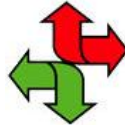


ARIZONA DEPARTMENT OF TRANSPORTATION



ARIZONA SUPPLEMENT TO THE 2003 MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES

September 1, 2004

Arizona MUTCD users are to modify the 2003 MUTCD as follows:

September 1, 2004

IMPLEMENTATION DATES

<u>Section 2B.04, 2B.50, 2D.15, 2E.28</u>	<u>Based on sign rehab program</u>
<u>Section 3B.01, 3B.07</u>	<u>January 17, 2005</u>
<u>Section 3B.02, 3B.19</u>	<u>January 17, 2007</u>

ADOT SUPPLEMENT FOR THE 2003 MUTCD

Note: If there is a discrepancy between wording of the MUTCD and corresponding figure, the text shall supersede the figure.

Change all references of “Bicycle Trail” to “Bikeways”.

Section 1A.08 Authority for Placement of Traffic Control Devices

Standard:

Traffic control devices, advertisements, announcements, and other signs or messages within the highway right-of-way shall be placed only as authorized by a public authority or the official having jurisdiction, for the purpose of regulating, warning, or guiding traffic.

When the public agency or the official having jurisdiction over a street or highway has granted proper authority, others such as contractors and public utility companies shall be permitted to install temporary traffic control devices in temporary traffic control zones. Such traffic control devices shall conform with the Standards of this Manual.

Guidance:

Any unauthorized traffic control device or other sign or message placed on the highway right-of-way by a private organization or individual constitutes a public nuisance and should be removed. All unofficial or nonessential traffic control devices, signs, or messages should be removed.

Standard:

All regulatory traffic control devices shall be supported by laws, ordinances, or regulations.

Support:

The provisions of this Manual are based upon the concept that effective traffic control depends upon both appropriate application of devices and reasonable enforcement of regulations.

Jurisdictions having authority for placement of traffic control devices may specify acceptable control devices that are based on engineering judgment, adopted laws, ordinances, project specifications, or approved jurisdictional manuals.

Section 1A.09 Engineering Study and Engineering Judgment

Standard:

This Manual describes the application of traffic control devices, but shall not be a legal requirement for their installation.

Guidance:

The decision to use a particular device at a particular location should be made on the basis of either an engineering study or the application of engineering judgment. Thus, while this Manual provides Standards, Guidance, and Options for design and application of traffic control devices, this Manual should not be considered a substitute for engineering judgment.

Engineering judgment should be exercised in the selection and application of traffic control devices, as well as in the location and design of the roads and streets that the devices complement. Jurisdictions with responsibility for traffic control that do not have engineers on their staffs should seek engineering assistance from others, such as the State transportation agency, their County, a nearby large City, or a traffic engineering consultant.

Support:

No single reference can address all acceptable engineering options. It is for that reason the MUTCD describes a few typical situations, but acknowledges that “the applications described therein shall not be a legal requirement for installation”, and that the MUTCD “should not be considered a substitute for engineering judgment”.

This Arizona MUTCD supplement blends local procedures predicated on engineering judgment that have worked successfully in Arizona, with the national MUTCD. To assure the Arizona MUTCD remains in substantial conformance with the national MUTCD, special care has been taken to preserve the requirements for basic shapes, colors, and intent of traffic control devices.

Controlling traffic in urban areas sometimes requires different treatments to safely and efficiently move traffic because of different physical conditions, operating characteristics, and driver conditioning. Differences that exist on city streets may include:

- City streets are designed to provide access to adjacent properties.
- Right-of-way for city streets typically extends no more than five or ten feet beyond curb lines. Sidewalks, utilities, and drainage support must fit in this narrow right-of-way as well.
- The “clear zone” concept prevalent on rural highways is replaced by a philosophy in cities that gives higher priority to protecting pedestrians and other users. For example, on urban arterials, collectors and local streets, curbs are used to separate vehicular traffic from pedestrians and minimize the use of mechanisms such as breakaway poles.
- On city streets, high speeds typically are not desirable, and roadway designs are frequently intended to “calm” traffic.
- Engineers designing traffic control for urban streets must consider the same vehicles, drivers and road geometry as used on rural roadways, but also must design for different modes and conditions including:
 - Safe and efficient access to businesses and homes
 - Bicycles, mopeds, skateboards and wheelchairs
 - Buses, bus stops, and light rail
 - Pedestrians
 - Parades and other special events
 - Schools
 - Sidewalks and landscaping (personal and public)
 - On-street parking and drainage
 - Passenger loading, freight loading, fire lanes, and other curb uses

The MUTCD, when combined with the knowledge of trained engineers familiar with local conditions, and policy and procedure manuals that document best practices, provides a resource for operating safe and efficient roadways.

In addition, reference material applicable to operating traffic effectively on urban streets in Arizona is available in three chapters (7, 13, and 14) of the Traffic Control Device Handbook (2001) published by the Institute of Transportation Engineers (ITE). Another reference covering effective traffic control options on urban streets is chapters 4 and 6 of the Traffic Signing Handbook (1997), also published by ITE.

Section 1A.14 Abbreviations Used on Traffic Control Devices

Guidance:

When the word messages shown in Table 1A-1 need to be abbreviated in connection with traffic control devices, the abbreviations shown in Table 1A-1 should be used.

The abbreviations for the words listed in Table 1A-2 should not be used in connection with traffic control devices unless the prompt word shown in Table 1A-2 either precedes or follows the abbreviation.

Standard:

The abbreviations shown in Table 1A-3 shall not be used in connection with traffic control devices because of their potential to be misinterpreted by road users.

Guidance:

Where multiple abbreviations are permitted in Tables 1A-1 or 1A-2, the same abbreviation should be used throughout a single jurisdiction

Section 2A.03 Standardization of Application

Support:

It is recognized that urban traffic conditions differ from those in rural environments, and in many instances signs are applied and located differently. Where pertinent and practical, this Manual sets forth separate recommendations for urban and rural conditions.

The national MUTCD places all city streets into a single category (conventional roadways), even though substantial differences exist. Engineering judgment can be used to select an appropriate sign size based roadway environment.

Factors that have already been developed through engineering practice in Arizona include:

- Speed limits in Arizona are set consistent with Arizona Revised Statutes. Prima facie speed limits apply, which require drivers to select speeds commensurate with conditions. If drivers cannot see other vehicles or road users because of faulty vision, inclement weather, medical reasons, parked cars, or landscaping near corners, Arizona drivers are obligated to reduce speed commensurate with conditions.
- Signs can safely be combined with other signs (to minimize roadside obstacles).
- Yield Here to Pedestrians signs, need not accompany YIELD lines on local roads, except when placed at an unexpected location for motorists (more than 30 feet in advance of the conflict point).
- Intersection control decisions, particularly on residential streets need to be predicated on recognition of differently conditioned drivers, lower speeds, and the prima facie speed limits that exist. Chapter 7 of ITE's Traffic Control Device Handbook (2001) discusses why procedures appropriate for high speed rural roads may not be appropriate for city streets.
- Warning sign placement on city streets can be in accordance with section 6C.04 or Table 2C-4, due to driver conditioning resulting in different reaction times.
- Lighting of retroreflectorized overhead signs in urban areas is not normally needed.

Guidance:

Signs should be used only where justified by engineering judgment or studies, as noted in Section 1A.09.

Results from traffic engineering studies of physical and traffic factors should indicate the locations where signs are deemed necessary or desirable.

Roadway geometric design and sign application should be coordinated so that signing can be effectively placed to give the road user any necessary regulatory, warning, guidance, and other information.

Standard:

Each standard sign shall be displayed only for the specific purpose as prescribed in this Manual. Determination of the particular signs to be applied to a specific condition shall be made in accordance with the criteria set forth in Part 2. Before any new highway, detour, or temporary route is opened to traffic, all necessary signs shall be in place. Signs required by road conditions or restrictions shall be removed when those conditions cease to exist or the restrictions are withdrawn.

Section 2A.15 Sign Borders

Standard:

Unless specifically designed otherwise, each sign illustrated herein shall have a border of the same color as the legend, at or just inside the edge.

The corners of all sign borders shall be rounded, except for STOP signs.

Guidance:

A dark border on a light background should be set in from the edge, while a light border on a dark background should extend to the edge of the panel. A border for 750 mm (30 in) signs with a light background should be from 13 to 19 mm (0.5 to 0.75 in) in width, 13 mm (0.5 in) from the edge. For similar signs with a light border, a width of 25 mm (1 in) should be used. For other sizes, the border width should be of similar proportions, but should not exceed the stroke-width of the major lettering of the sign. On signs exceeding 1800 x 3000 mm (72 x 120 in) in size, the border should be 50 mm (2 in) wide, or on larger signs, 75 mm (3 in) wide. Except for STOP signs and as otherwise provided in Section 2E.15, the corners of the sign should be rounded to fit the border.

Section 2A.16 Standardization of Location

Support:

Standardization of position cannot always be attained in practice. Examples of heights and lateral locations of signs for typical installations are illustrated in Figure 2A-1, and examples of locations for some typical signs at intersections are illustrated in Figure 2A-2.

Standard:

Signs requiring different decisions by the road user shall be spaced sufficiently far apart for the required decisions to be made reasonably safely. One of the factors considered when determining the appropriate spacing shall be the posted or 85th-percentile speed.

Guidance:

Signs should be located on the right side of the roadway where they are easily recognized and understood by road users. Signs in other locations should be considered only as supplementary to signs in the normal locations, except as otherwise indicated.

Signs should be individually installed on separate posts or mountings except where:

- A. One sign supplements another, or
- B. Route or directional signs are grouped to clarify information to motorists, or
- C. Regulatory signs that do not conflict with each other are grouped, such as turn prohibition signs posted with one-way signs, street name signs posted with a stop or yield sign, or a parking regulation sign posted with a speed limit sign.

Signs should be located so that they:

- A. Are outside the clear zone unless placed on a breakaway or yielding support (see Section 2A.19);
- B. Optimize nighttime visibility;
- C. Minimize the effects of mud splatter and debris;
- D. Do not obscure each other; and
- E. Are not hidden from view.

Support:

The clear zone is the total roadside border area, starting at the edge of the traveled way, available for use by errant vehicles. The width of the clear zone is dependent upon traffic volumes, speeds, and roadside geometry. Additional information can be found in the "AASHTO Roadside Design Guide" (see Addresses for AASHTO's address).

Guidance:

With the increase in traffic volumes and the desire to provide road users regulatory, warning, and guidance information, an order of priority for sign installation should be established.

Support:

An order of priority is especially critical where space is limited for sign installation and there is a demand for several different types of signs. Overloading road users with too much information is not desirable.

Guidance:

Because regulatory and warning information is more critical to the road user than guidance information, regulatory and warning signing whose location is critical should be displayed rather than guide signing in cases where conflicts occur. Information of a less critical nature should be moved to less critical locations or omitted.

Option:

Under some circumstances, such as on curves to the right, signs may be placed on median islands or on the left side of the road. A supplementary sign located on the left of the roadway may be used on a multi-lane road where traffic in the right lane might obstruct the view to the right.

Section 2A.18 Mounting Height

Support:

The provisions of this Section apply unless specifically stated otherwise for a particular sign elsewhere in this Manual.

Standard:

Signs installed at the side of the road in rural districts shall be at least 1.5 m (5 ft), measured from the bottom of the sign to the near edge of the pavement.

Where parking or pedestrian movements occur, the clearance to the bottom of the sign shall be at least 2.1 m (7 ft).

Directional signs on freeways and expressways shall be installed with a minimum height of 2.1 m (7 ft). If a secondary sign is mounted below another sign, the major sign shall be installed at least 2.4 m (8 ft) and the secondary sign at least 1.5 m (5 ft) above the level of the pavement edge. All route signs, warning signs, and regulatory signs on freeways and expressways shall be at least 2.1 m (7 ft) above the level of the pavement edge.

Option:

The height to the bottom of a secondary sign mounted below another sign may be 0.3 m (1 ft) less than the height specified above.

Where signs are placed 9 m (30 ft) or more from the edge of the traveled way, the height to the bottom of such signs may be 1.5 m (5 ft) above the level of the pavement edge.

A route sign assembly consisting of a route sign and auxiliary signs (see Section 2D.27) may be treated as a single sign for the purposes of this Section.

The mounting height may be adjusted when supports are located near the edge of the right-of-way on a steep backslope.

Flexibility in mounting heights may be exercised in urban areas to account for differing conditions. Sign mounting height may be determined by engineering judgment.

Support:

Without this flexibility regarding steep backslopes, some agencies might decide to relocate the sign closer to the road, which might be less desirable.

Standard:

Overhead mounted signs shall provide a vertical clearance of not less than 5.2 m (17 ft) to the sign, light fixture, or sign bridge, over the entire width of the pavement and shoulders except where a lesser vertical clearance is used for the design of other structures.

Option:

If the vertical clearance of other structures is less than 4.9 m (16 ft), the vertical clearance to overhead sign structures or supports may be as low as 0.3 m (1 ft) higher than the vertical clearance of the other structures.

In special cases it may be necessary to reduce the clearance to overhead signs because of substandard dimensions in tunnels and other major structures such as double-deck bridges.

Support:

Figure 2A-1 illustrates some examples of the mounting height requirements contained in this Section.

Section 2A.19 Lateral Offset

Standard:

For overhead sign supports, the minimum lateral offset from the edge of the shoulder (or if no shoulder exists, from the edge of the pavement) to the near edge of overhead sign supports (cantilever or sign bridges) shall be 1.8 m (6 ft). Overhead sign supports shall have a barrier or crash cushion to shield them if they are within the clear zone.

Ground-mounted sign supports shall be breakaway, yielding, or shielded with a longitudinal barrier or crash cushion if within the clear zone.

Option:

In urban areas where lateral offsets are limited, a minimum lateral offset of 0.6 m (2 ft) may be used.

A minimum offset of 0.3 m (1 ft) from the face of the curb may be used in urban areas where sidewalk width is limited or where existing poles are close to the curb.

Typically right of way restrictions coupled with low speeds may make crash cushions/longitudinal barriers inappropriate for use on city streets.

Guidance:

For ground-mounted signs, the minimum lateral offset should be 3.7 m (12 ft) from the edge of the traveled way. If a shoulder wider than 1.8 m (6 ft) exists, the minimum lateral offset for ground-mounted signs should be 1.8 m (6 ft) from the edge of the shoulder.

Support:

The minimum lateral offset is intended to keep trucks and cars that use the shoulders from striking the signs or supports.

Guidance:

All supports should be located as far as practical from the edge of the shoulder. Advantage should be taken to place signs behind existing roadside barriers, on over-crossing structures, or other locations that minimize the exposure of the traffic to sign supports.

Option:

Where permitted, signs may be placed on existing supports used for other purposes, such as highway traffic signal supports, highway lighting supports, and utility poles.

Standard:

If signs are placed on existing supports, they shall meet other placement criteria contained in this Manual.

Option:

Lesser lateral offsets may be used on connecting roadways or ramps at interchanges, but not less than 1.8 m (6 ft) from the edge of the traveled way.

In areas where lateral offsets are limited, a minimum lateral offset of 0.6 m (2 ft) may be used.

A minimum offset of 0.3 m (1 ft) from the face of the curb may be used in urban areas where sidewalk width is limited or where existing poles are close to the curb.

Support:

Figures 2A-1 and 2A-2 illustrate some examples of the lateral offset requirements contained in this Section.

Section 2A.21 Posts and Mountings

Standard:

Sign posts, foundations, and mountings shall be so constructed as to hold signs in a proper and permanent position, and to resist swaying in the wind or displacement by vandalism.

Support:

The latest edition of AASHTO's "Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals" contains additional information regarding posts and mounting (see Addresses for AASHTO's address).

Option:

Where engineering judgment indicates a need to draw attention to the sign during nighttime conditions, a strip of retroreflective material may be used on regulatory and warning sign supports.

Standard:

If a strip of retroreflective material is used on the sign support, its color shall match the background color of the sign, except that the color of the strip for the YIELD and DO NOT ENTER signs shall be red.

Section 2A.22 Maintenance

Guidance:

All traffic signs should be kept properly positioned, clean, and legible, and should have adequate retroreflectivity. Damaged or deteriorated signs should be replaced.

To assure adequate maintenance, a program for inspecting, cleaning, and replacing signs should be established. Employees of highway, law enforcement, and other public agencies whose duties require that they travel on the roadways should be encouraged to report any damaged, deteriorated, or obscured signs at the first opportunity. Steps should be taken to see that weeds, trees, shrubbery, and construction, maintenance, and utility materials and equipment do not obscure the face of any sign.

A regular schedule of replacement of lighting elements for illuminated signs should be maintained.

Section 2B.06 STOP Sign Placement

Standard:

The STOP sign shall be installed on the right side of the approach to which it applies. When the STOP sign is installed at this required location and the sign visibility is restricted, a Stop Ahead sign (see Section 2C.29) shall be installed in advance of the STOP sign.

The STOP sign shall be located as close as practical to the intersection it regulates, while optimizing its visibility to the road user it is intended to regulate.

STOP signs and YIELD signs shall not be mounted on the same post, unless they are controlling different intersections.

Guidance:

Other than a DO NOT ENTER sign, no sign should be mounted back-to-back with a STOP sign in a manner that obscures the shape of the STOP sign.

Support:

Section 2A.16 contains additional information about separate and combined mounting of other signs with STOP signs.

Guidance:

Stop lines, when used to supplement a STOP sign, should be located at the point where the road user should stop (see Section 3B.16).

Support:

The placement of the STOP sign will generally be in the vicinity of the point of where the drivers make their first stop and/or where the sign is most visible to approaching traffic. Arizona Revised Statutes require a driver approaching a STOP sign to employ a two-step movement, regardless of the positioning of the STOP sign. A driver must first stop at the locations as defined in State law, and secondly must yield or stop before entering an intersection if traffic is approaching as to constitute a hazard. Drivers must make the second stop or yield from a position where they have full view of approaching traffic.

STOP lines can be used to gain improved driver performance in various ways. For example, STOP bars may be used to advise where drivers are to:

1. Stop in the event pedestrians are present; or
2. Stop at a signal to retain view of nearside signals, or remain on vehicle detectors; or
3. Yield or Stop where they have a full view of approaching traffic; or
4. Stop far enough back to not obstruct turning vehicles from opposing streets; or
5. Stop at wide throat intersections where the optimum stopping locations is a substantial distance from the STOP sign.

Guidance:

If only one STOP sign is installed on an approach, the STOP sign should not be placed on the far side of the intersection.

Where two roads intersect at an acute angle, the STOP sign should be positioned at an angle, or shielded, so that the legend is out of view of traffic to which it does not apply.

Where there is a marked crosswalk at the intersection, the STOP sign should be installed in advance of the crosswalk line nearest to the approaching traffic.

Option:

At wide-throat intersections or where two or more approach lanes of traffic exist on the signed approach, observance of the stop control may be improved by the installation of an additional STOP sign on the left side of the road and/or the use of a stop line. At channelized intersections, the additional STOP sign may be effectively placed on a channelizing island.

Support:

Figure 2A-2 shows examples of some typical placements of STOP signs.

Section 2B.09 YIELD Sign Applications

Option:

YIELD signs may be used instead of STOP signs if engineering judgment indicates that one or more of the following conditions exist:

- A- At the entrance to an intersection where it is necessary to assign right-of-way and where the safe approach speed on the entrance exceeds 10 miles per hour.
- B- If controlling a merge-type movement on the entering roadway where acceleration geometry and/or sight distance is not adequate for merging traffic operation.
- C- The second crossroad of a divided highway, where the median width at the intersection is 9 m (30 ft) or greater. In this case, a STOP sign may be installed at the entrance to the first roadway of a divided highway, and a YIELD sign may be installed at the entrance to the second roadway.
- D- An intersection where a special problem exists and where engineering judgment indicates the problem to be susceptible to correction by the use of the YIELD sign.

Standard:

A YIELD (R1-2) sign shall be used to assign right-of-way at the entrance to a roundabout intersection.

Section 2B.10 YIELD Sign Placement

Standard:

The YIELD sign shall be installed on the right side of the approach to which it applies. YIELD signs shall be placed on both the left and right sides of approaches to roundabout intersections with more than one lane on the signed approach where raised splitter islands are available on the left side of the approach. When the YIELD sign is installed at this required location and the sign visibility is restricted, a Yield Ahead sign (see Section 2C.29) shall be installed in advance of the YIELD sign.

The YIELD sign shall be located as close as practical to the intersection it regulates, while optimizing its visibility to the road user it is intended to regulate.

YIELD signs and STOP signs shall not be mounted on the same post, unless they are controlling different intersections.

Guidance:

Other than a DO NOT ENTER sign, no sign should be mounted back-to-back with a YIELD sign in a manner that obscures the shape of the YIELD sign.

Support:

Section 2A.16 contains additional information about separate and combined mounting of other signs with YIELD signs.

Guidance:

Yield lines, when used to supplement a YIELD sign, should be located at a point where the road user should yield (see Section 3B.16).

Where two roads intersect at an acute angle, the YIELD sign should be positioned at an angle, or shielded, so that the legend is out of view of traffic to which it does not apply.

Except at roundabout intersections, where there is a marked crosswalk at the intersection, the YIELD sign should be installed in advance of the crosswalk line nearest to the approaching traffic.

At a roundabout intersection, to prevent circulating vehicles from yielding unnecessarily, the face of the YIELD sign should not be visible from the circulatory roadway.

Option:

At wide-throat intersections or where two or more approach lanes of traffic exist on the signed approach, observance of the yield control may be improved by the installation of an additional YIELD sign on the left side of the road and/or the use of a yield line. At channelized intersections, the additional YIELD sign may be effectively placed on a channelizing island.

Section 2B.12 In-Street Pedestrian Crossing Signs (R1-6(AZ), R1-6(AZ)a)

Option:

The In-Street Pedestrian Crossing (R1-6 or R1-6a) sign (see Figure 2B-2) may be used to remind road users of laws regarding right of way at an unsignalized pedestrian crossing. The legend STATE LAW may be shown at the top of the sign if applicable. The legends STOP FOR or YIELD TO may be used in conjunction with the appropriate symbol.

Guidance:

If an island (See Chapter 3G) is available, the In-Street Pedestrian Crossing sign, if used, should be placed on the island.

Standard:

The In-Street Pedestrian Crossing sign shall not be used at signalized locations.

The STOP FOR legend shall only be used in States where the State law specifically requires that a driver must stop for a pedestrian in a crosswalk.

If used, the In-Street Pedestrian Crossing sign shall have a black legend (except for the red STOP or YIELD sign symbols) and border on either a white and/or fluorescent yellow-green background.

If the In-Street Pedestrian Crossing sign is placed in the roadway, the sign support shall comply with the breakaway requirements of the latest edition of AASHTO's "Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals" (See Addresses).

Support:

The provisions of Section 2A.18 concerning mounting height are not applicable for the In-Street Pedestrian Crossing sign.

Option:

The In-Street Pedestrian Crossing sign may be used seasonably to prevent damage in winter because of plowing operations, and may be removed at night if the pedestrian activity at night is minimal.

In-street Pedestrian Crossing signs are not normally helpful for use in cities where substantial traffic and narrow traffic lanes typically exist. If used, adult attendants are needed on-site to keep the signs in place. Oversize signs, mounted in conventional locations may be used in lieu of in-street signs.

Section 2B.20 Intersection Lane Control Signs (R3-5 through R3-8)

Standard:

Intersection Lane Control signs, if used, shall require road users in certain lanes to turn, shall permit turns from a lane where such turns would otherwise not be permitted, shall require a road user to stay in the same lane and proceed straight through an intersection, or shall indicate permitted movements from a lane.

Intersection Lane Control signs (see Figure 2B-4) shall have three applications:

- A. Mandatory Movement Lane Control (R3-5, R3-5a, and R3-7) signs;**
- B. Optional Movement Lane Control (R3-6) sign; and**
- C. Advance Intersection Lane Control (R3-8 series) signs.**

Guidance:

When used, Intersection Lane Control signs should be overhead or ground-mounted, based on engineering judgment. In urban areas the R3-8 series (Advance Intersection signs) may be used at the intersection in lieu of the R3-5 series where engineering judgment indicates doing so will properly communicate permissible lane movement for road users.

Standard:

Use of an overhead sign for one approach lane shall not require installation of overhead signs for the other lanes of that approach.

Option:

Where the number of through lanes on an approach is two or less, the Intersection Lane Control signs (R3-5, R3-6, or R3-8) may be overhead or ground mounted.

Intersection Lane Control signs may be omitted where:

- A. Turning bays have been provided by physical construction or pavement markings, and
- B. Only the road users using such turning bays are permitted to make a similar turn.

Section 2B.37 ONE WAY Signs (R6-1, R6-2)

Standard:

Except as noted in the Option, the ONE WAY (R6-1 or R6-2) sign (see Figure 2B-11) shall be used to indicate streets or roadways upon which vehicular traffic is allowed to travel in one direction only. ONE WAY signs shall be placed parallel to the one-way street at roadways that intersect one-way roadways as shown in Figures 2B-12 through 2B-15.

Guidance:

Where divided highways are separated by median widths at the intersection itself of 9 m (30 ft) or more, ONE WAY signs should be placed, visible to each crossroad approach, on the near right and far left corners of each intersection with the directional roadways as shown in Figures 2B-12 and 2B-13.

Option:

ONE WAY signs may be omitted on the one-way roadways of divided highways, where the design of interchanges indicates the direction of traffic on the separate roadways.

ONE WAY signs may be omitted (see Figure 2B-14) at intersections with divided highways that have median widths at the intersection itself of less than 9 m (30 ft).

Standard:

At unsignalized intersections, ONE WAY signs shall be placed on the near right and the far left corners of the intersection facing traffic entering or crossing the one-way street.

At signalized intersections, ONE WAY signs shall be placed either near the appropriate signal faces, on the poles holding the traffic signals, on the mast arm or span wire holding the signals, or at the locations specified for unsignalized intersections.

Section 2B.41 Placement of Parking, Stopping, and Standing Signs

Guidance:

When signs with arrows are used to indicate the extent of the restricted zones, the signs should be set at an angle of not less than 30 degrees nor more than 45 degrees with the line of traffic flow in order to be visible to approaching traffic.

Spacing of signs should be based on legibility and sign orientation.

If the zone is unusually long, signs showing a double arrow should be used at intermediate points within the zone.

Option:

If the signs are mounted at an angle of 90 degrees to the curb line, two signs may be mounted back to back at the transition point between two parking zones, each with the appended message THIS SIDE OF SIGN.

Guidance:

At intermediate points within a zone, a single sign without any arrow or appended plaque should be used, facing in the direction of approaching traffic. Otherwise the standards of placement should be the same as for signs using directional arrows.

Section 2B.45 Traffic Signal Signs (R10-1 through R10-13)

Option:

To supplement traffic signal control, Traffic Signal signs R10-1 through R10-21 may be used to regulate road users.

Guidance:

Traffic signal signs should be located where they will be best understood by road users.

Standard:

Traffic Signal signs applicable to pedestrian actuation (see Figure 2B-18) shall be mounted immediately above or incorporated in pedestrian pushbutton units (see Section 4E.08).

Support:

Traffic Signal signs applicable to pedestrians include:

CROSS ON GREEN LIGHT ONLY (R10-1);

CROSS ON WALK SIGNAL ONLY (R10-2);

PUSH BUTTON FOR GREEN LIGHT (R10-3); and

PUSH BUTTON FOR WALK SIGNAL (R10-4).

Option:

The following signs may be used as an alternate for the R10-3 and R10-4 signs:

TO CROSS STREET (arrow), PUSH BUTTON WAIT FOR GREEN LIGHT (R10-3a); and

TO CROSS STREET (arrow), PUSH BUTTON WAIT FOR WALK SIGNAL (R10-4a).

The symbol sign R10-2a may be used as an alternate to sign R10-2. Where symbol-type pedestrian signal indications are used, an educational sign (R10-3b) may be used to improve pedestrian understanding of pedestrian indications at signalized intersections. Where word-type pedestrian signal indications are being retained for the remainder of their useful service life, the legends WALK/DONT WALK may be substituted for the symbols on the educational sign R10-3b, thus creating sign R10-3c. The R10-3d sign may be used if the pedestrian clearance time is sufficient only for the pedestrian to cross to the median. The diagrammatic sign R10-4b may also be used as an alternate to sign R10-4. At intersections where pedestrians cross in two stages using

a median refuge island, the word message "CROSS TO MEDIAN" may be placed on the near corner of the refuge island along with the educational plaque.

Traffic Signal signs (see Figure 2B-19) may be installed at certain locations to clarify signal control. Among the legends for this purpose are LEFT ON GREEN ARROW ONLY (R10-5), STOP HERE ON RED (R10-6 or R10-6a) for observance of stop lines, DO NOT BLOCK INTERSECTION (R10-7) for avoidance of traffic obstructions, USE LANE(S) WITH GREEN ARROW (R10-8) for obedience to Lane Control signals, LEFT TURN YIELD ON GREEN (symbolic green ball) (R10-12), and LEFT TURN SIGNAL YIELD ON GREEN (symbolic green ball) (R10-21) (see Section 4D.06).

In situations where traffic control signals are coordinated for progressive timing, the Traffic Signal Speed (I1-1) sign may be used (see Section 2D.47).

Standard:

The NO TURN ON RED (R10-11a, R10-11b) sign (see Figure 2B-19) shall be used to prohibit a right turn on red (or a left turn on red from a one-way street to a one-way street).

Option:

A symbolic NO TURN ON RED (R10-11) sign (see Figure 2B-19) may be used as an alternate to the R10-11a and R10-11b signs.

Guidance:

If used, the NO TURN ON RED sign should be installed near the appropriate signal head.

A NO TURN ON RED sign should be considered when engineering judgment determines that one or more of the following conditions exists:

- A- Inadequate sight distance to vehicles approaching from the left (or right, if applicable);
- B- Geometrics or operational characteristics of the intersection that might result in unexpected conflicts;
- C- An exclusive pedestrian phase;
- D- An unacceptable number of pedestrian conflicts with right-turn-on-red maneuvers, especially involving children, older pedestrians, or persons with disabilities; and
- E- More than three right-turn-on-red accidents reported in a 12-month period for the particular approach.

Where turns on red are permitted and the signal indication is a RED ARROW, the RIGHT (LEFT) ON RED ARROW AFTER STOP (R10-17a) sign (see Figure 2B-19) should be installed adjacent to the RED ARROW signal indication.

Option:

In order to remind drivers who are making turns to yield to pedestrians, especially at intersections where right turn on red is permitted and pedestrian crosswalks are marked, a TURNING TRAFFIC MUST YIELD TO PEDESTRIANS (R10-15) sign may be used (see Figure 2B-19).

A supplemental R10-20a plaque (see Figure 2B-19) showing times of day (similar to the S4-1 plaque shown in Figure 7B-1) with a black legend and border on a white background may be mounted below a NO TURN ON RED sign to indicate that the restriction is in place only during certain times.

Standard:

The EMERGENCY SIGNAL (R10-13) sign (see Figure 2B-19) shall be used in conjunction with emergency-vehicle traffic control signals (see Section 4F.02).

Option:

A U-TURN YIELD TO RIGHT TURN (R10-16) sign (see Figure 2B-19) may be installed near the left-turn signal face if U-turns are allowed on a protected left-turn movement on an approach from which drivers making a right turn from the conflicting approach to their left are simultaneously being shown a right-turn GREEN ARROW signal indication

Section 2C.02 Application of Warning Signs

Standard:

The use of warning signs shall be based on an engineering study or on engineering judgment.

Guidance:

The use of warning signs should be kept to a minimum as the unnecessary use of warning signs tends to breed disrespect for all signs.

Support:

The categories of warning signs are shown in Table 2C-1.

Warning signs specified herein cover most of the conditions that are likely to be encountered. Additional warning signs for low-volume roads (as defined in Section 5A.01), temporary traffic control zones, school areas, highway-rail grade crossings, bicycle facilities, and highway-light rail transit grade crossings are discussed in Parts 5 through 10, respectively.

Option:

Word message warning signs other than those specified in this Manual may be developed and installed by State and local highway agencies.

Table 2C-4 Placement of Warning Signs: ADD NEW NOTE:

NOTE: On city streets, drivers remain continuously alert and warning signs are typically placed to be highly visible. Some signs, such as Lane Ends symbol or word signs, may be placed between four to ten times the speed limit in feet in advance of the hazard. The higher ratios are applicable on higher speed roads, and lower ratios on lower speed streets.

Section 2C.11 Hill Signs (W7-1, W7-1a, W7-1b)

Guidance:

Based on engineering judgment the Hill (W7-1) sign (see Figure 2C-2) should be 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.

The Hill sign and supplemental grade (W7-3) plaque (see Section 2C.48) used in combination, or the W7-1b sign used alone, should be installed in advance of downgrades for the following conditions:

5% grade that is more than 900 m (3,000 ft) in length;

6% grade that is more than 600 m (2,000 ft) in length;

7% grade that is more than 300 m (1,000 ft) in length;

8% grade that is more than 230 m (750 ft) in length; or

9% grade that is more than 150 m (500 ft) in length.

These signs should also be installed for steeper grades or where crash experience and field observations indicate a need.

Supplemental plaques (see Section 2C.48) and larger signs should be used for emphasis or where special hill characteristics exist. On longer grades, the use of the Hill sign with a distance (W7-3a) plaque or the combination distance/grade (W7-3b) plaque at periodic intervals of approximately 1.6 km (1 mi) spacing should be considered.

Standard:

When the percent grade is shown, the message X% plaque shall be placed below the inclined ramp/truck symbol (W7-1) or the word message HILL (W7-1a) sign.

Option:

The word message HILL (W7-1a) sign may be used as an alternate to the symbol (W7-1) sign. The percent grade message may be included within these signs.

Section 2C.18 Divided Highway (Road) Sign (W6-1)

Option:

A Divided Highway (W6-1) symbol sign (see Figure 2C-3) may be used on the approaches to a section of highway (not an intersection or junction) where the opposing flows of traffic are separated by a median or other physical barrier.

The word message DIVIDED HIGHWAY (W6-1a) or DIVIDED ROAD (W6-1b) sign (see Figure 2C-3) may be used as an alternate to the symbol sign.

Section 2C.19 Divided Highway (Road) Ends Sign (W6-2)

Option:

A Divided Highway Ends (W6-2) symbol sign (see Figure 2C-3) may be used in advance of the end of a section of physically divided highway (not an intersection or junction) as a warning of two-way traffic ahead.

The Two-Way Traffic (W6-3) symbol sign (see Section 2C.34) may be used to give warning and notice of the transition to a two-lane, two-way section.

The word message DIVIDED HIGHWAY ENDS (W6-2a) or DIVIDED ROAD ENDS (W6-2b) sign (see Figure 2C-3) may be used as an alternate to the symbol sign.

Section 2C.21 DEAD END/NO OUTLET Plaques (W14-1P, W14-2P)

Option:

The DEAD END (W14-1) sign (see Figure 2C-3) 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.

DEAD END (W14-1a) or NO OUTLET (W14-2a) signs (see Figure 2C-3) may be used in combination with Street Name (D3-1) signs (see Section 2D.38) to warn turning traffic that the cross street ends in the direction indicated by the arrow.

At locations where the cross street does not have a name, the W14-1a or W14-2a signs may be used alone in place of a street name sign.

On low-speed residential streets, the W-14-1a (DEAD END) signs or the W-14-2a (NO OUTLET) signs may substitute for the W14-1 or W14-2 signs based on engineering judgment.

Standard:

When the W14-1 or W14-2 sign is used, the sign shall be posted as near as practical to the entry point or at a sufficient advance distance to permit the road user to avoid the dead end or no outlet condition by turning off, if possible, at the nearest intersecting street.

The DEAD END (W14-1a) or NO OUTLET (W14-2a) signs shall not be used instead of the W14-1 or W14-2 signs where traffic can proceed straight through the intersection into the dead end street or no outlet area.

The number, type and location of signs are to be based on engineering judgment.

Section 2C.24 SPEED HUMP Sign (W17-1)

Option:

The SPEED HUMP (W17-1) sign (see Figure 2C-4) may be used to give warning of a vertical deflection in the roadway that is designed to limit the speed of traffic.

If used, the SPEED HUMP sign may be supplemented by an Advisory Speed plaque (see Section 2C.46).

If a series of speed humps exists in close proximity, an Advisory Speed plaque may be eliminated on all but the first SPEED HUMP sign in the series.

The legend SPEED BUMP may be used instead of the legend SPEED HUMP on the W17-1 sign.

Support:

Speed humps generally provide more gradual vertical deflection than speed bumps. Speed bumps limit the speed of traffic more severely than speed humps. However, this difference in engineering terminology is not well known by the public, so for signing purposes the terms are interchangeable.

Section 2C.25 PAVEMENT ENDS Sign (W8-3)

Option:

A PAVEMENT ENDS (W8-3) word message sign (see Figure 2C-4) may be used where a paved surface changes to either a gravel treated surface or an earth road surface.

An Advisory Speed plaque (see Section 2C.46) may be used when the change in roadway condition requires a reduced speed.

Section 2C.30 Speed Reduction Signs (W3-5, W3-5a, W3-5(AZ)a)

Guidance:

A Speed Reduction (W3-5 or W3-5a, W3-5(AZ)a) sign should be used to inform road users of a reduced speed zone when engineering judgment indicates the need for advance notice to comply with the posted speed limit ahead.

Standard:

If used, Speed Reduction signs shall be followed by a Speed Limit (R2-1) sign installed at the beginning of the zone where the speed limit applies.

The speed limit displayed on the Speed Reduction sign shall be identical to the speed limit displayed on the subsequent Speed Limit sign.

Section 2C.32 Added Lane Signs (W4-3, W4-6)

Guidance:

Based on engineering judgment the Added Lane (W4-3) sign (see Figure 2C-6) should be installed in advance of a point where two roadways converge and merging movements are not required. When possible, the Added Lane sign should be placed such that it is visible from both roadways; if this is not possible, an Added Lane sign should be placed on the side of each roadway.

When an Added Lane sign is to be installed on a roadway that curves before converging with another roadway that has a tangent alignment at the point of convergence, the Entering Roadway Added Lane (W4-6) sign (see Figure 2C-6) should be used to better portray the actual geometric conditions to road users on the curving roadway.

Section 2C.34 Two-Way Traffic Sign (W6-3)

Option:

A Two Way Traffic (W6-3) sign is intended to give warning of a transition from a one-way roadway to a two-way roadway. This sign may be used as required at intervals to periodically remind drivers that they are on a two-way roadway.

Section 2D.38 Street Name Sign (D3-1)

Guidance:

Street Name (D3-1) signs (see Figure 2D-8) should be installed in urban areas at all street intersections regardless of other route signs that may be present and should be installed in rural areas to identify important roads that are not otherwise signed.

Lettering on ground-mounted Street Name signs should be at least 150 mm (6 in) high in capital letters, or 150 mm (6 in) upper-case letters with 113 mm (4.5 in) lower-case letters.

Option:

For local urban streets with speed limits of 40 mph or less, the lettering height may be a minimum of 100 mm (4 in).

Supplementary lettering to indicate the type of street (such as Street, Avenue, or Road) or the section of the City (such as NW) may be in smaller lettering, at least 75 mm (3 in) high. Conventional abbreviations (see Section 1A.14) may be used except for the street name itself.

A symbol or letter designation may be used on a Street Name sign to identify the governmental jurisdiction, area of jurisdiction, or other government-approved institution.

Standard:

If a symbol or letter designation is used, the height and width of the symbol or letter designation shall not exceed the letter height of the sign.

Guidance:

The symbol or letter designation should be positioned to the left of the street name.

Standard:

The Street Name sign shall be retroreflective or illuminated to show the same shape and similar color both day and night. The legend and background shall be of contrasting colors.

Guidance:

Street Name signs should have a white legend on a green background. A border, if used, should be the same color as the legend.

In business districts and on principal arterials, Street Name signs should be placed at least on diagonally opposite corners. In residential areas, at least one Street Name sign should be mounted at each intersection. Signs naming both streets should be installed at each intersection. They should be mounted with their faces parallel to the streets they name.

Option:

To optimize visibility, Street Name signs may be mounted overhead. Street Name signs may also be placed above a regulatory or STOP or YIELD sign with no required vertical separation.

At intersection crossroads where the same road has two different street names for each direction of travel, both street names may be shown on the same sign along with directional arrows.

Guidance:

In urban or suburban areas, especially where Advance Street Name signs are not used, the use of overhead-mounted Street Name signs should be considered. If overhead Street Name signs are used, the lettering should be at least 300 mm (12 in) high in capital letters, or 300 mm (12 in) upper-case letters with 225 mm (9 in) lower-case letters.

Support:

Information regarding the use of street names on supplemental plaques for use with intersection-related warning signs is contained in Section 2C.49.

Section 2D.47 Traffic Signal Speed Sign (I1-1)

Option:

The Traffic Signal Speed (I1-1) sign (see Figure 2D-12), reading SIGNALS SET FOR XX km/h (XX MPH), may be used to indicate a section of street or highway on which 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.

Guidance:

If used, the sign should be mounted as near as practical to each intersection where the signal progression speed changes and at intervals deemed appropriate using engineering judgment.

Standard:

The Traffic Signal Speed sign shall be a minimum of 300 x 450 mm (12 x 18 in) with the longer dimension vertical. It shall have a white message and border on a green background.

Section 2E.01 Scope of Freeway and Expressway Guide Sign Standards

Support:

These standards provide a uniform and effective system of highway signing for high-volume, high-speed motor vehicle traffic on freeways and expressways. The requirements and specifications for expressway signing exceed those for conventional roads (see Chapter 2D), but are less than those for freeway signing. Since there are many geometric design variables to be found in existing roads, a signing concept commensurate with prevailing conditions is the primary consideration. Section 2A.01 includes definitions of freeway and expressway.

Guide signs for freeways and expressways are primarily identified by the name of the sign rather than by an assigned sign code. Guidelines for the design of guide signs for freeways and expressways are provided in Chapter 8 (Design Guidelines) of the "Standard Highway Signs" book (see Section 1A.11).

Standard:

The standards prescribed herein for freeway and expressway guide signs shall apply to highways in accordance with formal designation of that highway as a freeway or expressway by the agency having authority over that highway.

Section 2E.13 Size and Style of Letters and Signs

Standard:

With all freeway and expressway signs, the message dimensions shall be determined first, and the outside sign dimensions secondarily. Word messages in the legend of expressway guide signs shall be in letters at least 200 mm (8 in) high. Larger lettering shall be used for major guide signs at or in advance of interchanges and for all overhead signs. Minimum numeral and letter sizes for expressway guide signs according to interchange classification, type of sign and component of sign legend are shown in Tables 2E-1 and 2E-2. Minimum numeral and letter sizes for freeway guide signs, according to interchange classification, type of sign, and component of sign legend, appear in Tables 2E-3 and 2E-4. All names of places, streets, and highways on freeway and expressway guide signs shall be composed of lower-case letters with initial upper-case letters. The letters and the numerals used shall be Series E(M) of the "Standard Highway Signs" book (see Section 1A.11). Other word legends shall be in capital letters. Interline and edge spacing shall be as specified in Section 2E.14.

Lettering size on freeway and expressway signs shall be the same for both rural and urban conditions.

Option:

The letter and numeral sizes in Table 2E-3 for intermediate interchanges may be used for other types of interchanges based on engineering judgment.

Support:

Sign size is determined primarily in terms of the length of the message and the size of the lettering necessary for proper legibility. Letter style and height, and arrow design have been standardized for freeway and expressway signs to assure uniform and effective application.

Designs for uppercase, lowercase, and capital alphabets together with tables of recommended letter spacing, are shown in the "Standard Highway Signs" book.

Guidance:

Where upper- and lower-case lettering is used, the initial upper-case letters should be approximately 1.33 times the "loop" height of the lower-case letters. Freeway lettering sizes (see Tables 2E-3 and 2E-4) should be used when expressway geometric design is comparable to freeway standards.

Other sign letter size requirements not specifically identified elsewhere in this Manual should be guided by these specifications. Abbreviations should be kept to a minimum.

Support:

A sign mounted over a particular roadway lane to which it applies might have to be limited in horizontal dimension to the width of the lane, so that another sign can be placed over an adjacent lane. The necessity to maintain proper vertical clearance might also place a further limitation on the size of the overhead sign and the legend that can be accommodated.

Section 2E.15 Sign Borders

Standard:

Signs shall have a border of the same color as the legend in order to outline their distinctive shape and thereby give them easy recognition and a finished appearance.

Guidance:

For guide signs larger than 3000 x 1800 mm (120 x 72 in), the border should have a width of 50 mm (2 in). For smaller guide signs, a border width of 1 in be used, but the width should not exceed the stroke width of the major lettering on the sign.

Corner radii of sign borders should be one-eighth of the minimum sign dimension on guide signs, except that the radii should not exceed 300 mm (12 in) on any sign.

Option:

The sign material in the area outside of the corner radius may be trimmed.

Section 2E.18 Arrows for Interchange Guide Signs

Standard:

On all Exit Direction signs for single lane exits, both overhead and ground mounted, arrows shall be upward slanting and shall be located on the side of the sign consistent with the direction of the exiting movement.

Downward pointing arrows shall be used only for overhead guide signs to prescribe lane assignment for traffic bound for a destination or route that can be reached only by being in the designated lane(s).

Guidance:

Arrows on overhead Exit Direction signs for multiple-lane exits should be placed near the bottom of the sign panel and approximately centered above the exiting lanes.

Option:

Downward pointing arrows may be tilted where it is desired to emphasize the separation of roadways.

Support:

Examples of arrows for use on guide signs are shown in Figure 2D-2. Detailed dimensions of arrows are provided in the "Standard Highway Signs" book (see Section 1A.11).

Section 2E.20 Signing for Interchange Lane Drops

Standard:

Major guide signs for all lane drops at interchanges shall be mounted overhead. An EXIT ONLY panel shall be used for all interchange lane drops at which the through route is carried on the mainline.

Guidance:

The EXIT ONLY (down arrow) (E11-1) panel (see Figure 2E-9) should be used on all signing of lane drops on all Advance Guide signs for right exits (see Figure 2E-10). For lane drops on the left side, diagrammatic signing with the EXIT ONLY (E11-1c) panel (see Figure 2E-9) should be used without a down arrow for Advance Guide signs (see Figure 2E-8).

Standard:

The Exit Direction sign (see Figure 2E-20) and E11-1a panel (see Figure 2E-9) shall be of the format shown in Figures 2E-8 and 2E-10 for all lane drops. The standard slanted up arrow (left or right side) shall be included on the Exit Direction sign.

Option:

EXIT ONLY messages of either E11-1b or E11-1c formats may be used to retrofit existing signing to warn of a lane drop situation ahead.

Standard:

If used on an existing sign, the E11-1b panel (see Figure 2E-9) shall be placed on either side of a white down arrow. The E11-1c panel, if used on an existing nondiagrammatic sign, shall be placed between the lower destination message and the white down arrow.

Guidance:

Wherever the dropped lane carries the through route, diagrammatic signs should be used without the EXIT ONLY panel.

Section 2E.41 Freeway-to-Freeway Interchange

Support:

Freeway-to-freeway interchanges are major decision points where the effect of taking a wrong ramp cannot be easily corrected. Reversing direction on the connecting freeway or reentering to continue on the intended course is usually not possible. Figure 2E-27 shows examples of guide signs at a freeway-to-freeway interchange.

Guidance:

The sign messages should contain only the route shield(s), cardinal direction(s), and the name of the next control city or cities on the route. Arrows should point as indicated in Section 2D.08, unless a diagrammatic representation of the interchange layout requires otherwise.

Standard:

Overhead signs shall be used at a distance of 2 km or 1 mile and at the theoretical gore of each connecting ramp. When diagrammatic signs are used, they shall conform to the provisions of Section 2E.19.

Option:

Overhead signs may also be used at the 1 km or 0.5 mile and 4 km or 2 mile points.

The arrow and/or the name of the control city may be omitted on signs that indicate the straight-ahead continuation of a route.

An Exit Speed sign may be used where an engineering study shows that it is necessary to display a speed reduction message for ramp signing (see Section 2C.36).

of the ramp.

Guide sign configurations as approved by the appropriate highway authority may be used at freeway-to-freeway interchanges in lieu of the configurations shown in Figure 2E.27.

Section 3A.02 Standardization of Application

Standard:

Each standard marking shall be used only to convey the meaning prescribed for that marking in this Manual. When used for applications not described herein, markings shall conform in all respects to the principles and standards set forth herein.

Guidance:

Before any new highway, paved detour, or temporary route is opened to traffic, all necessary markings should be in place.

Standard:

Markings that are no longer applicable for roadway conditions or restrictions and that might cause confusion for the road user shall be removed or obliterated to be unidentifiable as a marking as soon as practical. 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.

Option:

Markings may be temporarily masked with tape until they can be removed or obliterated.

Support:

When placed on local roads, pavement markings can be counterproductive by inferring to road users that a street has a higher classification than a local street, thus encouraging higher speeds.

Section 3B.02 No-Passing Zone Pavement Markings and Warrants

Standard:

Where centerline markings are used, no-passing zones shall be marked by either the one direction no-passing zone pavement markings or the two-direction no-passing zone pavement markings described previously and shown in Figures 3B-1 and 3B-3.

When centerline markings are used, no-passing zone markings shall be used on two-way roadways at lane reduction transitions (see Section 3B.09) and on approaches to obstructions that must be passed on the right (see Section 3B.10).

Guidance:

Where the distance between successive no-passing zones is less than 120 m (400 ft), no-passing markings should connect the zones.

Standard:

Where centerline markings are used, no-passing zone markings shall be used on approaches to highway-rail grade crossings in conformance with Section 8B.20.

Option:

In addition to pavement markings, no-passing zone signs (see Sections 2B.29, 2B.30, and 2C.35) may be used to emphasize the existence and extent of a no-passing zone.

Support:

Section 11-307 of the "Uniform Vehicle Code (UVC) Revised" contains further information regarding no-passing zones. The "UVC" can be obtained from the National Committee on Uniform Traffic Laws and Ordinances (see Addresses).

Standard:

On two-way, two- or three-lane roadways where centerline markings are installed, no-passing zones shall be established at vertical and horizontal curves and other locations where an engineering study indicates that passing must be prohibited because of inadequate sight distances or other special conditions.

On three-lane roadways where the direction of travel in the center lane transitions from one direction to the other, a no-passing buffer zone shall be provided in the center lane as shown in Figure 3B-4. A lane transition shall be provided at each end of the buffer zone.

The buffer zone shall be a median island that is at least 15 m (50 ft) in length.

Guidance:

For three-lane roadways having a posted or statutory speed limit of 70 km/h (45 mph) or greater, the lane transition taper length should be computed by the formula $L = 0.62 WS$ for speeds in km/h ($L = WS$ for speeds in mph). For roadways where the posted or statutory speed limit is less than 70 km/h (45 mph), the formula $L = WS^2/155$ for speeds in km/h ($L = WS^2/60$ for speeds in mph) should be used to compute taper length. Under both formulas, L equals the taper length in meters (feet), W equals the width of the center lane or offset distance in meters (feet), and S equals the posted or statutory speed limit.

Standard:

The minimum lane transition taper length shall be 30 m (100 ft) in urban areas and 60 m (200 ft) in rural areas.

On roadways with centerline markings, no-passing zone markings shall be used at horizontal or vertical curves where the passing sight distance is less than the minimum necessary for reasonably safe passing at the 85th-percentile speed or the posted or statutory speed limit as shown in Table 3B-1. The passing sight distance on a vertical curve is the distance at which an object 1.07 m (3.5 ft) above the pavement surface can be seen from a point 1.07 m (3.5 ft) above the pavement (see Figure 3B-5). Similarly, the passing sight distance on a horizontal curve is the distance measured along the centerline (or right-hand lane line of a three-lane roadway) between two points 1.07 m (3.5 ft) above the pavement on a line tangent to the embankment or other obstruction that cuts off the view on the inside of the curve (see Figure 3B-5).

Support:

The beginning of a no-passing zone at point "a" in Figure 3B-5 is that point where the sight distance first becomes less than that specified in Table 3B-1. The end of the no-passing zone at point "b" in Figure 3B-5 is that point at which the sight distance again becomes greater than the minimum specified.

Section 3B.09 Lane Reduction Transition Markings

Standard:

Where pavement markings are used, lane reduction transition markings shall be used to guide traffic through transition areas where the number of through lanes is reduced, as shown in Figure 3B-12. On two-way roadways, no-passing zone markings shall be used to prohibit passing in the direction of the convergence, and shall continue through the transition area.

Guidance:

For roadways having a posted or statutory speed limit of 70 km/h (45 mph) or greater, the transition taper length for a lane reduction should be computed by the formula $L = 0.62 WS$ for speeds in km/h ($L = WS$ for speeds in mph). For roadways where the posted or statutory speed limit is less than 70 km/h (45 mph), the formula $L = WS^2/155$ for speeds in km/h ($L = WS^2/60$ for speeds in mph) should be used to compute taper length. Under both formulas, L equals the taper length in meters (feet), W equals the width of the offset distance in meters (feet), and S equals the posted or statutory speed limit.

Option:

On new construction, where no posted or statutory speed limit is established, the design speed may be used in the transition taper length formula.

Guidance:

Lane line markings should be discontinued one-quarter of the distance between the Lane Ends sign (see Section 2C.33) and the point where the transition taper begins. Edge line markings should be installed from the location of the warning sign to beyond the beginning of the narrower roadway.

Support:

Pavement markings at lane reduction transitions supplement the standard signs.

Option:

In urban areas where raised curbs or pavement contrast sufficiently define the edge of roadway, engineering judgment may determine whether the edge line or delineators may be used.

Section 3B.13 Raised Pavement Markers Supplementing Other Markings

Guidance:

The use of raised pavement markers for supplementing longitudinal line markings should conform to the following:

A- Lateral Positioning

- 1- When supplementing double line markings, pairs of raised pavement markers placed laterally in line with or immediately outside of the two lines should be used.
- 2- When supplementing wide line markings, pairs of raised pavement markers placed laterally adjacent to each other should be used.

B- Longitudinal Spacing

- 1- When supplementing solid line markings, raised pavement markers at a spacing no greater than N (see Section 3B.11) should be used, except when supplementing left edge line markings, a spacing of no greater than N/2 should be used. Raised markers should not supplement right edge line markings, unless they are spaced closely enough (no greater than 20 ft apart) to approximate the appearance of a solid line. If raised markers are used on edge lines, consideration should be given to their effect on bicyclists.

- 2- When supplementing broken line markings, a spacing no greater than $3N$ should be used. However, when supplementing broken line markings identifying reversible lanes, a spacing of no greater than N should be used.
- 3- When supplementing dotted line markings, a spacing appropriate for the application should be used.
- 4- When supplementing longitudinal line markings through at-grade intersections, one raised pavement marker for each short line segment should be used.
- 5- When supplementing edge line extensions through freeway interchanges, a spacing of no greater than N should be used.

Option:

Raised pavement markers also may be used to supplement other markings for channelizing islands or approaches to obstructions.

Section

3B.14 Raised Pavement Markers Substituting for Pavement Markings

Option:

Retroreflective or internally illuminated raised pavement markers, or nonretroreflective raised pavement markers supplemented by retroreflective or internally illuminated markers, may be substituted for markings of other types.

Guidance:

If used, the pattern and color of the raised pavement markers should simulate the pattern and color of the markings for which they substitute.

The normal spacing of raised pavement markers, when substituting for other markings, should be determined in terms of the standard length of the broken line segment.

Option:

The side of a raised pavement marker that is visible to traffic proceeding in the wrong direction may be red.

Standard:

If raised pavement markers are used to substitute for broken line markings, a group of three to five markers equally spaced at a distance no greater than $N/8$ (see Section 3B.11) shall be used. If N is other than 12 m (40 ft), the markers shall be equally spaced over the line segment length (at $1/2$ points for 3 markers, at $1/3$ points for 4 markers, and at $1/4$ points for 5 markers). At least one retroreflective or internally illuminated marker per group shall be used or a retroreflective or internally illuminated marker shall be installed midway in each gap between successive groups of nonretroreflective markers.

When raised pavement markers substitute for solid lane line markings, the markers shall be equally spaced at no greater than $N/4$, with retroreflective or internally illuminated units at a spacing no greater than $N/2$.

Guidance:

Raised pavement markers should not substitute for right edge line markings, unless they are spaced closely enough (no greater than 20 ft apart) to approximate the appearance of a solid line. If raised markers are used to substitute for edge lines, consideration should be given to their effect on bicyclists.

Standard:

When raised pavement markers substitute for dotted lines, they shall be spaced at no greater than $N/4$, with not less than one raised pavement marker per dotted line. At least one raised marker every N shall be retroreflective or internally illuminated.

Option:

When substituting for wide lines, raised pavement markers may be placed laterally adjacent to each other to simulate the width of the line.

Section 3B.15 Transverse Markings

Standard:

Transverse markings, which include shoulder markings, word and symbol markings, stop lines, yield lines, crosswalk lines, speed measurement markings, speed hump markings, parking space markings, and others, shall be white unless otherwise specified herein.

Guidance:

Because of the low approach angle at which pavement markings are viewed, transverse lines should be proportioned to provide visibility equal to that of longitudinal lines.

Standard:

Pavement marking letters, numerals, and symbols shall be installed in accordance with the Pavement Markings chapter of the "Standard Highway Signs" book (see Section 1A.11).

Section 3B.16 Stop and Yield Lines

Standard:

If used, stop lines shall consist of solid white lines extending across approach lanes to indicate the point at which the stop is intended or required to be made.

If used, yield lines (see Figure 3B-14) shall consist of a row of solid white isosceles triangles pointing toward approaching vehicles extending across approach lanes to indicate the point at which the yield is intended or required to be made.

Guidance:

Stop lines should be 10 to 24 in wide.

Stop lines should be used to indicate the point behind which vehicles are required to stop, in compliance with a STOP (R1-1) sign, traffic control signal, or some other traffic control device, except YIELD signs.

The individual triangles comprising the yield line should have a base of 10 to 24 in wide and a height equal to 1.5 times the base. The space between the triangles should be 3 to 12 in.

Option:

Yield lines may be used to indicate the point behind which vehicles are required to yield in compliance with a YIELD (R1-2) sign or a Yield Here to Pedestrians (R1-5 or R1-5a) sign.

Guidance:

If used, stop and yield lines should be placed a minimum of 1.2 m (4 ft) in advance of the nearest crosswalk line at controlled intersections, except for yield lines at roundabout intersections as provided for in Section 3B.24 and at midblock crosswalks. In the absence of a marked crosswalk, the stop line or yield line should be placed at the desired stopping or yielding point, but should be placed no more than 9 m (30 ft) nor less than 1.2 m (4 ft) from the nearest edge of the intersecting traveled way. Stop lines should be placed to allow sufficient sight distance to all other approaches to an intersection.

If used at an unsignalized midblock crosswalk, yield lines should be placed adjacent to the Yield Here to Pedestrians sign located 6.1 to 15 m (20 to 50 ft) in advance of the nearest crosswalk line, and parking should be prohibited in the area between the yield line and the crosswalk (see Figure 3B-15).

Stop lines at midblock signalized locations should be placed at least 12 m (40 ft) in advance of the far side signal indication (see Section 4D.15).

Support:

Drivers who yield too close to crosswalks on multi-lane approaches place pedestrians at risk by blocking other drivers' views of pedestrians.

The placement of stop lines will generally be in the vicinity of the point of the driver's first stop and/or where the STOP sign is most visible to approaching traffic. Arizona Revised Statutes require a driver approaching a STOP sign to employ a two-step movement, regardless of the positioning of the stop line. A motorist must first stop at the locations as defined in State law, and secondly must yield or stop before entering an intersection if traffic is approaching as to constitute a hazard. Drivers must make the second stop or yield from a position where they have full view of approaching traffic.

STOP lines can be used to gain improved driver performance in various ways as indicated in several handbooks published by the Institute of Transportation Engineers. For example, STOP lines may be used to advise where motorists are to:

1. Stop in the event pedestrians are present; or
2. Stop at a signal to retain view of nearside signals, or remain on vehicle detectors; or
3. Yield or stop where they have a full view of approaching traffic; or
4. Stop far enough back to not obstruct turning vehicles from opposing streets; or
5. Stop at wide throat intersections where the optimum stopping locations is a substantial distance from the STOP sign.

Section 3B.21 Curb Markings

Support:

Curb markings are most often used to indicate parking regulations or to delineate the curb.

Standard:

Signs shall be used with curb markings in those areas where curb markings are frequently obliterated by snow and ice accumulation unless the no parking zone is controlled by statute or local ordinance.

Where curbs are marked, the colors shall conform to the general principles of markings (see Section 3A.04).

Guidance:

Except as noted in the Option, when curb markings are used without signs to convey parking regulations, a legible word marking regarding the regulation (such as "No Parking" or "No Standing") should be placed on the curb.

Option:

Curb markings without word markings or signs may be used to convey a general prohibition of parking.

Retroreflective solid yellow markings may be placed on the noses of raised medians and curbs of islands that are located in the line of traffic flow where the curb serves to channel traffic to the right of the obstruction.

Retroreflective solid white markings may be used when traffic may pass on either side of the island.

Option:

Local highway agencies may prescribe special colors for curb markings to supplement standard signs for parking regulation.

Support:

Since yellow and white curb markings are frequently used for curb delineation and visibility, it is advisable to establish parking regulations through the installation of standard signs (see Sections 2B.39 through 2B.41).

Where the curbs of the islands become parallel to the direction of traffic flow, it is not necessary to mark the curbs unless an engineering study indicates the need for this type of delineation.

Curbs at openings in a continuous median island need not be marked unless an engineering study indicates the need for this type of marking.

Section 3C.01 Object Marker Design and Placement Height

Support:

Object markers are used to mark obstructions within or adjacent to the roadway.

Standard:

When used, object markers (see Figure 3C-1) shall consist of an arrangement of one or more of the following types:

Type 1—either a marker consisting of nine yellow retroreflectors, each with a minimum diameter of 75 mm (3 in), mounted symmetrically on a yellow (OM1-1) or black (OM1-2) diamond panel 450 mm (18 in) or more on a side; or on an all-yellow retroreflective diamond panel (OM1-3) of the same size.

Type 2—either a marker (OM2-1V or OM2-1H) consisting of three yellow retroreflectors, each with a minimum diameter of 75 mm (3 in), arranged either horizontally or vertically on a white panel measuring at least 150 x 300 mm (6 x 12 in), or on an all-yellow horizontal or vertical retroreflective panel (OM2-2V or OM2-2H), measuring at least 150 x 300 mm (6 x 12 in).

Type 3—a striped marker, 300 x 900 mm (12 x 36 in), consisting of a vertical rectangle with alternating black and retroreflective yellow stripes sloping downward at an angle of 45 degrees toward the side of the obstruction on which traffic is to pass. The minimum width of the yellow and black stripes shall be 75 mm (3 in).

Support:

A better appearance can be achieved if the black stripes are wider than the yellow stripes.

Type 3 object markers with stripes that begin at the upper right side and slope downward to the lower left side are designated as right object markers (OM-3R). Object markers with stripes that begin at the upper left side and slope downward to the lower right side are designated as left object markers (OM-3L).

Guidance:

When used for marking objects in the roadway or objects that are 2.4 m (8 ft) or less from the shoulder or curb, the mounting height to the bottom of the object marker should be at least 2 1/2 ft above the surface of the nearest traffic lane.

When used to mark objects more than 2.4 m (8 ft) from the shoulder or curb, the mounting height to the bottom of the object marker should be at least 2 1/2 ft above the ground.

Option:

When object markers or markings are applied to an object that by its nature requires a lower or higher mounting, the vertical mounting height may vary according to need.

Section 3C.04 End-of-Roadway Markings

Support:

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

Standard:

The end-of-roadway marker (see Figure 3C-1) shall be one of the following: a marker consisting of nine red retroreflectors, each with a minimum diameter of 75 mm (3 in), mounted symmetrically on a red (OM4-1) or black (OM4-2) diamond panel 450 mm (18 in) or more on a side; or a retroreflective red diamond panel (OM4-3) 450 mm (18 in) or more on a side.

Option:

The end-of-roadway marker may be used in instances where there are no alternate vehicular paths.

Where conditions warrant, more than one marker, or a larger marker with or without a Type III barricade (see Section 3F.01), may be used at the end of the roadway.

Standard:

The minimum mounting height to the bottom of an end-of-roadway marker shall be 2 1/2 ft above the edge of the pavement.

Guidance:

Appropriate advance warning signs (see Chapter 2C) should be used.

Section 3D.04 Delineator Placement and Spacing

Guidance:

Delineators should be mounted on suitable supports so that the top of the highest retroreflector is approximately 1.2 m (4 ft) above the near roadway edge. They should be placed 0.6 to 2.4 m (2 to 8 ft) outside the outer edge of

the shoulder, or if appropriate, in line with the roadside barrier that is 2.4 m (8 ft) or less outside the outer edge of the shoulder.

Based on engineering judgment delineators should be placed at a constant distance from the edge of the roadway, except that where an obstruction intrudes into the space between the pavement edge and the extension of the line of the delineators, the delineators should be transitioned to be in line with or inside the innermost edge of the obstruction. If the obstruction is a guardrail, the delineators should be transitioned to be either just behind, directly above (in line with), or on the innermost edge of the guardrail.

Delineators should be spaced 60 to 160 m (200 to 530 ft) apart on mainline tangent sections. Delineators should be spaced 30 m (100 ft) apart on ramp tangent sections.

Support:

Examples of delineator installations are shown in Figure 3D-1. Delineators are typically not appropriate on urban lane reduction transitions as the curb and gutter adequately define the intended driver path.

Section 3G.02 Approach-End Treatment

Guidance:

Based on engineering judgment the ends of islands first approached by traffic should be preceded by a gradually diverging marking on the roadway surface, to guide vehicles into desired paths of travel along the island edge.

Option:

Approach-end markings that can be readily crossed even at considerable speed may contain slightly raised (usually less than 25 mm (1 in) high) sections of coarse aggregate or other suitable materials to create rumble sections that provide increased visibility of the marked areas and that produce an audible warning to road users traveling across them.

Standard:

Rumble strips or other devices, when used in advance of islands having raised curbs, shall not be placed in such a manner as to constitute an unexpected obstacle.

Guidance:

Bars or buttons should not project more than 25 to 75 mm (1 to 3 in) above the pavement surface and should be designed so that any wheel encroachment within the area will be obvious to the vehicle operator, but will not result in loss of control of the vehicle.

Option:

Bars or buttons may be preceded by rumble sections, or their height may be gradually increased as approached by traffic.

Pavement markings may be used with raised bars to better designate the island area.

Section 3G.03 Island Marking Application

Standard:

Markings, as related to islands, shall consist only of pavement and curb markings, object markers, and delineators.

If used on the approach to islands, the triangular neutral area in advance of the end of the island shall include pavement markings as described in Section 3B.10.

Option:

As indicated in Section 3G.02, rumble sections, or other similar traffic control designs which contrast with the pavement surface, may also be applied in the triangular neutral area in advance of the end of an island.

Guidance:

When raised bars or buttons are used in these neutral areas, they should be marked with white or yellow retroreflective materials, as determined by the direction or directions of travel they separate.

Section 4B.04 Alternatives to Traffic Control Signals

Guidance:

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

Option:

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

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

Guidance:

Neither signalization nor alternatives listed should be selected unless they can logically be expected to improve the overall safety and/or operations of the intersection.

Support:

Traffic control devices, including signals, offer potential advantages and disadvantages. Engineering judgment is needed to weigh the advantages and disadvantages, and compare to existing conditions to determine if changes are appropriate.

Crash experience in synchronized systems has shown both the number and severity of crashes typically rise following signalization.

Adding a new signal within a synchronized signal system will virtually always increase road user delay on both streets (total delay and delay per user). This occurs because the majority non-stop flow will be periodically stopped upon signalization. Even the minor street users (typically considered the beneficiary of signalization) will incur additional delay most hours of a 24-hour time period due to having to wait for the synchronized signal.

Clearance intervals are optional, and if used at urban intersections are most typically predicated on the posted speed limit.

Section 4D.10 Yellow Change and Red Clearance Intervals

Standard:

A yellow signal indication shall be displayed following every CIRCULAR GREEN or GREEN ARROW signal indication.

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

The duration of a yellow change interval shall be predetermined.

Guidance:

A yellow change interval should have a duration of approximately 3 to 6 seconds. The longer intervals should be

reserved for use on approaches with higher speeds. Excessively long clearance or change intervals should be avoided.

Option:

The yellow change interval may be followed by a red clearance interval to provide additional time before conflicting traffic movements, including pedestrians, are released.

Standard:

The duration of a red clearance interval shall be predetermined.

Guidance:

A red clearance interval, if used, should have a duration not exceeding 6 seconds. Excessively long clearance or change intervals should be avoided.

Section 4F.02 Design of Emergency-Vehicle Traffic Control Signals

Standard:

Except as specified in this Section, an emergency-vehicle traffic control signal shall meet the requirements of this Manual.

Guidance:

An Emergency Vehicle (W11-8) sign (see Section 2C.40) with an EMERGENCY SIGNAL AHEAD (W11-12p) supplemental plaque should be placed in advance of all emergency-vehicle traffic control signals based on engineering judgment. If a warning beacon is installed to supplement the W11-8 sign, the design and location of the beacon should conform to the Standards specified in Sections 4K.01 and 4K.03.

At least one of the two required signal faces for each approach on the major street should be located over the roadway.

The following size signal lenses should be used for emergency-vehicle traffic control signals: 300 mm (12 in) diameter for red and steady yellow signal indications, and 200 mm (8 in) diameter for flashing yellow or steady green signal indications.

Option:

An EMERGENCY SIGNAL (R10-13) sign may be mounted adjacent to a signal face on each major street approach (see Section 2B.45). If an overhead signal face is provided, the EMERGENCY SIGNAL sign may be mounted adjacent to the overhead signal face.

An approach that only serves emergency vehicles may be provided with only one signal face consisting of one or more signal sections.

Besides using a 200 mm (8 in) diameter signal indication, other appropriate means to reduce the flashing yellow light output may be used.

Section 6B.01 Fundamental Principles of Temporary Traffic Control

Support:

Whenever the acronym "TTC" is used in this Chapter, it refers to "temporary traffic control."

The State of Arizona and local jurisdictions maintain policy and/or procedure manuals that describe optional methods of controlling traffic within work zones. These manuals may be used in conjunction with Part VI of the MUTCD.

Examples of differences in traffic control application in work zones on city streets with lower speeds include:

1. Shadow vehicles are typically not necessary, and can aggravate congestion.
2. Vehicle mounted crash attenuators are typically not necessary, and can be counter-productive by lengthening the exposure of large vehicles at intersections.
3. Traffic control devices and lighting on breakaway and frangible supports in areas with pedestrian activity can create hazards due to debris and exposed electrical wires if struck by errant vehicles.
4. Crash cushions and temporary barriers are not typically appropriate.

5. Adding additional warning signs on city streets above those specified in the MUTCD is typically not appropriate nor needed.

Standard:

The needs and control of all road users (motorists, bicyclists, and pedestrians within the highway, including persons with disabilities in accordance with the Americans with Disabilities Act of 1990 (ADA), Title II, Paragraph 35.130) through a TTC zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents.

Support:

Construction, maintenance, utility, and incident zones can all benefit from TTC to compensate for the unexpected or unusual situations faced by road users. When planning for TTC in these zones, it can be assumed that it is appropriate for road users to exercise caution. Even though road users are assumed to be using caution, special care is still needed in applying TTC techniques.

Special plans preparation and coordination with transit, other highway agencies, law enforcement and other emergency units, utilities, schools, and railroad companies might be needed to reduce unexpected and unusual road user operation situations.

During TTC activities, commercial vehicles might need to follow a different route from passenger vehicles because of bridge, weight, clearance, or geometric restrictions. Also, vehicles carrying hazardous materials might need to follow a different route from other vehicles. The Hazardous Materials and National Network signs are included in Sections 2B.52 and 2B.53, respectively.

Experience has shown that following the fundamental principles of Part 6 will assist road users and help protect workers in the vicinity of TTC zones.

Guidance:

Road user and worker safety and accessibility in TTC zones should be an integral and high-priority element of every project from planning through design and construction. Similarly, maintenance and utility work should be planned and conducted with the safety and accessibility of all motorists, bicyclists, pedestrians (including those with disabilities), and workers being considered at all times. If the TTC zone includes a highway-rail grade crossing, early coordination with the railroad company should take place.

Support:

Formulating specific plans for TTC at traffic incidents is difficult because of the variety of situations that can arise.

Guidance:

General plans or guidelines should be developed to provide safety for motorists, bicyclists, pedestrians, workers, enforcement/emergency officials, and equipment, with the following factors being considered:

- A. The basic safety principles governing the design of permanent roadways and roadsides should also govern the design of TTC zones. The goal should be to route road users through such zones using roadway geometrics, roadside features, and TTC devices as nearly as possible comparable to those for normal highway situations.
- B. A TTC plan, in detail appropriate to the complexity of the work project or incident, should be prepared and understood by all responsible parties before the site is occupied. Any changes in the TTC plan should be approved by an official knowledgeable (for example, trained and/or certified) in proper TTC practices.

Road user movement should be inhibited as little as practical, based on the following considerations:

- A. TTC at work and incident sites should be designed on the assumption that drivers will only reduce their speeds if they clearly perceive a need to do so (see Section 6C.01).
- B. Frequent and abrupt changes in geometrics such as lane narrowing, dropped lanes, or main roadway transitions that require rapid maneuvers, should be avoided.
- C. Provisions should be made for the reasonably safe operation of work, particularly on high-speed, high-volume roadways.
- D. Road users should be encouraged to use alternative routes that do not include TTC zones.
- E. Bicyclists and pedestrians, including those with disabilities, should be provided with access and reasonably safe passage through the TTC zone.

- F. Roadway occupancy should be scheduled during off-peak hours and, if necessary, night work should be considered.
- G. Early coordination with officials having jurisdiction over the affected cross streets and providing emergency services should occur before roadway or ramp closings.

Motorists, bicyclists, and pedestrians should be guided in a clear and positive manner while approaching and traversing TTC zones and incident sites. The following principles should be applied:

- A. Adequate warning, delineation, and channelization should be provided to assist in guiding road users in advance of and through the TTC zone or incident site by using proper pavement marking, signing, or other devices that are effective under varying conditions. Providing information that is in usable formats by pedestrians with visual disabilities should also be considered.
- B. TTC devices inconsistent with intended travel paths through TTC zones should be removed or covered. However, in intermediate-term stationary, short-term, and mobile operations, where visible permanent devices are inconsistent with intended travel paths, devices that highlight or emphasize the appropriate path should be used. Providing traffic control devices that are accessible to and usable by pedestrians with disabilities should be considered.
- C. Flagging procedures, when used, should provide positive guidance to road users traversing the TTC zone.

To provide acceptable levels of operations, routine day and night inspections of TTC elements should be performed as follows:

- A. Individuals who are knowledgeable (for example, trained and/or certified) in the principles of proper TTC and/or incident command should be assigned responsibility for safety in TTC zones. The most important duty of these individuals should be to check that all TTC devices of the project are reasonably consistent with the TTC plan and are effective in providing reasonably safe conditions for motorists, bicyclists, pedestrians, and workers.
- B. As the work progresses, temporary traffic controls and/or working conditions should be modified in order to provide reasonably safe and efficient road user movement and to provide worker safety. The individual responsible for TTC should have the authority to halt work until applicable or remedial safety measures are taken.
- C. TTC zones should be carefully monitored under varying conditions of road user volumes, light, and weather to check that applicable TTC devices are effective, clearly visible, clean, and in compliance with the TTC plan.
- D. When warranted, an engineering study should be made (in cooperation with law enforcement officials) of reported crashes occurring within the TTC zone. Crash records in TTC zones should be monitored to identify the need for changes in the TTC zone.

Attention should be given to the maintenance of roadside safety during the life of the TTC zone by applying the following principles:

- A. To accommodate run-off-the-road incidents, disabled vehicles, or emergency situations, unencumbered roadside recovery areas or clear zones should be provided where practical.
- B. Channelization of road users should be accomplished by the use of pavement markings, signing, and crashworthy, detectable channelizing devices.
- C. Work equipment, workers' private vehicles, materials, and debris should be stored in such a manner to reduce the probability of being impacted by run-off-the-road vehicles.

Each person whose actions affect TTC zone safety, from the upper-level management through the field workers, should receive training appropriate to the job decisions each individual is required to make. Only those individuals who are trained in proper TTC practices and have a basic understanding of the principles (established by applicable standards and guidelines, including those of this Manual) should supervise the selection, placement, and maintenance of TTC devices used for TTC zones and for incident management.

Good public relations should be maintained by applying the following principles:

- A. The needs of all road users should be assessed such that appropriate advance notice is given and clearly defined alternative paths are provided.
- B. The cooperation of the various news media should be sought in publicizing the existence of and reasons for TTC zones because news releases can assist in keeping the road users well informed.

- C. The needs of abutting property owners, residents, and businesses should be assessed and appropriate accommodations made.
- D. The needs of emergency service providers (law enforcement, fire, and medical) should be assessed and appropriate coordination and accommodations made.
- E. The needs of railroads and transit should be assessed and appropriate coordination and accommodations made.
- F. The needs of operators of commercial vehicles such as buses and large trucks should be assessed and appropriate accommodations made.

Standard:

Before any new detour or temporary route is opened to traffic, all necessary signs shall be in place. All TTC devices shall be removed as soon as practical when they are no longer needed. When work is suspended for short periods of time, TTC devices that are no longer appropriate shall be removed or covered.

Section 6C.02 Temporary Traffic Control Zones

Support:

A TTC zone is an area of a highway where road user conditions are changed because of a work zone or an incident through the use of TTC devices, uniformed law enforcement officers, or other authorized personnel.

A work zone is an area of a highway with construction, maintenance, or utility work activities. A work zone is typically marked by signs, channelizing devices, barriers, pavement markings, and/or work vehicles. It extends from the first warning sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to the END ROAD WORK sign or the last TTC device.

An incident area is an area of a highway where temporary traffic controls are imposed by authorized officials in response to a traffic incident, or natural disaster. It extends from the first warning device (such as a sign, light, or cone) to the last TTC device or to a point where road users return to the original lane alignment and are clear of the incident.

Another type of temporary traffic control zone is created by special events which temporarily close portions of or all of the roadway. Special events are planned events, and promoters need to seek permission and guidance from authorities to temporarily suspend part or all of street usage. Typically abbreviated street closure procedures are acceptable utilizing police cars, officers, or Type I or II barricades, instead of Type III barricades on local residential streets, with traffic diverted away from the primary activity area. Crowds linked with special events make it clear to road users that reduced speed and caution is required, which can help result in safe operations.

Section 6F.03 Sign Placement

Guidance:

Signs should be located on the right side of the roadway unless otherwise specified in this Manual.

Option:

Where special emphasis is needed, signs may be placed on both the left and right sides of the roadway. Signs mounted on portable supports may be placed within the roadway itself. Signs may also be mounted on or above barricades.

Support:

The provisions of this Section regarding mounting height apply unless specifically stated otherwise for a particular sign elsewhere in this Manual.

Guidelines for height and lateral clearance of temporary ground-mounted signs are shown in Figure 6F-1.

Standard:

Ground-mounted signs installed at the side of the road in rural areas shall be mounted at a height of at least 1.5 m (5 ft), measured from the bottom of the sign to the near edge of the pavement. In business, commercial, and residential districts where parking and/or bicycle or pedestrian movement is likely to occur, or where there are other obstructions to view, the distance between the bottom of the sign and the top of the near edge of the traveled way shall be at least 2.1 m (7 ft).

Signs mounted on barricades and barricade/sign combinations shall be crashworthy. Where it has been determined that the accommodation of pedestrians with disabilities is necessary, signs shall be mounted and placed in accordance with Section 4.4 of the "Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)" (see Section 1A.11).

Guidance:

Engineering judgment should be used to determine optimum placement of portable and permanent sign supports. When located on sidewalks, care should be taken to assure sidewalk interference is minimized, sidewalks are not blocked, and the 36-inch minimum widths required by ADA regulations are maintained.

Option:

A 2.1 m (7 ft) mounting height may be used in rural areas for increased visibility.

The height to the bottom of a secondary sign mounted below another sign may be 0.3 m (1 ft) less than the appropriate height specified above.

Guidance:

Except as noted in the Option, signs mounted on portable supports should not be used for a duration of more than 3 days.

Option:

The R9-8 through R9-11a series, R11 series, W1-6 through W1-8 series, M4-10, E5-1, or other similar type signs (see Figures 6F-3, 6F-4, and 6F-5) may be used on portable supports for longer than 3 days.

Support:

Methods of mounting signs other than on posts are illustrated in Figure 6F-2.

Guidance:

Signs mounted on Type III barricades should not cover more than 50 percent of the top two rails or 33 percent of the total area of the three rails.

Standard:

Sign supports shall be crashworthy. Large signs having an area exceeding 5 square meters (50 square feet) that are installed on multiple breakaway posts shall be mounted a minimum of 2.1 m (7 ft) above the ground.

Signs mounted on barricades, or other portable supports, shall be no less than 0.3 m (1 ft) above the traveled way.

Option:

For mobile operations, a sign may be mounted on a work vehicle, a shadow vehicle, or a trailer stationed in advance of the TTC zone or moving along with it. The work vehicle, the shadow vehicle, or the trailer may or may not have an impact attenuator.

Guidance:

Unshielded sign posts placed in the clear zone should yield or breakaway upon impact to minimize obstructions to road users.

Support:

If alterations are made to specific traffic control device supports that have been successfully crash tested in accordance with NCHRP Report 350 (see Section 1A.11), the altered supports might not be considered to be crashworthy.

Section 6F.06 Regulatory Sign Design

Guidance:

Temporary traffic control regulatory signs should conform to the standards for regulatory signs presented in Part 2, or the Arizona Department of Transportation's Manual of Approved Signs or local agency manuals as applicable.

Support:

Regulatory signs are generally rectangular with a black legend and border on a white background. Exceptions include the STOP, YIELD, DO NOT ENTER, WRONG WAY, and ONE WAY signs.

Option:

The ONE WAY sign may be either a horizontal or vertical rectangular sign.

Section 6F.19 ROAD (STREET) CLOSED Sign (W20-3)

Option:

The ROAD (STREET) CLOSED (W20-3) sign (see Figure 6F-4, Sheet 3 of 4) may be used in advance of the point where a highway is closed to all road users, or to all but local road users.

Standard:

The ROAD (STREET) CLOSED sign shall have the legend ROAD (STREET) CLOSED, XX m (FT), XX km (MILES), or AHEAD.

Section 6F.30 Two-Way Traffic Sign (W6-3)

Option:

A Two Way Traffic (W6-3) sign is intended to give warning of a transition from a one-way roadway to a two-way roadway. This sign may be used as required at intervals to periodically remind drivers that they are on a two-way roadway.

Section 6F.36 SURVEY CREW Sign (W21-6)

Guidance:

Based on engineering judgment the SURVEY CREW (W21-6) sign (see Figure 6F-4, Sheet 4 of 4) should be used to warn of surveying crews working in or adjacent to the roadway.

Section 6F.43 UNEVEN LANES Sign (W8-11)

Guidance:

The UNEVEN LANES (W8-11) sign (see Figure 6F-4, Sheet 2 of 4) should be used during operations that create a substantial difference in elevation between adjacent lanes that are open to travel.

Section 6F.44 NO CENTER STRIPE Sign (W8-12)

Guidance:

The NO CENTER STRIPE (W8-12) sign (see Figure 6F-4, Sheet 2 of 4) should be used when the work obliterates the existing centerline pavement markings and no channelizing devices are used. This sign should be placed at the beginning of the TTC zone and repeated at 3.2 km (2 mi) intervals in long TTC zones.

Section 6F.52 END ROAD WORK Sign (G20-2), END ROAD WORK THANK YOU Sign (G20-2(AZ))

Guidance:

When used, the END ROAD WORK (G20-2) sign (see Figure 6F-4, Sheet 4 of 4), or the END ROAD WORK THANK YOU sign (G20-2(AZ)), should be placed near the end of the termination area, as determined by engineering judgment.

Option:

The END ROAD WORK, or END ROAD WORK THANK YOU sign may be installed on the back of a warning sign facing the opposite direction of road users or on the back of a Type III barricade.

Section 6F.76 Floodlights

Support:

Utility, maintenance, or construction activities on highways are frequently conducted during nighttime periods when vehicular traffic volumes are lower. Large construction projects are sometimes operated on a double-shift basis requiring night work (see Section 6G.20).

Option:

When nighttime work is being performed, floodlights may be used to illuminate the work area, equipment crossings, and other areas.

Standard:

Except in emergency situations, flagger situations shall be illuminated at night. Floodlighting shall not produce a disabling glare condition for approaching road users, flaggers, or workers.

Guidance:

The adequacy of the floodlight placement and elimination of potential glare should be determined by driving through and observing the floodlighted area from each direction on all approaching roadways after the initial floodlight setup, at night, and periodically.

Support:

Desired illumination levels vary depending upon the nature of the task involved. An average horizontal luminance of 50 lux (5 foot candles) can be adequate for general activities. Tasks requiring high levels of precision and extreme care can require an average horizontal luminance of 216 lux (20 foot candles).

Section 6F.78 Warning Lights

Support:

Type A, Type B, Type C, and Type D 360-degree warning lights are portable, powered, yellow, lens-directed, enclosed lights.

Standard

Warning lights shall be in accordance with the current ITE "Purchase Specification for Flashing and Steady-Burn Warning Lights" (see Section 1A.11).

When warning lights are used, they shall be mounted on signs or channelizing devices in a manner that, if hit by an errant vehicle, they will not be likely to penetrate the windshield.

Guidance:

The minimum spacing for warning lights should be identical to the channelizing device spacing requirements.

Support:

The light weight and portability of warning lights are advantages that make these devices useful as supplements to the retroreflectorization on signs and channelizing devices. The flashing lights are effective in attracting road users' attention.

Option:

Warning lights may be used in either a steady-burn or flashing mode.

Standard:

Flashing warning lights shall not be used for delineation, as a series of flashers fails to identify the desired vehicle path.

Type A Low-Intensity Flashing warning lights, Type C Steady-Burn warning lights, and Type D 360-degree Steady-Burn warning lights shall be maintained so as to be capable of being visible on a clear night from a distance of 900 m (3,000 ft). Type B High-Intensity Flashing warning lights shall be maintained so as to be capable of being visible on a sunny day when viewed without the sun directly on or behind the device from a distance of 300 m (1,000 ft).

Warning lights shall have a minimum mounting height of 750 mm (30 in) to the bottom of the lens.

Support:

Type A Low-Intensity Flashing warning lights are used to warn road users during nighttime hours that they are approaching or proceeding in a potentially hazardous area.

Option:

Type A warning lights may be mounted on channelizing devices.

Support:

Type B High-Intensity Flashing warning lights are used to warn road users during both daylight and nighttime hours that they are approaching a potentially hazardous area.

Option:

Type B warning lights are designed to operate 24 hours per day and may be mounted on advance warning signs or on independent supports.

Type C Steady-Burn warning lights and Type D 360-degree Steady-Burn warning lights may be used during nighttime hours to delineate the edge of the traveled way.

Guidance:

When used to delineate a curve, Type C and Type D 360-degree warning lights should only be used on devices on the outside of the curve, and not on the inside of the curve.

Section 6G.03 Location of Work

Support:

Chapter 6D and Sections 6F.68 and 6G.05 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite. The choice of TTC needed for a TTC zone depends upon where the work is located. As a general rule, the closer the work is to road users (including bicyclists and pedestrians), the greater the number of TTC devices that are needed. Procedures are described later in this Chapter for establishing TTC zones in the following locations:

- A. Outside the shoulder;
- B. On the shoulder with no encroachment;
- C. On the shoulder with minor encroachment;
- D. Within the median; and
- E. Within the traveled way.

Guidance:

When the work space is within the traveled way, except for short-duration and mobile operations, advance warning should provide a general message that work is taking place and should supply information about highway conditions. TTC devices should indicate how vehicular traffic can move through the TTC zone.

Section 6G.05 Work Outside of Shoulder

Support:

Chapter 6D and Sections 6F.68 and 6G.05 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

When work is being performed off the roadway (beyond the shoulders, but within the right-of-way), little or no TTC might be needed. TTC generally is not needed where work is confined to an area 4.6 m (15 ft) or more from the edge of the traveled way. However, TTC is appropriate where distracting situations exist, such as vehicles parked

on the shoulder, vehicles accessing the work site via the highway, and equipment traveling on or crossing the roadway to perform the work operations (for example, mowing). For work beyond the shoulder, see Figure 6H-1.

Option:

Where the above situations exist, a single warning sign, such as ROAD WORK AHEAD, may be used. If the equipment travels on the roadway, the equipment may be equipped with appropriate flags, high-intensity rotating, flashing, oscillating, or strobe lights, and/or a SLOW MOVING VEHICLE sign.

If work vehicles are on the shoulder, a SHOULDER WORK sign may be used. For mowing operations, the sign MOWING AHEAD may be used.

Where the activity is spread out over a distance of more than 3.2 km (2 mi), the SHOULDER WORK sign may be repeated every 1.6 km (1 mi).

A supplementary plaque with the message NEXT X km (MILES) may be used.

Guidance:

A general warning sign like ROAD MACHINERY AHEAD should be used if workers and equipment must occasionally move onto the shoulder

Section 6G.09 Work Within the Median

Support:

Chapter 6D and Sections 6F.68 and 6G.05 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

Option:

If work in the median of a divided highway is within 4.6 m (15 ft) from the edge of the traveled way for either direction of travel, TTC may be used through the use of advance warning signs and channelizing devices.

Section 6G.13 Work Within the Traveled Way at an Intersection

Support:

Chapter 6D and Sections 6F.68 and 6G.05 contain additional information regarding the steps to follow when pedestrian or bicycle facilities are affected by the worksite.

The typical applications for intersections are classified according to the location of the work space with respect to the intersection area (as defined by the extension of the curb or edge lines). The three classifications are near side, far side, and in-the-intersection. Work spaces often extend into more than one portion of the intersection. For example, work in one quadrant often creates a near-side work space on one street and a far-side work space on the cross street. In such instances, an appropriate TTC plan is obtained by combining features shown in two or more of the intersection and pedestrian typical applications.

TTC zones in the vicinity of intersections might block movements and interfere with normal road user flows. Such conflicts frequently occur at more complex signalized intersections having such features as traffic signal heads over particular lanes, lanes allocated to specific movements, multiple signal phases, signal detectors for actuated control, and accessible pedestrian signals and detectors.

Guidance:

The effect of the work upon signal operation should be considered, such as signal phasing for ensuring adequate capacity, maintaining or adjusting signal detectors, and ensuring the appropriate visibility of signal heads.

Standard:

When work will occur near an intersection where operational, capacity, or pedestrian accessibility problems are anticipated, the highway agency having jurisdiction shall be contacted.

Guidance:

For work at an intersection, advance warning signs, devices, and markings should be used on all cross streets, as appropriate. Where the posted speed limit exceeds 60 km/h (40 mph), additional warning signs should be considered for use in the advance warning area.

Pedestrian crossings near TTC sites should be separated from the worksite by appropriate Traffic Control Devices that maintain the accessibility and detectability for pedestrians with disabilities.

Support:

Near-side work spaces, as depicted in Figure 6H-21, are simply handled as a midblock lane closure. A problem that might occur with near-side lane closure is a reduction in capacity, which during certain hours of operation could result in congestion and backups.

Option:

When near-side work spaces are used, an exclusive turn lane may be used for through vehicular traffic. Where space is restricted in advance of near-side work spaces, as with short block spacings, two warning signs may be used in the advance warning area, and a third action-type warning or a regulatory sign (such as Keep Left) may be placed within the transition area.

Support:

Far-side work spaces, as depicted in Figures 6H-22 through 6H-25, involve additional treatment because road users typically enter the activity area by straight-through and left- or right-turning movements.

Guidance:

When a lane through an intersection must be closed on the far side, it should also be closed on the near-side approach to preclude merging movements within the intersection.

Option:

If there are a significant number of vehicles turning from a near-side lane that is closed on the far side, the near-side lane may be converted to an exclusive turn lane.

Support:

Figures 6H-26 and 6H-27 provide guidance on applicable procedures for work performed within the intersection.

Option:

If the work is within the intersection, any of the following strategies may be used:

- A. A small work space so that road users can move around it, as shown in Figure 6H-26;
- B. Flaggers or uniformed law enforcement officers to direct road users, as shown in Figure 6H-27;
- C. Work in stages so the work space is kept to a minimum; and
- D. Road closures or upstream diversions to reduce road user volumes.

Guidance:

Depending on road user conditions, a flagger(s) and/or a uniformed law enforcement officer(s) should be used to control road users.

Notes for Figure 6H-28—Typical Application 28 Sidewalk Detours or Diversions

Standard:

- 1. When crosswalks or other pedestrian facilities are closed or relocated, temporary facilities shall be detectable and shall include accessibility features consistent with the features present in the existing pedestrian facility.**

Option:

2. On high speed roadways, a temporary traffic barrier or crash cushions may be considered. Such devices normally may not be appropriate on urban roadways.

Guidance:

3. Audible information devices should be considered where midblock closings and changed crosswalk areas cause inadequate communication to be provided to pedestrians who have visual disabilities.

Option:

4. Street lighting may be considered.
5. Only the TTC devices related to pedestrians are shown. Other devices, such as lane closure signing or ROAD NARROWS signs, may be used to control vehicular traffic.
6. For nighttime closures, Type A Flashing warning lights may be used on barricades that support signs and close sidewalks.
7. Type C Steady-Burn or Type D 360-degree Steady-Burn warning lights may be used on channelizing devices separating the temporary sidewalks from vehicular traffic flow.
8. Signs, such as KEEP RIGHT (LEFT), may be placed along a temporary sidewalk to guide or direct pedestrians.

Figure 6H-35 (TA—35): Mobile Operation on Multi-Lane Freeways
SUBSTITUTE these notes for all notes in TA 35 (2003 MUTCD):

Standard:

If used, an arrow panel shall be a minimum of Type B, with a size of 1500 x 750 mm (60 x 30 in).

Guidance:

- 1- Vehicles used should be made highly visible with appropriate equipment such as high-intensity rotating, flashing, oscillating, or strobe lights, flags, signs, or arrow panels.
- 2- Consideration should be given to working during lower traffic hours.
- 3- Need for a shadow vehicle(s) should be based on engineering judgment considering the type of operation and site conditions.
- 4- When used, a shadow vehicle should follow the work vehicle in the same lane remaining an appropriate distance so as to be visible to vehicles approaching from the rear. The shadow vehicle should remain a sufficient distance behind the work vehicle so as to minimize probability of a struck shadow vehicle crashing into work vehicle, yet not be so far as to encourage motorists to re-enter the closed lane between the work and shadow vehicle.
- 5- If a vehicle is not closing a lane or if the vehicle is on the shoulder, the arrow board should be in the caution mode.

Option :

- 1- If a shadow vehicle is used and the work zone closes the lane for a distance, a "LANE CLOSED" sign may be mounted on the shadow vehicle in a manner that will not interfere with the display of other protection devices.
- 2- Truck-mounted attenuator(s) may be used.

Support :

Engineering judgment needs to be applied taking into consideration the relative speeds of vehicles, the type and duration of work, and the advantages and disadvantages offered by each device. Even on high speed freeways, the potential safety advantages offered by attenuators and shadow vehicles needs to be weighed against the costs, loss of maneuverability, extra exposure, and length. These same parameters make the use of attenuators and to some extent shadow vehicles impractical on urban streets.

For routine maintenance involving moving operations or only intermittent stops (sweeping or striping), best results result from jurisdictions focusing on making sure work vehicles are highly visible.

Section 7A.01 Need for Standards

Support:

It is important to stress that regardless of the school location, the best way to achieve reasonably safe and effective traffic control is through the uniform application of realistic policies, practices, and standards developed through engineering judgment.

Pedestrian safety depends upon public understanding of accepted methods for efficient traffic control. This principle is especially important in the control of pedestrians, bicycles, and other vehicles in the vicinity of schools. Neither pedestrians on their way to or from school nor road users can be expected to move safely in school areas unless they understand both the need for traffic controls and how these controls function for their benefit.

Procedures and devices that are not uniform might cause confusion among pedestrians and road users, prompt wrong decisions, and contribute to crashes. To achieve uniformity of traffic control in school areas, comparable traffic situations need to be treated in a consistent manner. Each traffic control device and control method described in Part 7 fulfills a specific function related to specific traffic conditions.

A uniform approach to school area traffic controls assures the use of similar controls for similar situations (which promotes uniform behavior on the part of motorists, pedestrians, and bicyclists).

A school traffic control plan permits the orderly review of school area traffic control needs, and the coordination of school/pedestrian safety education and engineering activities.

Arizona has found great success using special procedures for handling elementary and middle school students in Arizona, described in Arizona Revised Statute (ARS) 28-797. Initially, provisions of ARS 28-797 were also applicable to high schools, but officials learned that a different approach ought to be used at these locations. Older students resisted following instructions of adult guards, and this led officials to conclude that trying to make provisions of 28-797 apply to older students would undermine effectiveness for younger students. Accordingly, provisions used for traffic control around high schools in Arizona ought to be consistent with the portions of Part VII of this Manual not affected by ARS 28-797.

More information can be found regarding Arizona school crossing controls in section 7.5 and the Appendix of the Arizona Department of Transportation (ADOT) Traffic Safety for School Areas Guidelines. While this is the operating practice applicable to ADOT, input is solicited and incorporated from other jurisdictions in the state, resulting in local jurisdictions adhering closely to these provisions.

Arizona practice does not encourage the use of student patrol programs as described in 7E.07.

Guidance:

A school route plan for each school serving elementary through 8th grade students should be prepared in order to develop uniformity in the use of school area traffic controls and to serve as the basis for a school traffic control plan for each school.

The school route plan should be developed in a systematic manner by the school, in conjunction with law enforcement, and traffic officials responsible for school pedestrian safety. The plan should consist of a map (see Figure 7A-1) showing streets, the school, existing traffic controls, established school walk routes, and established school crossings. Such plans are not applicable for high schools, adult education, or trade schools.

The type(s) of school area traffic control devices used, either warning or regulatory, should be related to the volume and speed of vehicular traffic, street width, and the number and age of the students using the crossing.

School area traffic control devices should be included in a school traffic control plan.

All Kindergarten through 8th grade school area traffic control should comply with ARS 28-797 and the Traffic Safety for School Areas Guidelines, while traffic control for older students should comply with the remainder of Part VII.

Support:

Reduced speed limit signs for school areas and crossings are included in this Manual solely for the purpose of standardizing signing for these zones and not as an endorsement of mandatory reduced speed zones.

Information as to height, installation and lettering on signs can be found in the Traffic Safety for School Areas Guidelines.

Section 7A.02 School Routes and Established School Crossings

Support:

The planning criterion for school walk routes might make it necessary for children kindergarten through 8th grade, to walk an indirect route to an established school crossing located where there is existing traffic control and to avoid the use of a direct crossing where there is no existing traffic control.

Guidance:

School walk routes should be planned to take advantage of existing traffic controls.

The following factors should be considered when determining the feasibility of requiring children to walk a longer distance to a crossing with existing traffic control:

- A. The availability of adequate sidewalks or off-roadway sidewalk areas to and from the location with existing control;
- B. The number of students using the crossing;

- C. The age levels of the students using the crossing; and
- D. The total extra walking distance.

Section 7A.04 Scope

Standard:

Part 7 sets forth basic principles and prescribes standards that shall be followed in the design, application, installation, and maintenance of all traffic control devices (including signs, signals, and markings) and other controls (including adult crossing guards, and grade-separated crossings) required for the special pedestrian conditions in school areas.

Option:

In-roadway signs for school traffic control areas may be used consistent with the requirements the Traffic Safety for School Areas Guidelines.

Support:

Provisions discussed in Part 2 are also applicable in school areas, except where described differently under ARS.

Section 7B.01 Size of School Signs

Standard:

The sizes of signs and plaques to be used on conventional roadways in school areas shall be as shown in Table 7B-1, where not superseded by ARS 28-797 for 15 mph School Crossings for kindergarten through 8th grade students.

The Conventional Road sign size shall be used on public roads, streets, and highways unless engineering judgment determines that a Minimum or Oversized sign size would be more appropriate.

The Oversized sign size shall be used on expressways.

Guidance:

School signs related to ARS 28-797, should be sized consistent with the Traffic Safety for School Areas Guidelines. S1-1 signs are typically a minimum of 30" x 30" inch in urban areas and 36" x 36" in rural areas. The STOP WHEN CHILDREN IN CROSSWALK sign and the NO PASSING 15 MPH SCHOOL IN SESSION should be a minimum of 20" x 30" in urban areas and 24" x 30" in rural areas.

Section 7B.04 Height of Signs

Standard:

The portable "Stop When Children In Crosswalk" sign (S2-2) shall be mounted on a portable standard not less than 24" from the bottom of the sign to the roadway. The "School Speed Limit" sign (S4-5) shall be mounted on a portable standard not less than 24" from the bottom of the sign to the roadway.

Support:

Section 2A.18 and the Traffic Safety for School Areas Guidelines contains information regarding the mounting height of permanent signs.

Section 7B.07 Sign Color for School Warning Signs

Standard:

Except as noted in the Option, school warning signs shall have a yellow background with a black legend and border unless specifically designed otherwise.

Option:

All school warning signs in addition to the following signs may have a fluorescent yellow-green background with a black legend and border:

- A. School Advance Warning sign (S1-1);

- B. SCHOOL BUS STOP AHEAD sign (S3-1);
- C. SCHOOL plaque (S4-3);
- D. The "SCHOOL" portion of the School Speed Limit sign (S5-1);
- E. XXX FEET plaque (W16-2 series);
- F. AHEAD plaque (W16-9p);
- G. Diagonal Arrow plaque (W16-7p); and
- H. Reduced Speed School Zone Ahead sign (S4-5, S4-5a);
- I. Bottom section of S4-5;
- J. Other miscellaneous school warning signs.

Guidance:

When the fluorescent yellow-green background color is used, a systematic approach featuring one background color within a zone or area should be used. The mixing of standard yellow and fluorescent yellow-green backgrounds within a zone or area should be avoided.

Section 7B.08 School Advance Warning Sign (S1-1)

Guidance:

The School Advance Warning sign (see Figure 7B-1), if used should be installed in advance of locations where school buildings or grounds are adjacent to the highway, except where a physical barrier such as fencing separates school children from the highway. The School Advance Warning sign should be positioned using engineering judgment, typically between 45 m (150 ft) and 210 m (700 ft) in advance of the school grounds or school crossings (see Figure 7B-1).

Standard:

The School Advance Warning Sign shall be used in advance of any installation of the School Crosswalk Warning assembly (see Figure 7B-2), or in advance of the first installation of the School Speed Limit assembly (see Figure 7B-3).

Option:

If used, the School Advance Warning Sign may consist of a School Advance Warning (S1-1) sign supplemented with a plaque with the legend AHEAD (W16-9p) or XXX METERS (XXX FEET) (W16-2 or W16-2a) to provide advance notice to road users of crossing activity.

Section 7B.09 School Crosswalk Warning Assembly (S1-1 with Diagonal Arrow)

Standard:

If used, the School Crosswalk Warning assembly (see Figure 7B-1) shall be installed at the marked crosswalk, or as close to it as possible, and shall consist of a School Advance Warning (S1-1) sign supplemented with a diagonal downward pointing arrow (W16-7p) plaque to show the location of the crossing.

The School Crosswalk Warning assembly shall not be used at marked crosswalks other than those adjacent to schools and those on established school pedestrian routes.

The School Crosswalk Warning assembly shall not be installed on approaches controlled by a STOP, YIELD sign or signal.

Guidance:

Engineering Judgment should be used to determine need for a school crosswalk warning assembly at a marked crosswalk, but normally the sign is not needed.

Standard:

All in-street signing shall conform to the standards set forth in the Traffic Safety for School Areas Guidelines. These signs shall be placed and removed as required by the highway authority.

Option:

Larger signs can be permanently installed on the side of the street in lieu of the in-street installations

Section 7B.10 SCHOOL BUS STOP AHEAD Sign (S3-1)

Option:

The SCHOOL BUS STOP AHEAD (S3-1) sign (see Figure 7B-1) may be installed in advance of locations where a school bus, when stopped to pick up or discharge passengers, is not visible to road users on higher speed streets, for a distance of 150 m (500 ft) in advance and where there is no opportunity to relocate the bus stop to provide 150 m (500 ft) of visibility.

Section 7B.11 School Speed Limit Assembly (S4-1, S4-2, S4-3, S4-4, S4-6, S5-1)

Standard:

A School Speed Limit assembly (see Figure 7B-1) or a School Speed Limit (S5-1) sign (see Figure 7B-1) shall be used to indicate the speed limit where a reduced speed zone for a school area has been established (in accordance with law based upon an engineering study) or where a speed limit is specified for such areas by statute. This assembly signing (S4-1, S4-2, S4-3, S4-4, S5-1), shall only be considered for use at locations where the Arizona portable school speed limit signing (S4-5, S2-2) is not in use, as the two types of speed limit signing are incompatible. The speed limit shall remain reasonable per ARS, not deviating more than 10 mph below the speed limit approaching the reduced speed limit zone. The School Speed Limit assembly or School Speed Limit sign shall be placed at or as near as practical to the point where the reduced speed zone begins.

The Arizona School Speed Limit signs (S4-5 and S2-2) shall be used to mark school zones as defined under ARS 28-797 and in accordance with the guidelines set forth in the Appendix of the Traffic Safety for School Areas Guidelines.

Guidance:

Engineering judgment should be used to determine the start point of school speed zones.

Standard:

The School Speed Limit assembly shall be either a fixed-message sign assembly or a changeable message sign.

The fixed-message School Speed Limit assembly shall consist of a top plaque (S4-3) with the legend SCHOOL, a Speed Limit (R2-1) sign, and a bottom plaque (S4-1, S4-2, S4-4, or S4-6) indicating the specific periods of the day and/or days of the week that the special school speed limit is in effect (see Figure 7B-1).

Option:

Changeable message signs (see Sections 2A.07 and 6F.55) may be used to inform drivers of the special school speed limit. If the sign is internally illuminated, it may have a white legend on a black background. Changeable message signs with flashing beacons may be used for the more critical situations, where greater emphasis of the special school speed limit is needed.

Guidance:

Even though it might not always be practical because of special features to make changeable message signs conform in all respects to the accepted standards, during the periods that the school speed limit is in effect, their basic shape, message, legend layout, and colors should conform to the standards for fixed-message signs.

A confirmation beacon or device to indicate that the speed limit message is in operation should be considered for inclusion on the back of the changeable message sign.

Option:

Fluorescent yellow-green pixels may be used when school-related messages are shown on a changeable message sign.

Changeable message signs may use blank-out messages or other methods in order to display the school speed limit only during the periods it applies.

Changeable message signs that display the speed of approaching drivers (see Section 2B.13) may be used in a school speed limit zone.

A Speed Limit Sign Beacon also may be used, with a WHEN FLASHING legend, to identify the periods that the school speed limit is in effect. The lenses of the Speed Limit Sign Beacon may be positioned within the face of the School Speed Limit (S5-1) sign (see Figure 7B-1).

A FINES HIGHER (R2-6) sign (see Section 2B.17) may be used to advise road users when increased fines are imposed for traffic violations in school zones.

Section 7B.13 END SCHOOL ZONE Sign (S5-2)

Guidance:

The end of a posted school speed zone should be marked with an END SCHOOL ZONE (S5-2) sign, or with the new regulatory speed limit, depending upon an engineering judgment decision. With regard to Arizona's 15 mph zones (ARS 28-797), the zone automatically ends at the crosswalk, so no signs are typically posted. Additionally, it usually is not desirable to post the routine speed limit precisely near that point, as it may encourage motorists to accelerate sooner than desirable.

Section 7C.03 Crosswalk Markings

Support:

Crosswalk markings provide guidance for pedestrians who are crossing roadways by defining and delineating paths on approaches to and within signalized intersections, and on approaches to other intersections where traffic stops.

Crosswalk markings also serve to alert road users of a pedestrian crossing point across roadways not controlled by highway traffic signals or STOP signs.

At nonintersection locations, crosswalk markings legally establish the crosswalk.

Standard:

School crosswalk markings installed under ARS 28-797 (15 mph zones) shall be yellow at all locations where the Arizona portable school speed limit signing is placed. Crosswalk markings not related to Arizona's 15 mph School Crossings shall be white. ARS 28-797 crosswalk lines shall be not less than 10 inches in width, while white crosswalks shall not be less than 6 inches in width.

Guidance:

If transverse lines are used to mark a crosswalk, the gap between the lines should not be less than 1.8 m (6 ft). If diagonal or longitudinal lines are used without transverse lines to mark a crosswalk, the crosswalk should not be less than 1.8 m (6 ft) wide.

Crosswalk lines on both sides of the crosswalk should extend across the full width of pavement or to the edge of the intersecting crosswalk to discourage diagonal walking between crosswalks.

Crosswalks should be marked at all intersections on established routes to school where engineering judgment determines there is substantial conflict between motorists, bicyclists, and pedestrian movements, where students are encouraged to cross between intersections, or where students would not otherwise recognize the proper place to cross (see Figure 7A-1).

Crosswalk lines should not be used indiscriminately. An engineering study should be performed before they are installed at locations away from traffic control signals or STOP signs.

Crosswalk markings are not normally necessary at STOP or YIELD sign controlled crossings.

Option:

For added visibility, the area of the crosswalk may be marked with appropriately colored diagonal lines at a 45-degree angle to the line of the crosswalk or with appropriately colored longitudinal lines parallel to traffic flow. When diagonal or longitudinal lines are used to mark a crosswalk, the transverse crosswalk lines may be omitted.

Guidance:

The diagonal or longitudinal lines should be 300 to 600 mm (12 to 24 in) wide and spaced 300 to 1500 mm (12 to 60 in) apart. The spacing design should avoid the wheel paths.

Option:

Lane lines in advance of marked crosswalks of any type may be made solid and slightly wider than typical to discourage passing and to provide an additional alert that a crosswalk may exist ahead. On two lane urban streets, a skip yellow centerline may be either added or made solid as well for the same reasons stated above.

Section 7C.04 Stop and Yield Lines

Standard:

If used, stop lines shall consist of solid white lines extending across approach lanes to indicate the point at which the stop is intended or required to be made.

If used, yield lines (see Figure 3B-14) shall consist of a row of solid white isosceles triangles pointing toward approaching vehicles extending across approach lanes to indicate the point at which the yield is intended or required to be made.

Guidance:

Stop lines should be 10 to 24 in wide.

Stop lines should be used to indicate the point behind which vehicles are required to stop, in compliance with a STOP (R1-1) sign (see Figure 2B-1), traffic control signal, or some other traffic control device.

The individual triangles comprising the yield line should have a base of 300 to 600 mm (12 to 24 in) wide and a height equal to 1.5 times the base. The space between the triangles should be 75 to 300 mm (3 to 12 in).

Option:

Yield lines may be used to indicate the point behind which vehicles are required to yield in compliance with a YIELD (R1-2) sign (see Figure 2B-1) or a Yield Here to Pedestrians (R1-5 or R1-5a) sign (see Figure 2B-2).

Guidance:

If used at an unsignalized midblock crosswalk, yield lines should be placed adjacent to the Yield Here to Pedestrians sign located 6.1 to 15 m (20 to 50 ft) in advance of the nearest crosswalk line, and parking should be prohibited in the area between the yield line and the crosswalk (see Figure 3B-15).

Stop lines at midblock signalized locations should be placed at least 12 m (40 ft) in advance of the far-side signal indication (see Section 4D.15).

Support:

Drivers who yield too close to crosswalks on multi-lane approaches place pedestrians at risk by blocking other drivers' views of pedestrians, and pedestrians' views of other vehicles.

SUPPORT:

STOP bars can be used to gain improved driver performance in various ways as indicated in several handbooks published by the Institute of Transportation Engineers. For example, STOP lines may be used to advise where motorists are to:

1. Stop in the event pedestrians are present; or
2. Stop at a signal to retain view of nearside signals, or remain on vehicle detectors; or
2. Yield or stop where they have a full view of approaching traffic; or
3. Stop far enough back to not obstruct turning vehicles from opposing streets.
5. Stop at wide throat intersections where the optimum stopping locations a substantial distance from the STOP sign.

Section 8B.04 Highway-Rail Grade Crossing Advance Warning Signs (W10 Series)

Standard:

A Highway-Rail Grade Crossing Advance Warning (W10-1) sign (see Figure 8B-2) shall be used on each highway in advance of every highway-rail grade crossing except in the following circumstances:

- A. On low-volume, low-speed highways crossing minor spurs or other tracks that are infrequently used and are flagged by train crews; or**
- B. In business districts where active highway-rail grade crossing traffic control devices are in use; or**
- C. Where physical conditions do not permit even a partially effective display of the sign.**

Placement of the Highway-Rail Grade Crossing Advance Warning sign shall be in accordance with Chapter 2A and Table 2C-4.

Option:

If the distance between the railroad tracks and the parallel highway is too short to allow effective placement of the W10-1 sign, a W10-2, W10-3, or W10-4 sign may optionally be installed on the parallel highway to warn road users making a turn that they will encounter a highway-rail grade crossing. On divided highways and one-way streets, an additional W10-1 sign may be installed on the left side of the roadway.

Standard:

If the W10-2, W10-3, or W10-4 signs are used, sign placement in accordance with the guidelines for Intersection Warning signs in Table 2C-4 using the speed of through traffic shall be measured from the highway intersection.

Guidance:

If the distance between the railroad tracks and the parallel highway, from the edge of the tracks to the edge of the parallel roadway, is 30 m (100 ft) or more, a W10-1 sign should be installed in advance of the highway-rail grade crossing, and the W10-2, W10-3, or W10-4 signs should not be used on the parallel highway.

Section 8B.06 Turn Restrictions During Preemption

Option:

At a signalized intersection that is located within 60 m (200 ft) of a highway-rail grade crossing, measured from the edge of the track to the edge of the roadway, where the intersection traffic control signals are preempted by the approach of a train, all existing turning movements toward the highway-rail grade crossing may be prohibited during the signal preemption sequences.

A blank-out or changeable message sign and/or appropriate highway traffic signal indication or other similar type sign may be used to prohibit turning movements toward the highway-rail grade crossing during preemption. The R3-1a and R3-2a signs shown in Figure 8B-3 may be used for this purpose.

Standard:

Turn prohibition signs that are associated with preemption shall be visible only when the highway-rail grade crossing restriction is in effect.

Section 10C.02 Highway-Rail Grade Crossing (Crossbuck) Sign (R15-1) and Number of Tracks Sign (R15-2)

Standard:

The Highway-Rail Grade Crossing (R15-1) sign, commonly identified as the Crossbuck sign, shall be retroreflectorized white with the words RAILROAD CROSSING in black lettering, mounted as shown in Figure 10C-1.

As a minimum, one Crossbuck sign shall be used on each highway approach to every highway-light rail transit grade crossing on a semiexclusive alignment, unless the track is within an intersection otherwise controlled.

Option:

A Crossbuck sign may be used on a highway approach to a highway-light rail transit grade crossing on a mixed-use alignment, alone or in combination with other traffic control devices.

Standard:

If automatic gates are not present where a Crossbuck sign is being used and if there are two or more tracks at the highway-light rail transit grade crossing, the number of tracks shall be indicated on a supplemental Number of Tracks (R15-2) sign of inverted T shape mounted below the Crossbuck sign in the manner and at the height indicated in Figure 10C-1.

Option:

The supplemental Number of Tracks sign may also be used at highway-light rail transit grade crossings with automatic gates.

Standard:

If used, the Crossbuck sign shall be installed on the right side of the highway on each approach to the highway-light rail transit grade crossing. Where restricted sight distance or unfavorable highway geometry exists on an approach to a highway-light rail transit grade crossing, an additional Crossbuck sign shall be installed on the left side of the highway, possibly placed back-to-back with the Crossbuck sign for the opposite approach, or otherwise located so that two Crossbuck signs are displayed for that approach.

A strip of retroreflective white material not less than 50 mm (2 in) in width shall be used on the back of each blade of each Crossbuck sign for the length of each blade, at all highway-light rail transit grade crossings, except those where Crossbuck signs have been installed back-to-back.

A strip of retroreflective white material, not less than 50 mm (2 in) in width, shall be used on each support at passive highway-light rail transit grade crossings for the full length of the front and back of the support from the Crossbuck sign or Number of Tracks sign to within 0.6 m (2 ft) above the edge of the roadway, except on the side of those supports where a STOP (R1-1) or YIELD (R1-2) sign or flashing lights have been installed or on the back side of supports for Crossbuck signs installed on one-way streets.

Guidance:

If used, Crossbuck signs should be located with respect to the highway pavement or shoulder in accordance with the criteria in Chapter 2A and Figures 2A-1 and 2A-2, and should be located with respect to the nearest track in accordance with Figure 8D-2.

The minimum lateral clearance for the nearest edge of the Crossbuck sign should be 1.8 m (6 ft) from the edge of the shoulder or 3.7 m (12 ft) from the edge of the traveled way in rural areas, and 0.6 m (2 ft) from the face of the curb in urban areas.

Where unusual conditions make variations in location and lateral clearance appropriate, engineering judgment should be used to provide the best practical combination of view and safety clearances.

Section 10D.01 Introduction

Support:

Active light rail transit traffic control systems inform motorists, bicyclists, and pedestrians of the approach or presence of light rail transit vehicles at highway-light rail transit grade crossings. These systems include four-quadrant gate systems, automatic gates, flashing-light signals, traffic control signals, actuated blank-out and variable message signs, and other active traffic control devices.

Guidance:

Where both traffic control signals and flashing-light signals (with or without automatic gates) are in operation at the same highway-light rail transit grade crossing, the operation of the devices should be coordinated to avoid any display of conflicting signal indications.

If a pedestrian route is provided, sufficient clearance from supports, posts, and gate mechanisms should be maintained for pedestrian travel.

Where light rail historic transit vehicles use their own exclusive tracks along the public right of way and operate in accordance with the street's normal traffic controls, the highway-railroad traffic control devices, systems and practices need not be used.

Option:

Audible devices may be operated in conjunction with the flashing lights or traffic control signals.

Support:

Light rail transit typically operates through grade crossings in semi-exclusive and mixed-use alignments at speeds between 16 km/h (10 mph) and 105 km/h (65 mph).

When light rail transit speed is cited in this Part, it refers to the maximum speed at which light rail transit vehicles are permitted to traverse a particular grade crossing.