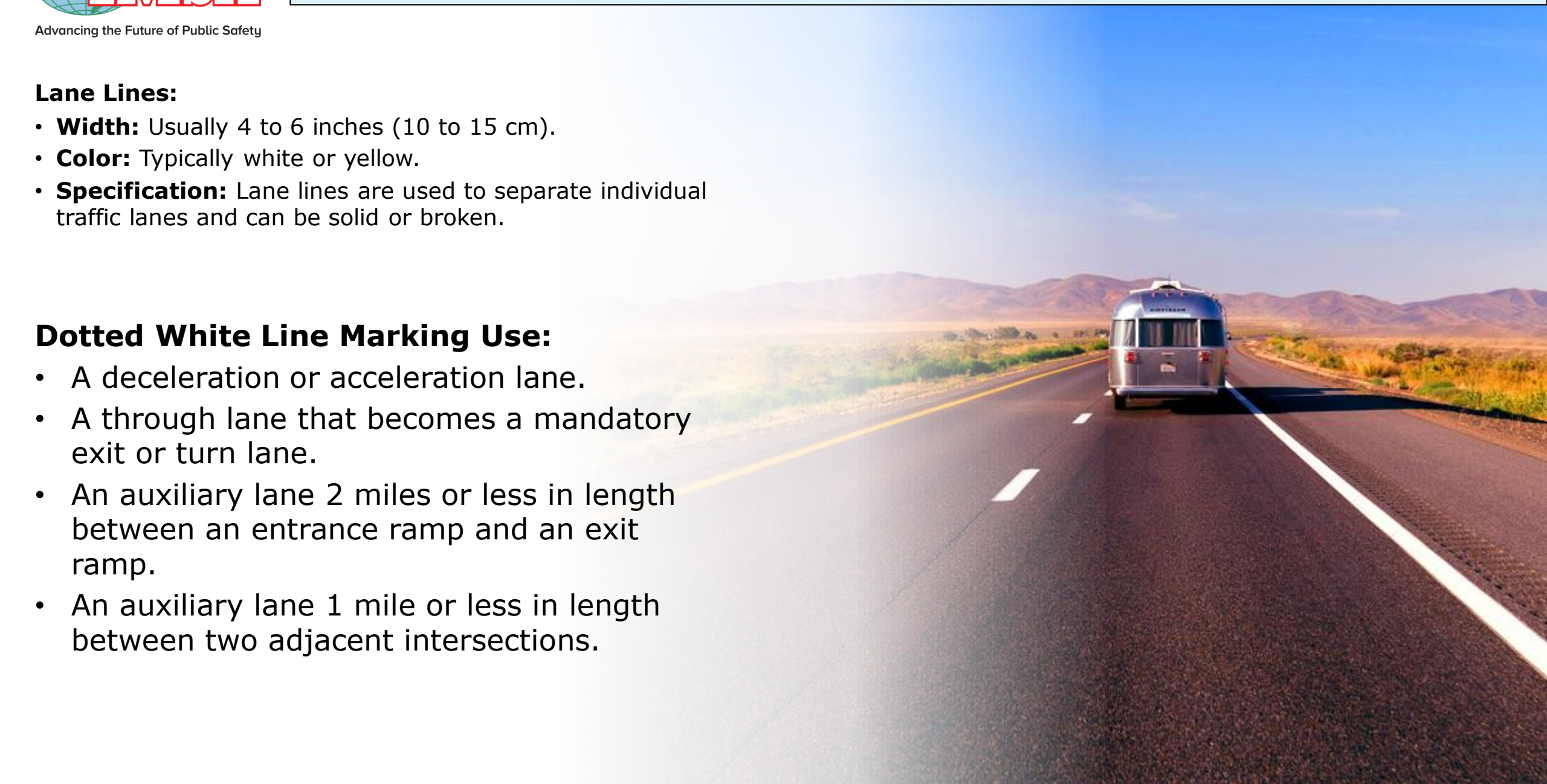
Lane Lines:

- **Width:** Usually 4 to 6 inches (10 to 15 cm).
- **Color:** Typically white or yellow.
- **Specification:** Lane lines are used to separate individual traffic lanes and can be solid or broken.



Dotted White Line Marking Use:

- A deceleration or acceleration lane.
- A through lane that becomes a mandatory exit or turn lane.
- An auxiliary lane 2 miles or less in length between an entrance ramp and an exit ramp.
- An auxiliary lane 1 mile or less in length between two adjacent intersections.

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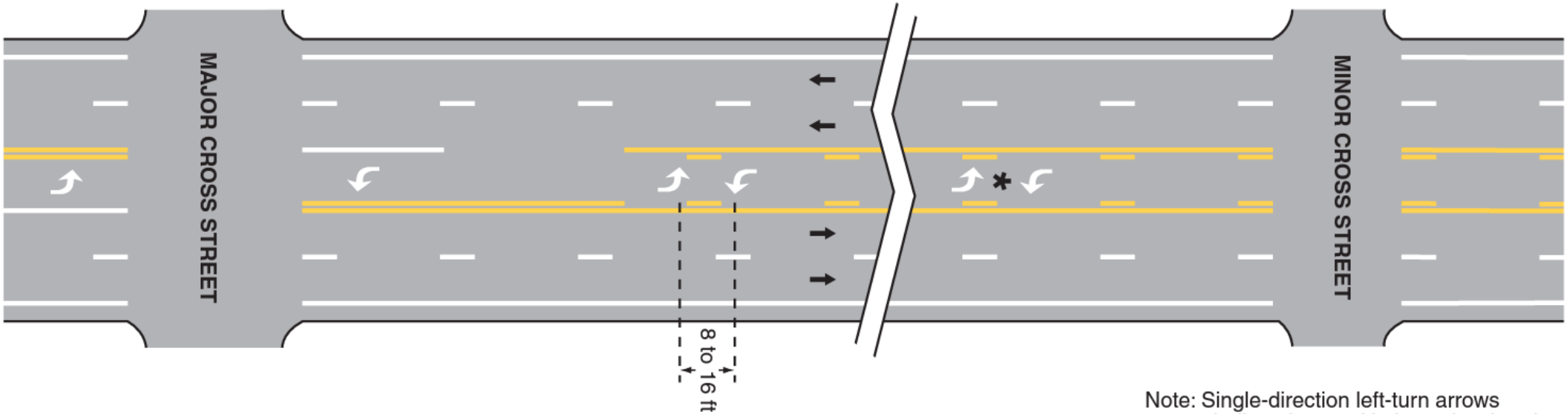
White Lane Line Pavements Markings and Warrants



Note: Single-direction left-turn arrows shall not be used in lanes bordered on both sides by two-way left-turn lane markings.

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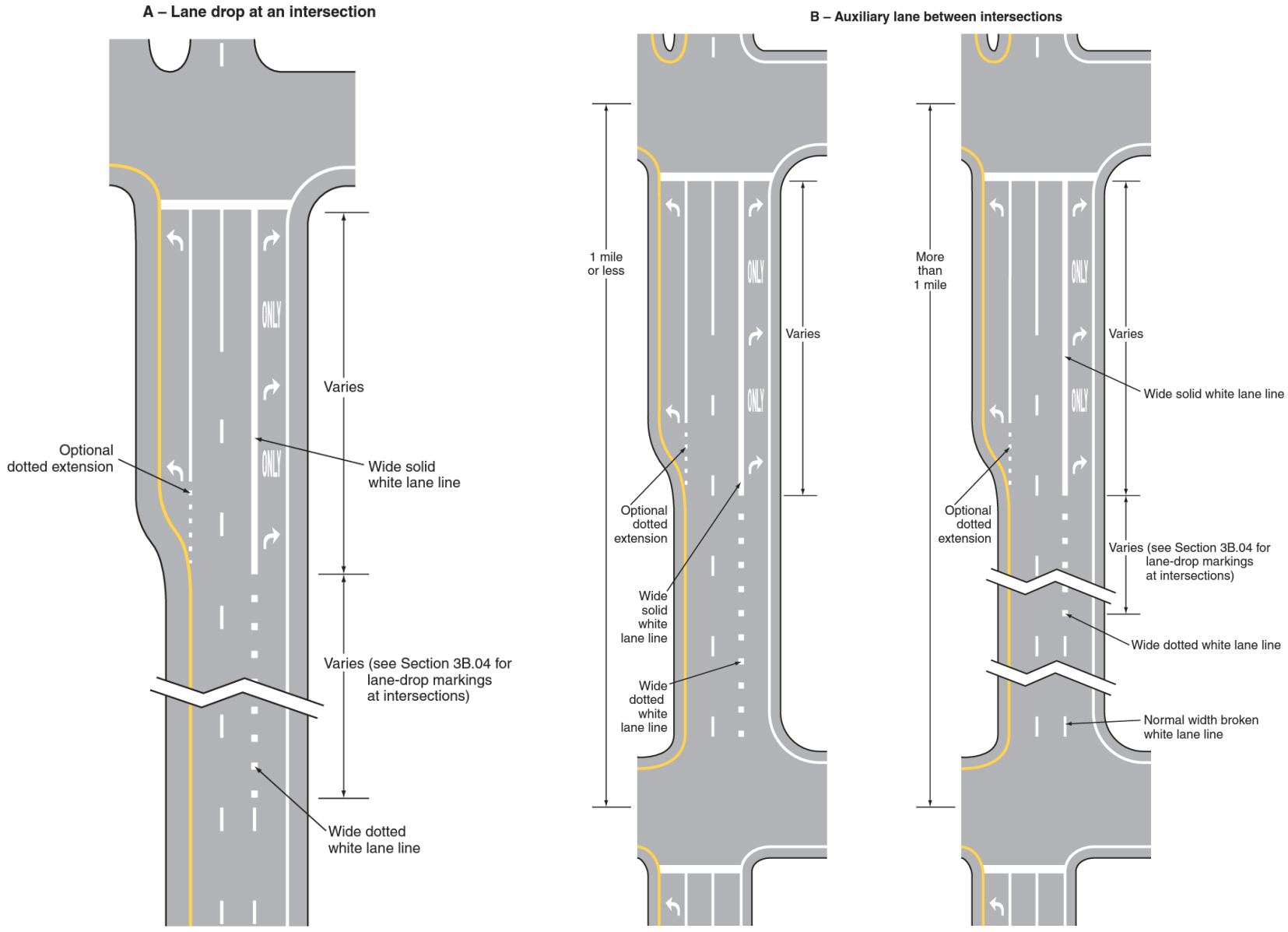
White Lane Line Pavements Markings and Warrants



Edge Line Pavement Markings

Edge Lines:

- **Width**: Varies between 4 to 6 inches (10 to 15 cm).
- **Color**: Typically white or yellow.
- **Specification**: Edge lines mark the outer boundaries of a roadway and help guide drivers.

Edge lines should not continue through an intersection or driveway

Warrants for Use of Edge Lines

Edge line markings must be placed on:

- Freeways.
- Expressways.
- Rural arterials with a traveled way of 20 feet or more in width and an ADT of 6,000 vehicles per day or greater.
- Rural arterials and collectors with a traveled way of 20 feet or more in width and an ADT of 3,000 vehicles per day or greater.
- At other paved streets and highways where an engineering study indicates a need for edge line markings.

Edge line markings may be placed on:

- Streets and highways with or without center line markings.

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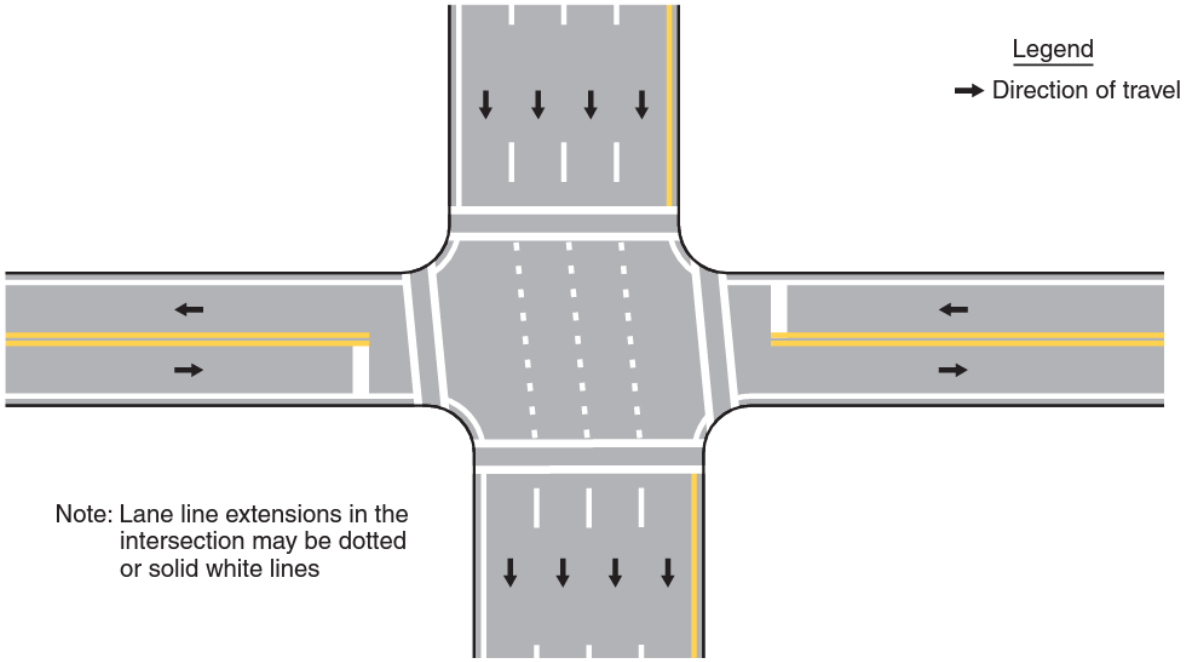
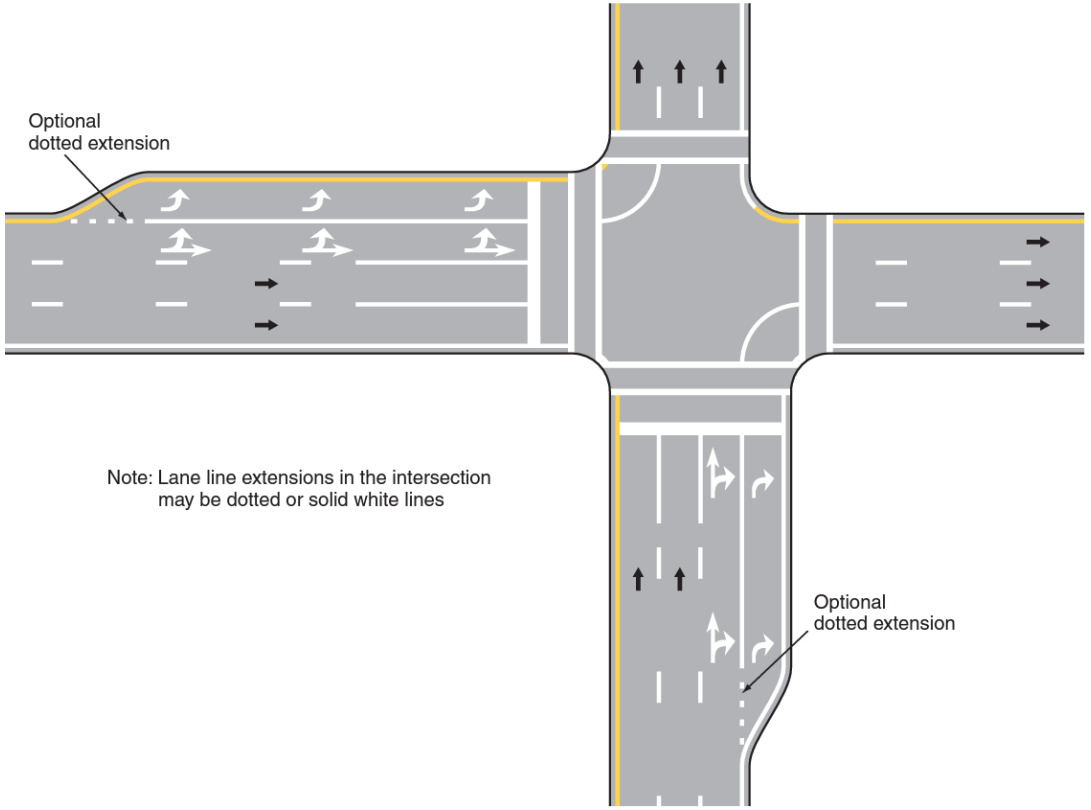
Warrants for Use of Edge Lines

A - Typical pavement markings with offset lane lines continued through the intersection and optional crosswalk lines and stop lines



B - Typical pavement markings with double-turn lanes, lane-use turn arrows, and optional crosswalk lines, stop lines, and line extensions into intersection for double turns



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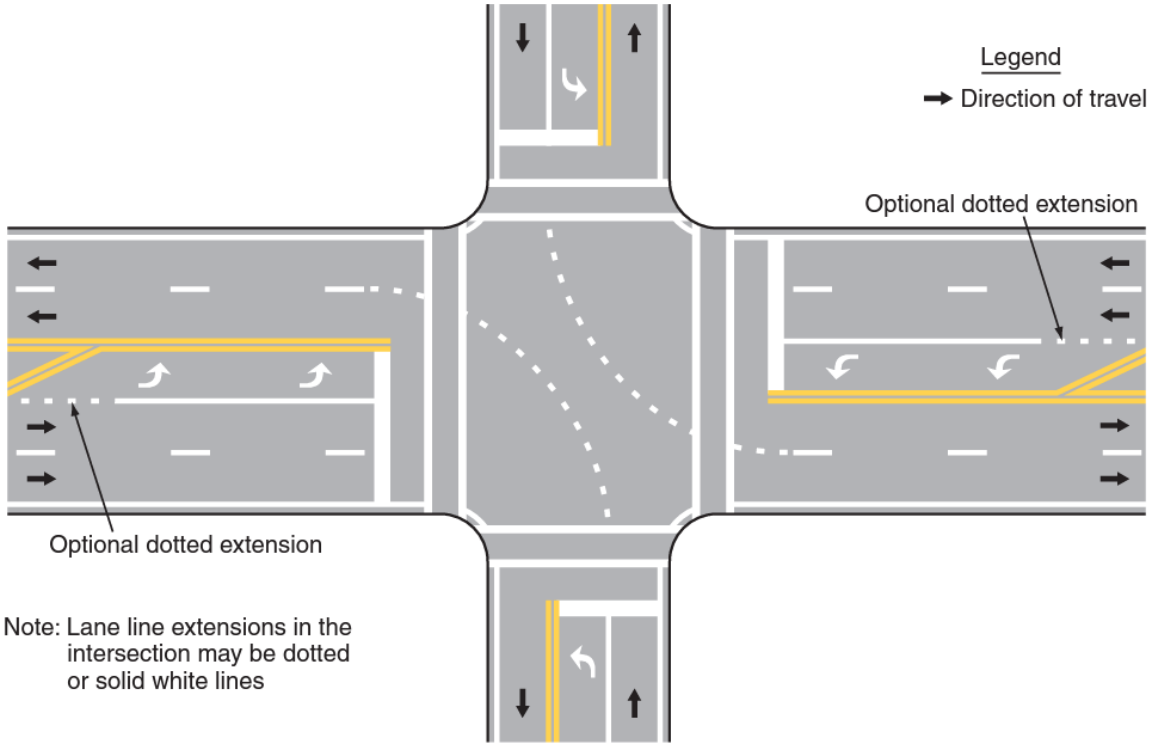
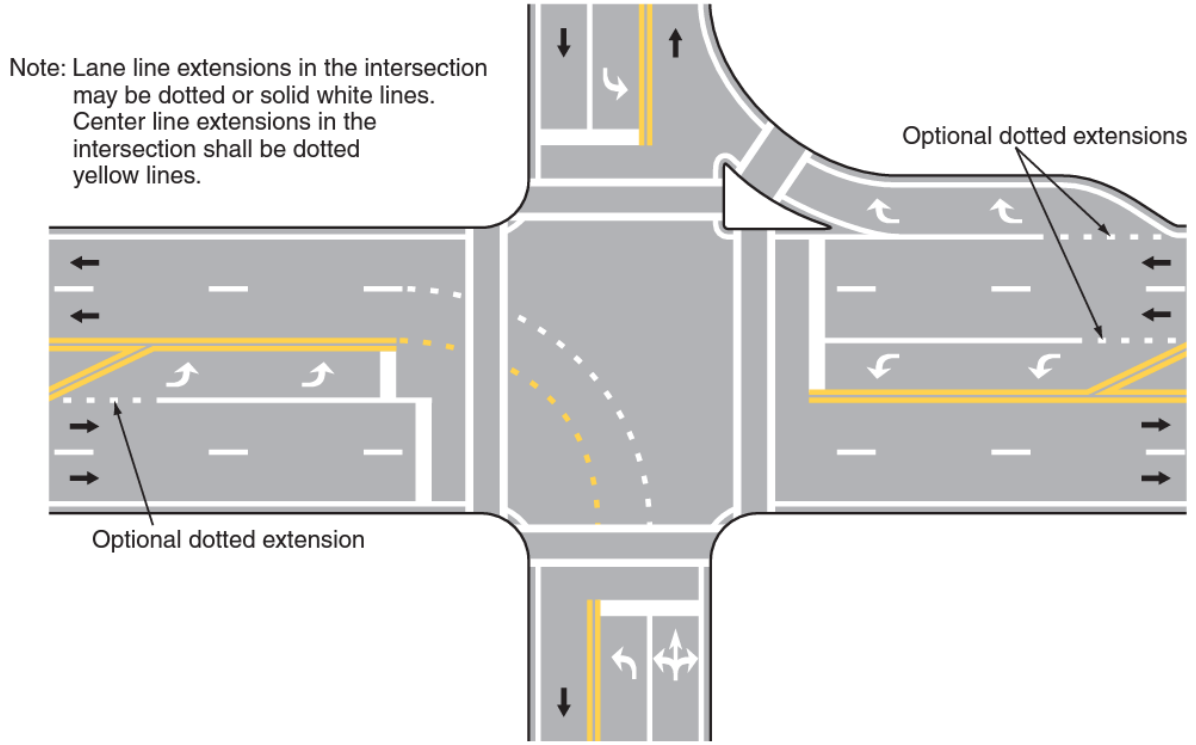
Warrants for Use of Edge Lines

C - Typical dotted line markings to extend lane line markings into the intersection



D - Typical dotted line markings to extend center line and lane line markings into the intersectior



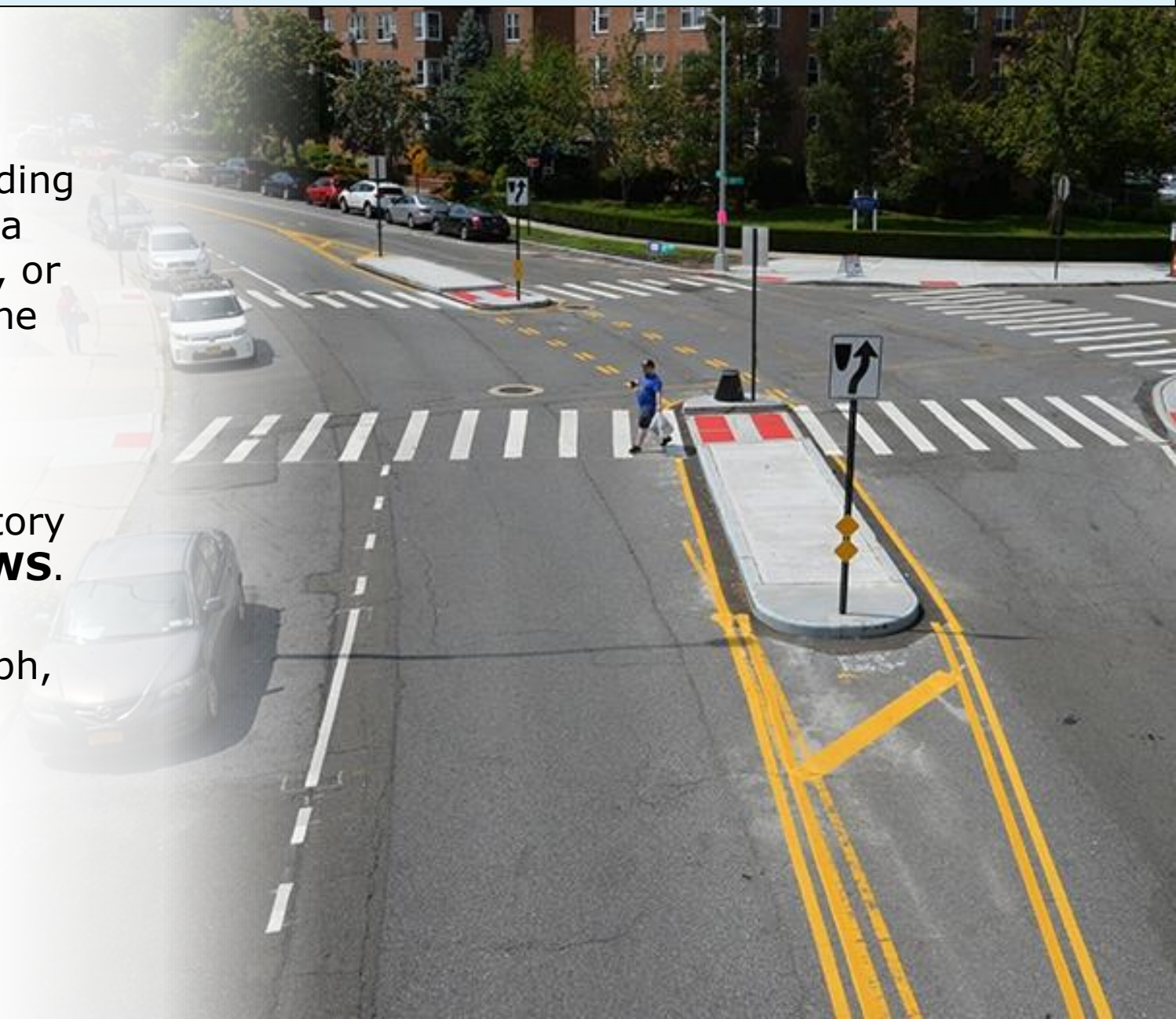
Approach Markings for Obstructions

Definition:

- Consist of a tapered line or lines extending from the center line or the lane line to a point 1 to 2 feet to the right-hand side, or to both sides, of the approach end of the obstruction.

Taper Formula:

- For roadways having a posted or statutory speed limit of 45 mph or greater, **L = WS**.
- For roadways where the posted or statutory speed limit is less than 45 mph, **L = WS2/60.**



Signs & Markings

Lesson 7.3: Raised Pavement Markers

Advancing the Future of Public Safety

Raised Pavement Markers – General

Colors and Markers:

- **Yellow RPMs**: Yellow markers are often used to indicate the presence of a median or a physical barrier between opposing traffic lanes. They help drivers stay within their designated lanes.
- **Red/White RPMs**: The Red Side of the marker is used to alert drivers they are traveling in the wrong direction. They are commonly found on ramps, highway exits, or one-way roads.
- **Blue RPMs**: Blue markers are used to indicate fire hydrant locations or provide guidance to emergency services. They are typically placed on the curbs near hydrants or at specific intervals along the road.

Raised Pavement Markers – Raised Median

A raised pavement marker may be used next to a curved approach end of a raised median when there is a need to enhance visibility and delineation for drivers approaching the median. These markers are typically small reflective devices placed on the pavement surface to provide visual cues to drivers, especially during nighttime or low-visibility conditions.

By placing raised pavement markers near the curved approach end of a raised median, several objectives can be achieved:

1. **Increased visibility**: The reflective properties of these markers make them highly visible to drivers, allowing them to better perceive the presence of the median and its curvature.
2. **Delineation of the roadway**: The markers can help delineate the boundary between the roadway and the raised median, assisting drivers in staying within their designated lanes and preventing encroachment onto the median.
3. **Warning of a change in alignment**: Curved approach ends of raised medians often represent a change in the alignment of the roadway. Raised pavement markers can serve as a visual warning to alert drivers to the upcoming change in the road's direction.

Overall, the use of raised pavement markers near a curved approach end of a raised median enhances safety by improving visibility, delineation, and driver awareness of roadway conditions. It is important to follow local traffic engineering guidelines and regulations when determining the appropriate placement and design of these markers to ensure optimal effectiveness and adherence to safety standards

Raised Pavement Markers – Applications

RPMs serve several purposes, including:

1. Lane delineation: RPMs are placed on the edges of lanes to provide clear separation between lanes, especially in low-visibility conditions. They help drivers maintain their position on the road.
2. Edge marking: RPMs can be installed on the road's edge or shoulder to help drivers identify the boundaries of the roadway.
3. Centerline marking: RPMs can be used to mark the centerline of a road, providing guidance and warning to drivers, especially in areas where the centerline may not be clearly visible.
4. Hazard identification: RPMs can be placed near potential hazards, such as sharp curves, intersections, or pedestrian crossings, to alert drivers and enhance safety awareness.

Raised Pavement Markers – Common Installation methods

The most common installation methods for RPMs include:

- **Adhesive:** RPMs can be installed using a strong adhesive that bonds the marker to the road surface. This method is often used for concrete or asphalt pavements.
- **Epoxy:** Epoxy resin is another common installation method for RPMs. The markers are embedded into the epoxy material, which is then applied to the road surface. This method provides a durable and long-lasting bond.
- **Drilling:** In some cases, RPMs are installed by drilling holes into the road surface and inserting the markers into the holes. This method is commonly used for concrete pavements.
- **Molding:** Some RPMs are installed during the road construction process by embedding them directly into the fresh asphalt or concrete. This method ensures a flush and seamless integration of the markers with the road surface.

Raised Pavement Markers – Bitumen

Bitumen, also known as asphalt, is a semi-solid form of petroleum that is typically used in road construction, roofing, and waterproofing due to its adhesive and waterproofing properties. When it comes to road paving, bitumen serves as a binder that combines with aggregate particles (such as sand, gravel, or crushed rock) to create a stable and durable surface. The mixture is often referred to as asphalt concrete, hot mix asphalt (HMA), or simply asphalt.

For installing road pavement markers (RPMs), which are devices used on roadways to delineate road edges and centerlines, bitumen can be used as an adhesive to secure the markers to the asphalt. The RPMs are embedded in the bitumen adhesive, which cools and hardens to firmly hold the markers in place.

Raised Pavement Markers – Bitumen

Benefits of using bitumen for installing RPMs and for roadway construction include:

1. Durability: Bitumen provides a durable and long-lasting surface that can withstand heavy traffic and various weather conditions. With proper maintenance, asphalt roads can last for many years.
2. Water Resistance: Bitumen is water-resistant, which prevents water from seeping into the underlying road structures and causing damage such as cracks and potholes
3. Cost-effectiveness: Bitumen is relatively inexpensive compared to other paving materials, and its
4. maintenance and repair costs are also generally lower.
5. Recyclability: Asphalt is 100% recyclable, meaning that old asphalt can be reprocessed and used in new pavement. This makes it an environmentally friendly choice for road construction.
6. Noise Reduction: Asphalt roads tend to produce less road noise compared to other types of road surfaces, which can be beneficial in populated areas.
7. Safety: The dark color of bitumen provides a high contrast with road markings and RPMs, which can enhance their visibility and contribute to road safety.
8. Ease of Application: Bitumen is easy to apply and doesn't take much time to harden, which makes the installation of RPMs a relatively quick and straightforward process.
9. Flexibility: Bitumen has a certain level of flexibility which allows it to adapt to changes in ground movement and temperature without cracking.

Raised Pavement Markers – Epoxy

- Handheld application of two part epoxy. This is beneficial for small jobs like repairing missing buttons or just adding buttons to median nose.

- To ensure a proper mix, apply epoxy to test material until it is a 50/50 mix and the material is gray and will bond and harden.

Raised Pavement Markers – Epoxy

- Truck Mounted Epoxy Applicators are great for larger projects since the cannisters can hold much more material. Each part of the Epoxy is poured into their own respective cylinder. The applicator will apply air pressure to force the material through the tubes to the mixing nozzle.

- To ensure a proper mix, apply epoxy to test material until it is a 50/50 mix and the material is gray and will bond and harden.

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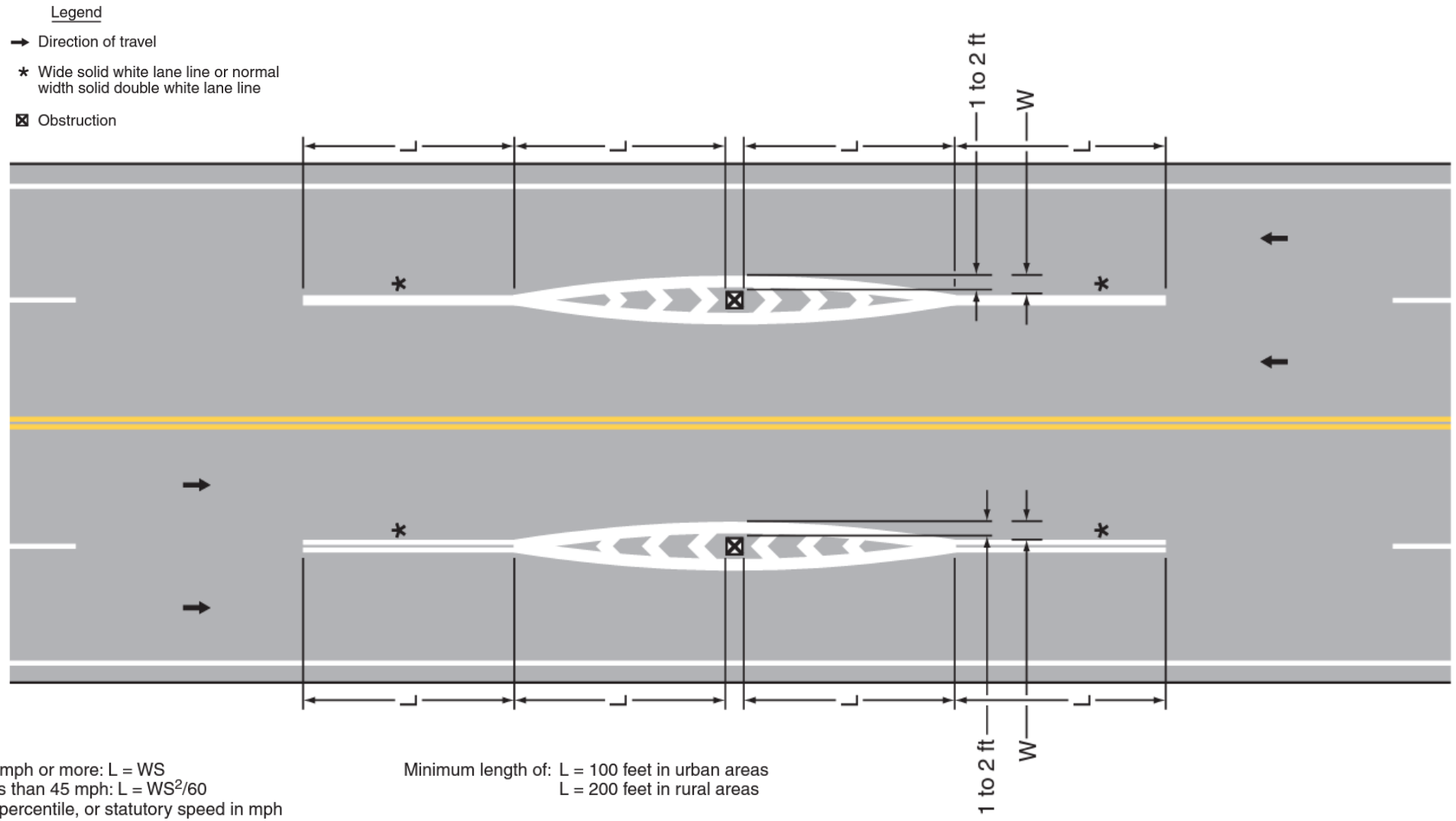
Raised Pavement Markers – General



For speeds of 45 mph or more: L = WS
For speeds of less than 45 mph: L = $WS^2/60$
S = Posted, 85th-percentile, or statutory speed in mph
W = Offset distance in feet

Minimum length of: L = 100 feet in urban areas
L = 200 feet in rural areas

Length "L" should be extended as required by sight distance conditions

Raised Pavement Markers Supplementing Other Markings

Lateral Positioning of Retroreflective Markers:

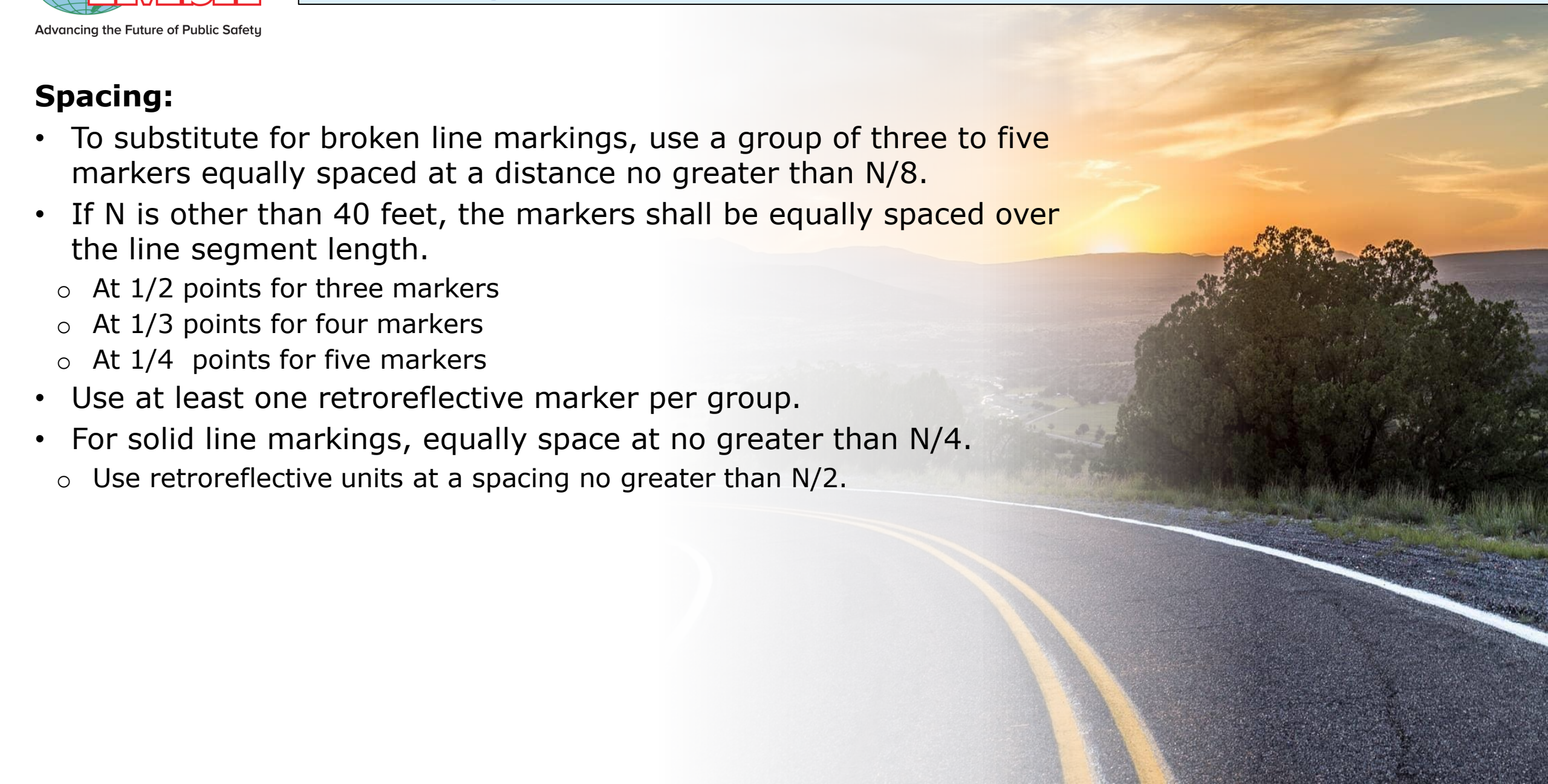
- In line with or immediately outside of the two lines.
- For wide line markings, use pairs of raised pavement markers placed laterally adjacent to each other.

Longitudinal Spacing of Retroreflective Markers:

- For solid line markings, use raised pavement markers at a spacing no greater than N.
- For edge line markings, use a spacing of no greater than N/2 .
- For broken line markings, use a spacing no greater than 3N.
- For dotted lane line markings, use a spacing appropriate for the application.
- For longitudinal line extension markings through at-grade intersections, use one raised pavement marker for each short line segment.
- For line extensions through freeway interchanges, use a spacing of no greater than N.

markers shall
equal the length of one line segment plus one gap of the broken lines used on the highway

Raised Pavement Markers Substituting for Pavement Marking



Spacing:

- To substitute for broken line markings, use a group of three to five markers equally spaced at a distance no greater than N/8.
- If N is other than 40 feet, the markers shall be equally spaced over the line segment length.
  - At 1/2 points for three markers
  - At 1/3 points for four markers
  - At 1/4 points for five markers
- Use at least one retroreflective marker per group.
- For solid line markings, equally space at no greater than N/4.
  - Use retroreflective units at a spacing no greater than N/2.

Signs & Markings

Lesson 7.4: Transverse Markings

Advancing the Future of Public Safety

Transverse Markings

Transverse Markings Include:

- Shoulder markings
- Word and symbol markings
- Arrows
- Stop lines
- Yield lines
- Crosswalk lines
- Speed measurement markings
- Speed reduction markings
- Speed hump markings
- Parking space markings

Color:

- White

Stop and Yield Lines

Use:

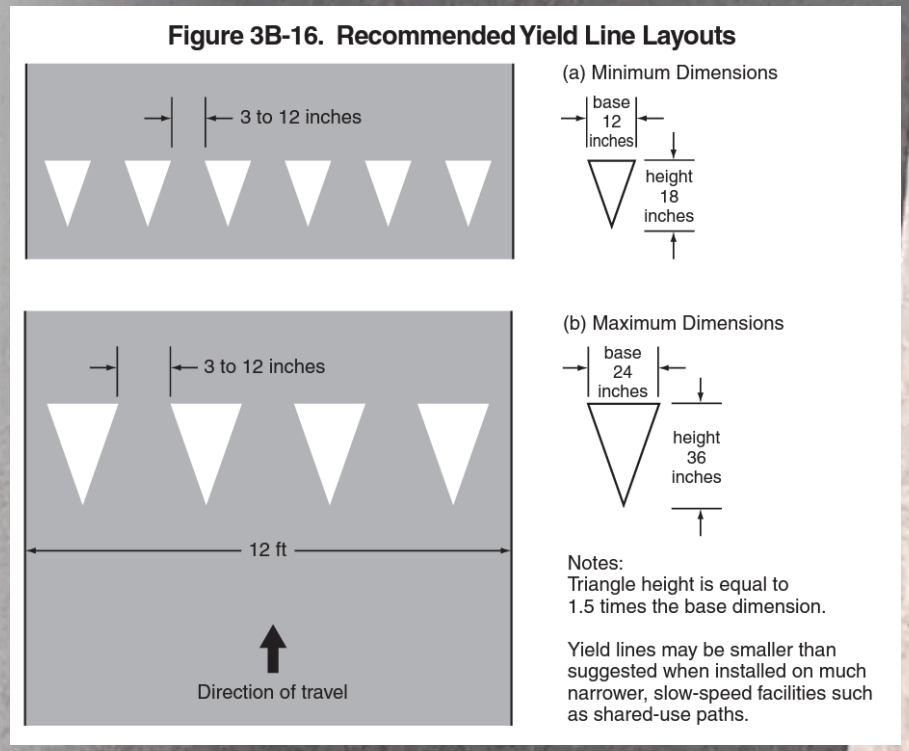
- Indicate the point behind which vehicles are required to stop in compliance with a traffic control signal.

Stop Lines:

- Width: Typically 12 to 24 inches (30 to 61 cm).
- Color: white.
- Specification: Stop lines indicate where vehicles must come to a complete stop at intersections and are usually located before crosswalks or traffic signals.

Yield Lines:

- Width: Varies, but typically similar to stop lines.
- Color: white.
- Specification: Yield lines indicate where drivers must yield to oncoming traffic or pedestrians. They are often used at roundabouts, merge points, or when entering a major road.



Crosswalk Markings

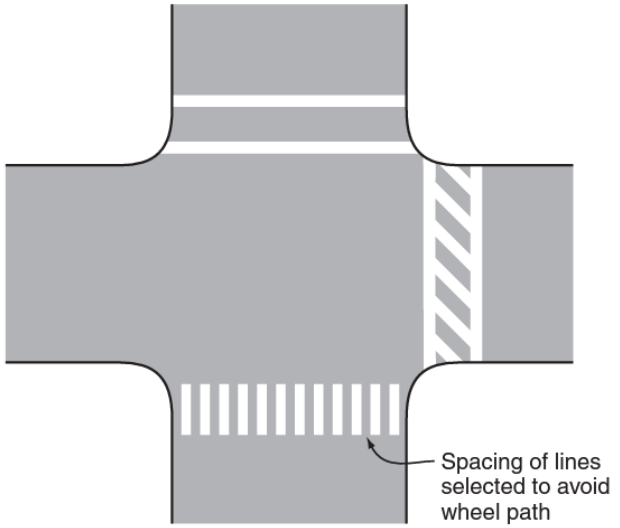
Purpose:

- Provide guidance for pedestrians who are crossing roadways.
- Define and delineate paths on approaches to and within signalized intersections.
- Help to alert road users of a designated pedestrian crossing point.

Standards:

- When crosswalk lines are used, they consist of solid white lines that mark the crosswalk.
- They shall not be less than 6 inches or greater than 24 inches in width.

Figure 3B-19. Examples of Crosswalk Markings



Pavement Word, Symbol, and Arrow Markings

Overview:

- Guiding, warning, or regulating traffic
- Supplementing signs and providing additional emphasis
- Symbol messages are preferable to word messages
- Color: White

Warning Examples:

- STOP or YIELD AHEAD
- SCHOOL XING
- SIGNAL AHEAD
- PED XING
- SCHOOL
- R X R
- BUMP
- Lane-reduction arrows

Regulatory Examples:

- STOP
- YIELD
- RIGHT (LEFT) TURN ONLY
- 25 MPH
- Lane-use and wrong-way arrows
- Diamond symbol for HOV lanes
- Other preferential lane word markings

Guide:

- Route numbers
- Cardinal directions
- TO
- Destination names or abbreviations thereof

Pavement Word, Symbol, and Arrow Marking Examples

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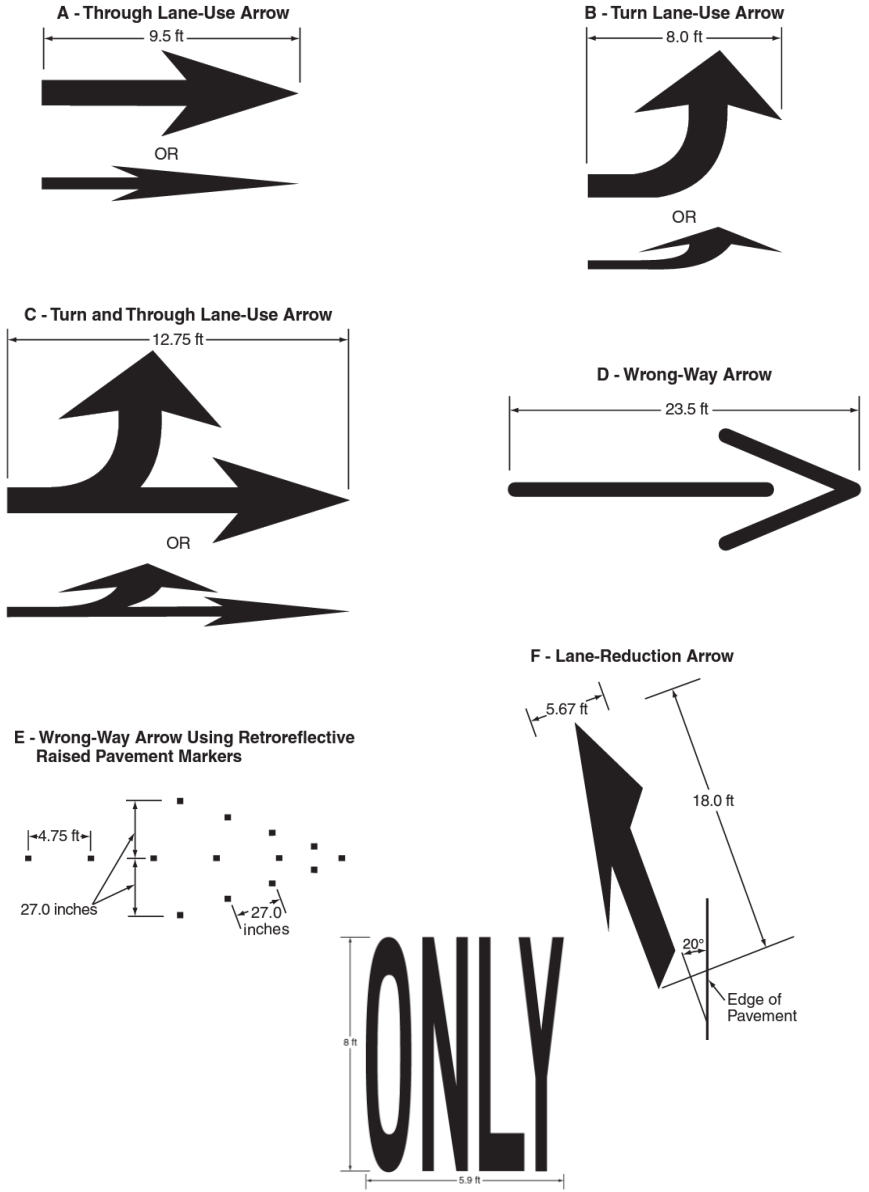
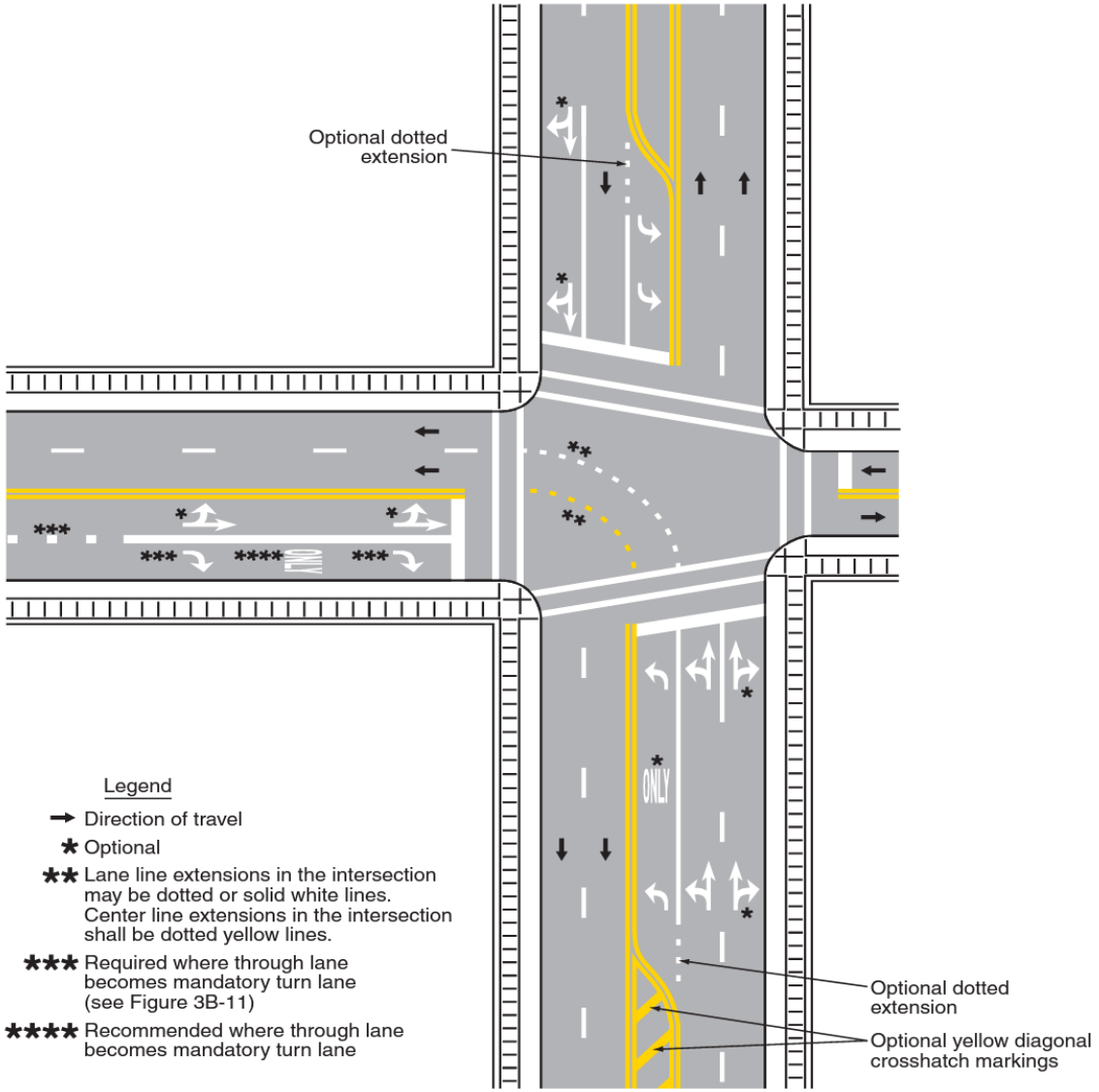


Figure 3B-27. Examples of Lane-Use Control Word and Arrow Pavement Markings



Pavement Word, Symbol, and Arrow Markings

Arrows:

- **Width:** Varies, but typically ranges from 12 to 24 inches (30 to 61 cm).
- **Color:** Usually white or yellow.
- **Specification:** Arrow markings provide directional guidance to drivers, indicating the proper lanes for turning or merging.

Word Markings:

- **Width:** Varies depending on the size of the words.
- **Color:** Typically white.
- **Specification:** Word markings include various textual information on the road, such as "STOP," "YIELD," "SCHOOL ZONE," or "BUS LANE," providing specific instructions or warnings to road users.

Pavement Word, Symbol, and Arrow Markings

The Manual on Uniform Traffic Control Devices (MUTCD) provides specifications and guidelines for traffic control devices in the United States. These devices include signs, signals, pavement markings, and more. When it comes to arrow markings, the MUTCD provides specific standards to ensure consistency and safety on the roads.

Here are some key specifications regarding arrow markings as outlined in the MUTCD:

- **Arrow Markings:** Arrows are used to provide directional guidance to motorists. They can be found on the pavement, on signs, or on other traffic control devices. The MUTCD provides guidelines for the design, size, and color of arrow markings.
- **Arrow Shape:** The standard arrow shape used for pavement markings is a right- or left-pointing arrowhead, typically with a rectangular or triangular body. The arrowhead should have a length of 4 to 5 times its width.
- **Arrow Size:** The MUTCD specifies different arrow sizes based on the type of road and the speed limit. For example, on high-speed roadways, the arrowhead width can range from 4 to 9 feet, while on lower-speed roads, it may range from 2 to 4 feet.
- **Arrow Color:** Arrow markings are typically white, yellow, or black, depending on their purpose and the color of the pavement. White arrows are used on roads with dark-colored pavement, while yellow arrows are used on light-colored pavement. Black arrows are used on light-colored pavement when a contrasting color is required.
- **Arrow Placement:** The MUTCD provides guidance on where arrow markings should be placed on the road. They are typically positioned in the center of the traffic lane, indicating the direction of travel or the appropriate lane to be used. Arrows may also be used to indicate turn lanes, merge points, or other specific traffic movements.
- **Retroreflectivity:** Arrow markings should have sufficient retroreflectivity to be clearly visible to motorists, especially at night. The MUTCD provides guidelines for the minimum retroreflectivity levels that should be maintained for various traffic control devices, including arrow markings.

Curb Markings

Purpose:

- Delineate the curb.

Retroreflective Yellow Curb Markings:

- Used on raised medians and curbs of islands.
- Located in the line of traffic flow where the curb serves to channel traffic to the right of an obstruction.

Retroreflective White Curb Markings:

- Used when traffic is permitted to pass on either side of an island.

Roundabout Markings

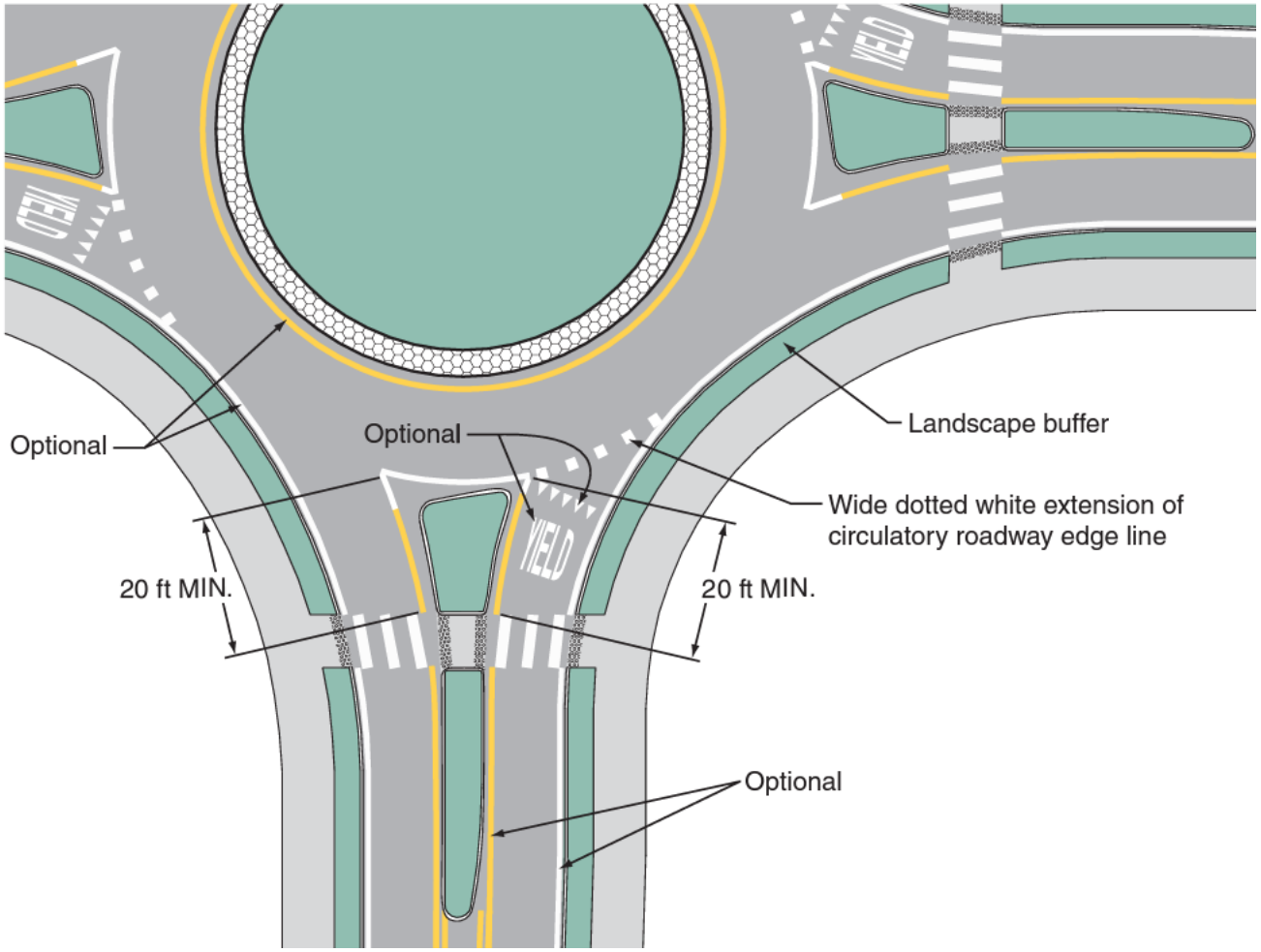
Purpose:

- Used with signs to control the flow of traffic in a roundabout.

Location:

- Look in the MUTCD Page 399 to see more examples of roundabout markings.

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



Bike Lanes

Look:

- Consist of a bicycle symbol or the word marking BIKE LANE.

Use:

- Static or changeable message regulatory signs should be used with preferential lane word or symbol markings.
- Markings should be placed at strategic locations such as:
  - Major decision points
  - Direct exit ramp departures from the preferential lane
  - Along access openings to and from adjacent general-purpose lanes

Delineators

Definition:

- Retroreflective devices that are capable of clearly retroreflecting light from a distance of 1,000 feet.
- Minimum dimension of 3 inches.

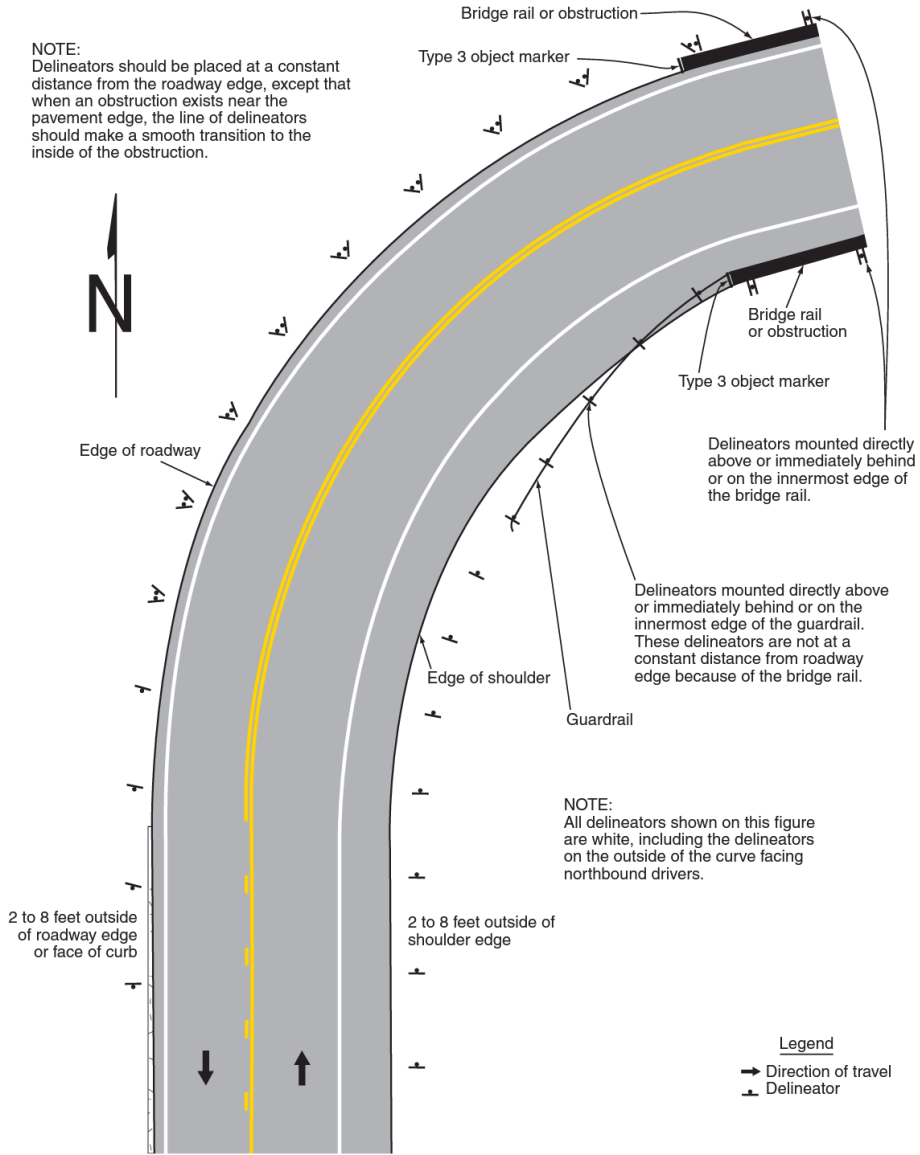
Used on sections of freeways and expressways when both of the following conditions are met:

- ✓ Raised pavement markers are used continuously on lane lines throughout all curves and on all tangents to supplement pavement markings.
- ✓ Roadside delineators are used to lead into all curves.

Other Uses:

- On sections of roadways where continuous lighting is in operation between interchanges.
- Should be placed 2 to 8 feet outside the outer edge of the shoulder.

Figure 3F-1. Examples of Delineator Placement



Delineator Spacing

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Placement:

- Should be placed 2 to 8 feet outside the outer edge of the shoulder.
- Mounted on suitable supports at a mounting height, measured vertically from the bottom of the lowest retroreflective device to the elevation of the near edge of the roadway, of approximately 4 feet.

Table 3F-1. Approximate Spacing for Delineators on Horizontal Curves

Radius (R) of Curve	Approximate Spacing (S) on Curve
50 feet	20 feet
115 feet	25 feet
180 feet	35 feet
250 feet	40 feet
300 feet	50 feet
400 feet	55 feet
500 feet	65 feet
600 feet	70 feet
700 feet	75 feet
800 feet	80 feet
900 feet	85 feet
1,000 feet	90 feet

Notes:
1. Spacing for specific radii may be interpolated from table.
2. The minimum spacing should be 20 feet.
3. The spacing on curves should not exceed 300 feet.
4. In advance of or beyond a curve, and proceeding away from the end of the curve, the spacing of the first delineator is 2S, the second 3S, and the third 6S, but not to exceed 300 feet.
5. S refers to the delineator spacing for specific radii computed from the formula $S=3\sqrt{R-50}$.
6. The distances for S shown in the table above were rounded to the nearest 5 feet.

Signs & Markings

Lesson 8: Storage and Inventory

Advancing the Future of Public Safety

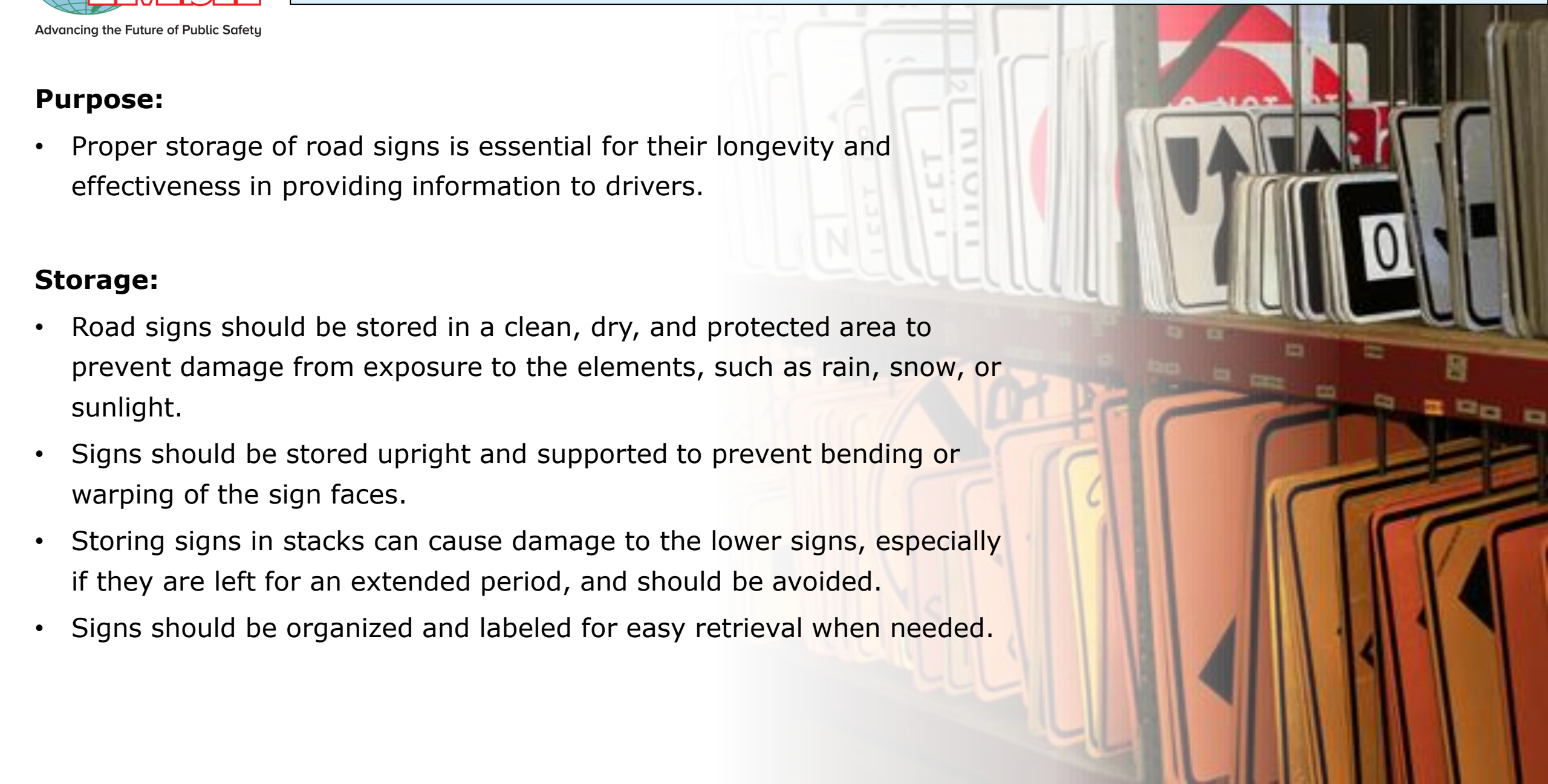
Sign Storage

Purpose:

- Proper storage of road signs is essential for their longevity and effectiveness in providing information to drivers.

Storage:

- Road signs should be stored in a clean, dry, and protected area to prevent damage from exposure to the elements, such as rain, snow, or sunlight.
- Signs should be stored upright and supported to prevent bending or warping of the sign faces.
- Storing signs in stacks can cause damage to the lower signs, especially if they are left for an extended period, and should be avoided.
- Signs should be organized and labeled for easy retrieval when needed.



Inventory Importance

Definition:

- A road sign inventory system is a tool used by transportation agencies to track and manage the inventory of road signs.

Importance of Proper Inventory:

- The inventory system helps transportation agencies to prioritize maintenance, repair, and replacement of signs to ensure that they are in compliance with current standards and regulations.
- A well-maintained road sign inventory system helps transportation agencies improve safety and efficiency on the roadways.

Inventory Tracking

Inventory Tracking

- The system provides an accurate and up-to-date record of the number, location, condition, and age of each sign in the inventory.
- A typical road sign inventory system includes a database or software that allows users to input and retrieve information about signs, such as type, size, material, and reflective sheeting.
- The system may use various technologies to gather information, such as GPS, barcodes, or RFID tags, to track the location and movement of signs.
- The inventory system may also include features for generating reports, setting alerts for upcoming maintenance or replacement, and conducting inspections of signs.

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Knowledge Check: Brainstorm

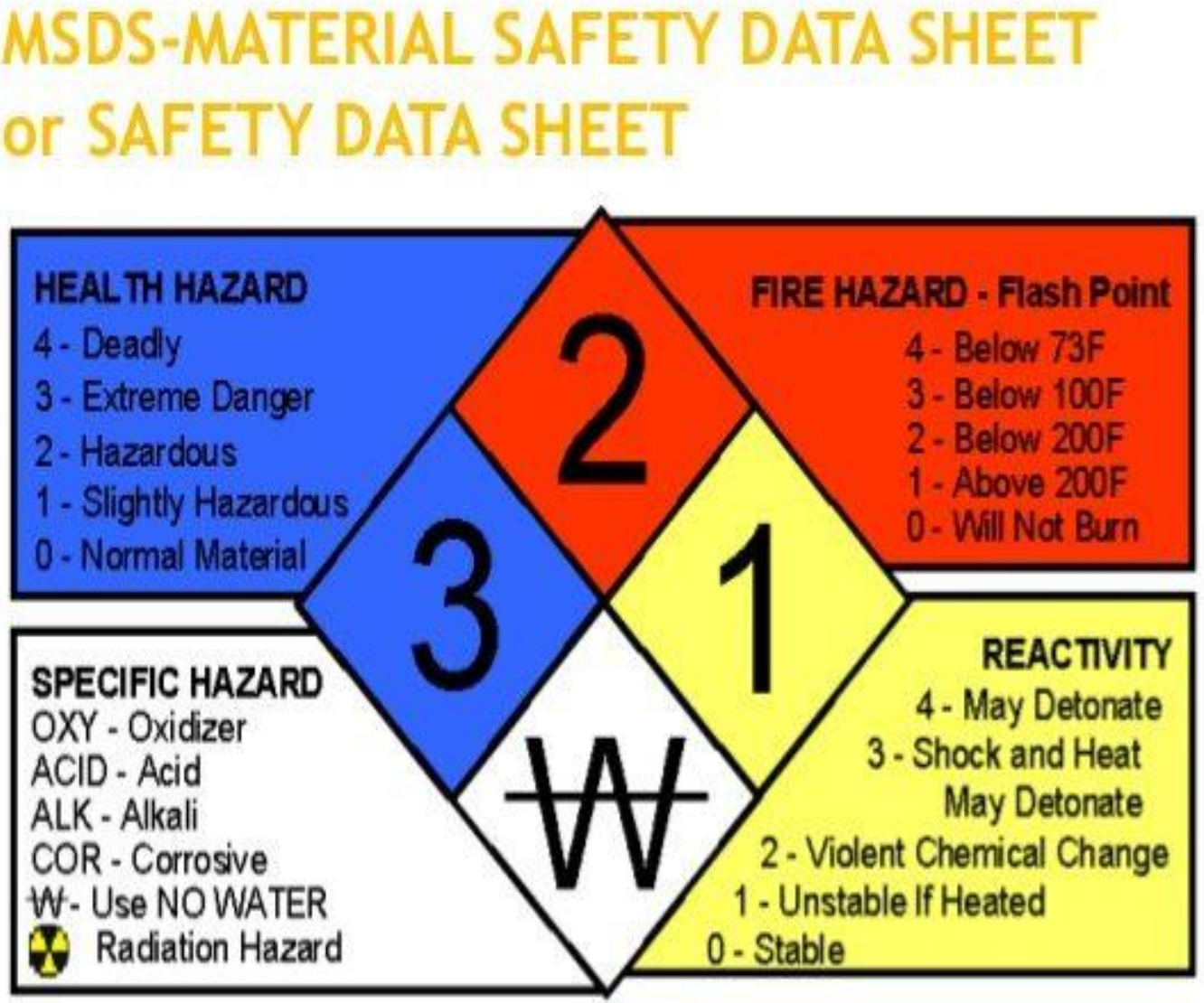
MSDS – Material Safety Data Sheet

Materials Safety

- Common storage procedures
- PPE basics

Common Symbols

- What symbols might you see?



Signs & Markings

Lesson 9: Sign Maintenance

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Why Maintain?

Preventative Maintenance

- Preventive maintenance is the practice of regularly inspecting and maintaining road signs to prevent failures and extend their useful life.
- Be *proactive* not *reactive*; instead of putting out fires, prevent them before they happen.
- Replace BEFORE it impacts the drivers.
- Less chance of liability if you catch it before it goes wrong.

Preventive Maintenance Tasks:

- Cleaning
- Straightening
- Tightening hardware
- Replacing damaged or faded reflective sheeting
- Removing vegetation that obstructs the sign's view

Sign Maintenance

Sign Maintenance:

Proper maintenance helps ensure that signs are clean, visible, and legible, reducing the risk of accidents and improving driver safety.

Check Warranties:

- Each grade of sheeting has warranty duration.
- Keep on top of each so you know when to replace.
- Replace signs before the warranty expires.

Size of Warning Signs – MUTCD Standards

Reduced Speed Limit Ahead	W3-5	2C.38	36 x 36	36 x 36	48 x 48	48 x 48	—	—
XX MPH Speed Zone A								
Draw Bridge								
Ramp Meter Ahead								
Ramp Metered When Flashing	W3-8	2C.37	36 x 36	36 x 36	—	—	—	—
Merge	W4-1	2C.40	36 x 36	36 x 36	48 x 48	48 x 48	30 x 30*	—
Lane Ends	W4-2	2C.42	36 x 36	36 x 36	48 x 48	48 x 48	30 x 30*	—
Added Lane	W4-3	2C.41	36 x 36	36 x 36	48 x 48	48 x 48	30 x 30*	—
Cross Traffic Does Not Stop (plaque)	W4-4P	2C.59	24 x 12	24 x 12	36 x 18	—	—	48 x 24
Traffic From Left (Right) Does Not Stop (plaque)	W4-4aP	2C.59	24 x 12	24 x 12	36 x 18	—	—	48 x 24
Oncoming Traffic Does Not Stop (plaque)	W4-4bP	2C.59	24 x 12	24 x 12	36 x 18	—	—	48 x 24
Entering Roadway Merge	W4-5	2C.40	36 x 36	36 x 36	48 x 48	—	—	—
No Merge Area (plaque)	W4-5P	2C.40	18 x 24	18 x 24	24 x 30	—	—	—
Entering Roadway Added Lane	W4-6	2C.41	36 x 36	36 x 36	48 x 48	—	—	—
Road Narrows	W5-1	2C.19	36 x 36	36 x 36	48 x 48	48 x 48	30 x 30*	—
Narrow Bridge	W5-2	2C.20	36 x 36	36 x 36	48 x 48	48 x 48	30 x 30*	—
One Lane Bridge	W5-3	2C.21	36 x 36	36 x 36	48 x 48	48 x 48	30 x 30*	—
Divided Highway	W6-1	2C.22	36 x 36	36 x 36	48 x 48	48 x 48	—	—
Divided Highway Ends	W6-2	2C.23	36 x 36	36 x 36	48 x 48	48 x 48	—	—
Two-Way Traffic	W6-3	2C.44	36 x 36	36 x 36	48 x 48	48 x 48	—	—
Hill	W7-1	2C.16	30 x 30*	36 x 36	36 x 36	36 x 36	24 x 24*	48 x 48
Hill with Grade	W7-1a	2C.16	30 x 30*	36 x 36	36 x 36	36 x 36	24 x 24*	48 x 48
Use Low Gear (plaque)	W7-2P	2C.57	24 x 18	24 x 18	—	—	—	—

Size of Warning Signs – MUTCD Standards

Divided Highway Ends	W6-2	2C.23	36 x 36	36 x 36	48 x 48	48 x 48	—	—
Two-Way Traffic								
Hill								
Hill with Grade								
Use Low Gear (plaque)	W7-2P	2C.57	24 x 18	24 x 18	—	—	—	—
Trucks Use Lower Gear (plaque)	W7-2bP	2C.57	24 x 18	24 x 18	—	—	—	—
XX% Grade (plaque)	W7-3P	2C.57	24 x 18	24 x 18	—	—	—	—
Next XX Miles (plaque)	W7-3aP	2C.55	24 x 18	24 x 18	—	—	—	—
XX% Grade, XX Miles (plaque)	W7-3bP	2C.57	24 x 18	24 x 18	—	—	—	—
Runaway Truck Ramp XX Miles	W7-4	2C.17	78 x 48	78 x 48	78 x 48	78 x 48	—	—
Runaway Truck Ramp (with arrow)	W7-4b	2C.17	78 x 60	78 x 60	78 x 60	78 x 60	—	—
Truck Escape Ramp	W7-4c	2C.17	78 x 60	78 x 60	78 x 60	78 x 60	—	—
Sand, Gravel, Paved (plaques)	W7-4dP, 4eP,4fP	2C.17	24 x 12	24 x 12	24 x 12	24 x 12	—	—
Hill Blocks View	W7-6	2C.18	30 x 30*	36 x 36	36 x 36	—	—	48 x 48
Bump or Dip	W8-1,2	2C.28	30 x 30*	36 x 36	36 x 36	48 x 48	24 x 24*	48 x 48
Pavement Ends	W8-3	2C.30	36 x 36	36 x 36	48 x 48	—	30 x 30*	—
Soft Shoulder	W8-4	2C.31	36 x 36	36 x 36	48 x 48	48 x 48	24 x 24*	48 x 48
Slippery When Wet	W8-5	2C.32	30 x 30*	36 x 36	36 x 36	48 x 48	24 x 24*	48 x 48
Road Condition (plaques)	W8-5P,5bP,5cP	2C.32	24 x 18	24 x 18	30 x 24	36 x 30	—	36 x 30
Ice	W8-5aP	2C.32	24 x 12	24 x 12	30 x 18	30 x 18	—	—
Truck Crossing	W8-6	2C.49	36 x 36	36 x 36	36 x 36	48 x 48	24 x 24*	48 x 48
Loose Gravel	W8-7	2C.32	36 x 36	36 x 36	36 x 36	—	24 x 24*	48 x 48
Rough Road	W8-8	2C.32	36 x 36	36 x 36	36 x 36	48 x 48	24 x 24*	48 x 48

Size of Regulatory Signs – MUTCD Standards

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 (pla								
Night Speed Limit (pla								
Minimum Speed Limit (								
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	—	—	—	—
Center Lane (plaque)	R3-5eP	2B.20	30 x 12	30 x 12	—	—	—	—
Right Lane (plaque)	R3-5fP	2B.20	30 x 12	30 x 12	—	—	—	—
Bus Lane (plaque)	R3-5gP	2B.20	30 x 12	30 x 12	—	—	—	—
Optional Movement Lane Control	R3-6	2B.21	30 x 36	30 x 36	—	—	—	—
Right (Left) Lane Must Turn Right (Left)	R3-7	2B.20	30 x 30*	36 x 36	—	—	—	—
Advance Intersection Lane Control	R3-8,8a,8b	2B.22	Varies x 30	Varies x 30	—	—	—	Varies x 36
Two-Way Left Turn Only (overhead)	R3-9a	2B.24	30 x 36	30 x 36	—	—	—	—

Size of Regulatory Signs – MUTCD Standards

Center Lane (plaque)	R3-5eP	2B.20	30 x 12	30 x 12	—	—	—	—
Right Lane (plaque)								
Bus Lane (plaque)								
Optional Movement La								
Right (Left) Lane Must Turn Right (Left)	R3-7	2B.20	30 x 30*	36 x 36	—	—	—	—
Advance Intersection Lane Control	R3-8,8a,8b	2B.22	Varies x 30	Varies x 30	—	—	—	Varies x 36
Two-Way Left Turn Only (overhead)	R3-9a	2B.24	30 x 36	30 x 36	—	—	—	—
Two-Way Left Turn Only (post-mounted)	R3-9b	2B.24	24 x 36	24 x 36	—	—	—	36 x 48
BEGIN	R3-9cP	2B.25	30 x 12	30 x 12	—	—	—	—
END	R3-9dP	2B.25	30 x 12	30 x 12	—	—	—	—
Reversible Lane Control (symbol)	R3-9e	2B.26	108 x 48	108 x 48	—	—	—	—
Reversible Lane Control (post-mounted)	R3-9f	2B.26	30 x 42*	36 x 54	—	—	—	—
Advance Reversible Lane Control Transition Signing	R3-9g,9h	2B.26	108 x 36	108 x 36	—	—	—	—
End Reverse Lane	R3-9i	2B.26	108 x 48	108 x 48	—	—	—	—
Begin Right (Left) Turn Lane	R3-20	2B.20	24 x 36	24 x 36	—	—	—	—
All Turns (U Turn) from Right Lane	R3-23,23a	2B.27	60 x 36	60 x 36	—	—	—	—
All Turns (U Turn) with arrow	R3-24,24b, 25,25b,26a	2B.27	72 x 18	72 x 18	—	—	—	—
U and Left Turns with arrow	R3-24a,25a,26	2B.27	60 x 24	60 x 24	—	—	—	—
Right Lane Must Exit	R3-33	2B.23	—	—	78 x 36	78 x 36	—	—
Do Not Pass	R4-1	2B.28	24 x 30	24 x 30	36 x 48	48 x 60	18 x 24	36 x 48
Pass With Care	R4-2	2B.29	24 x 30	24 x 30	36 x 48	48 x 60	18 x 24	36 x 48
Slower Traffic Keep Right	R4-3	2B.30	24 x 30	24 x 30	36 x 48	48 x 60	18 x 24	36 x 48
Trucks Use Right Lane	R4-5	2B.31	24 x 30	24 x 30	36 x 48	48 x 60	—	36 x 48

Types of Warning Signs – MUTCD Standards

	Roadway Surface	2C.31	Shoulder, Uneven Lanes	W8-4,9,11,17,17P,23,25
	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