AGENDA ITEM III.3, JUNE 2014

TECHNICAL COMMITTEE: RWSTC RECOMMENDATION

TOPIC: LED Sign Applications

Task Force: Pline, Bartlett, Carlson, Cohen, Heydel, Kennedy, Lipps, McCourt, Ranck, Ramisch, Forbes (Canada)

STATUS/DATE OF ACTION:
09/20/10, 03/30/11, 05/06/11, 06/29/11,
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Transmitted to Sponsors: April 2014

TC Approval following sponsor comments: June 26, 2014

Council Approval: June 28, 2014

ORIGIN OF REQUEST: Regulatory & Warning Signs Technical Committee

AFFECTED SECTIONS OF MUTCD: Parts 2A, 2B, 2C, 2G, 2H, 2L, 6E, 6F, 7B and 8B

DISCUSSION/QUESTION:

Industry has developed LED lights beyond the existing coverage in the MUTCD and are applying LEDs to various sign applications. State and local agencies are being contacted promoting various LED applications for sign enhancements, specific sign legends, and special applications. The existing MUTCD provisions for LEDs does not provide the requirements to evaluate...
the LED proposals while maintaining the basic principles of the MUTCD. The RWSTC considered these issues and appointed a Task Force in June 2009 to accomplish the following:

**OBJECTIVE:** Review traffic control products being marketed relative to MUTCD provisions for LED Regulatory and Warning signs and messages on all sign displays. Recommend MUTCD revisions to maintain basic traffic control concepts, recognize the adaptability of LED technology for communicating regulatory and warning sign messages and provide guidance to industry for LED signing developments.

The Task Force has reviewed the products in the market place, FHWA letters and responses relative to LED signs, Canadian LED-Embedded Traffic Signs report, and various other research projects relating to LED applications.

After this review and extensive discussion, the Task Force developed the following General Provisions and guidelines to address the MUTCD provisions:

### LED Signs – General Provisions 01/28/11, 02/19/13, 06/03/13, 07/22/13, 08/22/13, 09/16/13, 1-9-14

1. LED signs shall comply with the MUTCD relative to shape, color, dimensions, symbols, legends and border provisions for the comparable standard sign.
2. Dynamic (road user activated) signs should be supplemental to other standard signing.
3. No multiple concentration of LEDs or LED clusters or large LEDs that resemble a flasher shall be permitted within the face of the sign.
4. The appropriate viewing angles for signs incorporating LEDs will not change from the standard signing.
5. Viewing distance – 100 feet to ¼ mile
7. Minimum Intensity – The minimum maintained luminous intensity of the LEDs should be in accordance with industry practice to ensure adequate external luminance contrast. Maximum Intensity – The maximum luminous intensity shall be no more than 10 times the minimum maintained luminous intensity, shall not create disability glare, reduce sign legibility, or create undue road user distraction.
8. Uniformity – The ratio of the maximum and minimum luminance intensities in a single installation shall be a maximum of 10:1.
8. Due to the substantial difference in LED visibility between sunlight and nighttime conditions, the LEDs shall have dimming capabilities that adjust to ambient light conditions.

9. Not more than one message should flash at the same time. Only one flashing LED sign is permitted within XX feet of another flashing LED sign.

**LED SIGN MATRIX**

<table>
<thead>
<tr>
<th>Description</th>
<th>Border Only</th>
<th>Legend</th>
<th>Full Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong></td>
<td>Enhance sign</td>
<td>Increase sign</td>
<td>Individual sign display</td>
</tr>
<tr>
<td></td>
<td>conspicuity and legibility or on changeable</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>attract drivers</td>
<td>provide part time</td>
<td>message sign</td>
</tr>
<tr>
<td></td>
<td>attention</td>
<td>or dynamic legend</td>
<td></td>
</tr>
<tr>
<td><strong>LED Application</strong></td>
<td>Individual pixels</td>
<td>Legend only</td>
<td>Sign border, legend and background</td>
</tr>
<tr>
<td>border only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LED Color</strong></td>
<td>Same as sign</td>
<td>As specified for</td>
<td>Same as standard</td>
</tr>
<tr>
<td>background</td>
<td>each sign</td>
<td>sign</td>
<td></td>
</tr>
<tr>
<td><strong>LED Flash</strong></td>
<td>Simultaneously</td>
<td>Simultaneously</td>
<td>No</td>
</tr>
<tr>
<td><strong>Flash Rate</strong></td>
<td>50 to 120 times</td>
<td>50 to 120 times</td>
<td></td>
</tr>
<tr>
<td>per minute</td>
<td>per minute</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LED Diameter</strong></td>
<td>¼-inch maximum</td>
<td>¼ inch maximum</td>
<td>¼-inch maximum</td>
</tr>
<tr>
<td><strong>LED Spacing</strong></td>
<td>At least 25 % of sign</td>
<td>Legend &amp; Symbol layout</td>
<td>Not</td>
</tr>
<tr>
<td>size</td>
<td>shall match standard sign. Applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>perimeter</td>
<td>The pitch shall provide a legend that is comparable to a static sign when the LED’s are illuminated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dimension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sign Examples</strong></td>
<td>Stop/Yield</td>
<td>Variable Speed Limit</td>
<td>Route Markers</td>
</tr>
<tr>
<td>Stop/Slow Paddles</td>
<td>Turn Prohibitions</td>
<td>Guide Sign Legends</td>
<td></td>
</tr>
<tr>
<td>Do Not Enter</td>
<td>Variable Lane Control</td>
<td>Regulatory signs on CMS</td>
<td></td>
</tr>
<tr>
<td>Wrong Way</td>
<td>Reversible Lane Control</td>
<td>Warning signs on CMS</td>
<td></td>
</tr>
</tbody>
</table>
Warning Signs  Preferential Lane Control
Exit Speed  Chevrons
Ramp Speed  One Direction Large Arrow
School Crosswalk  School Speed Limit
Assembly  Your Speed XX MPH

There was some confusion generated when addressing the regulatory and warning signs and Changeable Message signs. To resolve that problem, it was the decision of the Task Force to retain the Changeable Message terminology for the full matrix LED signs and other wording such as “Part Time”, electronic, driver feedback, and blank-out to differentiate the regulatory and warning sign applications. The MUTCD provisions for Changeable Message signs have been included without modifications in the following proposed text revisions to facilitate a comparison of the LED provisions.

RECOMMENDED WORDING:

MUTCD 2009 Text pertaining to LEDs and Changeable Message Signs
Existing 2009 Text = Black
Deletions = strikethrough-Red  Additions = RED underlined
Previous Council Action = Blue
Comments and Explanation = Green
03/06/2012, 06/03/13, 08/22/13, 09/16/13,
1-9-14, 6/02/14

REVISE THE FOLLOWING DEFINITIONS
Section 1A.13 Definitions of Headings, Words, and Phrases in this Manual
5. Actuation – initiation of a change in or extension of a traffic signal phase or sign legend through the operation of any type of detector.
28. Changeable Message Sign—a sign that is capable of displaying more than one message, changeable manually, by remote control, or by automatic control. Electronic-display changeable message signs are referred to as Dynamic Message Signs in the National Intelligent Transportation Systems (ITS) Architecture and are referred to as Variable Message Signs in the National Electrical Manufacturers Association (NEMA) standards publication.
74. Flashing – an operation in which a light source, such as a traffic signal indication or LED, is turned on and off repetitively.

RECOMMEND THE FOLLOWING CHANGES
Section 2A.06 Design of Signs
The term legend shall include all word messages and symbol and arrow designs that are intended to convey specific meanings.

Uniformity in design shall include shape, color, dimensions, legends, borders, and illumination or retroreflectivity.

All symbols shall be unmistakably similar to, or mirror images of, the adopted symbol signs, all of which are shown in the "Standard Highway Signs and Markings" book (see Section 1A.11). Symbols and colors shall not be modified unless otherwise provided in this Manual. All symbols and colors for signs not shown in the "Standard Highway Signs and Markings" book shall follow the procedures for experimentation and change described in Section 1A.10.

Where a standard word message is applicable, the wording shall be as provided in this Manual.

In situations where word messages are required other than those provided in this Manual, the signs shall be of the same shape and color as standard signs of the same functional type.

Section 2A.07 Retroreflectivity and Illumination

There are many materials currently available for retroreflection and various methods currently available for the illumination of signs and object markers. New materials and methods continue to emerge. New materials and methods can be used as long as the signs and object markers meet the standard requirements for color, both by day and by night.

Regulatory, warning, and guide signs and object markers shall be retroreflective (see Section 2A.08) or illuminated to show the same shape and similar color by both day and night, unless otherwise provided in the text discussion in this Manual for a particular sign or group of signs.

The requirements for sign illumination shall not be considered to be satisfied by street or highway lighting.

Sign elements may be illuminated by the means shown in Table 2A-1.

<table>
<thead>
<tr>
<th>Means of Illumination</th>
<th>Sign Element to be Illuminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light behind the sign face</td>
<td>• Symbol or word message</td>
</tr>
<tr>
<td></td>
<td>• Background</td>
</tr>
<tr>
<td></td>
<td>• Symbol, word message, and background (through a translucent material)</td>
</tr>
<tr>
<td>Attached or independently mounted light source designed to direct essentially uniform</td>
<td>Entire sign face</td>
</tr>
<tr>
<td>178</td>
<td>illumination onto the sign face</td>
</tr>
<tr>
<td>179</td>
<td>Light emitting diodes (LED’s)</td>
</tr>
<tr>
<td>180</td>
<td>• Symbol or word message</td>
</tr>
<tr>
<td>181</td>
<td>• Portions of the Sign border</td>
</tr>
<tr>
<td>182</td>
<td>• Entire Background</td>
</tr>
<tr>
<td>183</td>
<td>Other devices, or treatments that highlight the sign shape, color, or message:</td>
</tr>
<tr>
<td>184</td>
<td>Luminous tubing</td>
</tr>
<tr>
<td>185</td>
<td>• Symbol or word message</td>
</tr>
<tr>
<td>186</td>
<td>Fiber optics</td>
</tr>
<tr>
<td>187</td>
<td>Entire sign face</td>
</tr>
<tr>
<td>188</td>
<td>Incandescent light bulbs</td>
</tr>
<tr>
<td>189</td>
<td>Luminescent panel</td>
</tr>
<tr>
<td>190</td>
<td>• Symbol or word message</td>
</tr>
</tbody>
</table>

06 Light Emitting Diode (LED) units may be used individually within the border, legend or symbol of a sign, in a one-legend “blank-out” sign, part-time sign, or driver feedback sign to enhance the sign conspicuity and increase the sign legibility. These application of LED units are not considered as changeable message signs, or provide a changeable message.

Support:

LED units that are used to illuminate the full sign matrix, background and legend, are changeable message signs (CMS) covered in Part 2L Regulatory and warning LED signs are covered in Parts 2B, 2C and 7.

07 Except as provided in Paragraphs 11 and 12, and changeable message signs neither individual LEDs nor groups of LEDs shall be placed within the background area of a sign.

08 If used, The LEDs shall not protrude outside the sign border or legend when used in such applications, shall have a maximum diameter of 1/4 inch, and shall be the following colors based on the type of sign:

A. White or Red, if used with STOP or YIELD with red background regulatory signs.
B. White, if used with other regulatory signs other than STOP or YIELD signs.
C. White or Yellow, if used with warning signs.
D. White or Green if used with guide signs.
E. White, Yellow, or orange, if used with temporary traffic control signs.
F. White or Yellow or yellow green, if used with school area or pedestrian or bicycle warning signs.

09 If flashed, all LED units shall flash simultaneously at any steady rate between 50 and 120 times per minute. All the LED units in a sign legend or border shall be illuminated simultaneously with no sequential (chasing) or variable flash (dancing) rates. A cluster of LEDs shall not be used within the border of a sign.

10 The uniformity of the sign design shall be maintained without any decrease in visibility, legibility, or driver comprehension during either daytime or nighttime conditions. The LEDs shall not produce disability glare that obscures the sign legend. The LED units shall have the capability to be dimmed automatically by a timing mechanism or a device sensitive to ambient light (photo-electric cell).
Option:

11 For STOP and YIELD signs and other regulatory signs with a red background, LEDs may be placed within the border or within one border width within the background of the sign.

12 For STOP/SLOW paddles used by flaggers see Section 6E.03 and the STOP paddles used by adult crossing guards see Section 7D.05.

Table 2A-5. Common Uses of Sign Colors

<table>
<thead>
<tr>
<th>Type of Sign</th>
<th>Legend</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changeable Message Signs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulatory</td>
<td>X***</td>
<td>X</td>
</tr>
<tr>
<td>Warning</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Temporary Traffic Control</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Guide</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Motorist Services</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Incident Management</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>School, Pedestrian, Bicycle</td>
<td>X**</td>
<td>X</td>
</tr>
</tbody>
</table>

* Fluorescent versions of these background colors may also be used.
** These alternative background colors would be provided by blue or green lighted pixels such that the entire CMS would be lighted, not just the legend.
*** Red is used only for the circle and slash or other red elements of a similar static regulatory sign.
**** The use of the color purple on signs is restricted per the provisions of Paragraph 1 of Section 2F.03.

Section 2A.12 Symbols

Standard:

01 Symbol designs shall in all cases be unmistakably similar to those shown in this Manual and in the "Standard Highway Signs and Markings" book (see Section 1A.11).

08 A symbol used for a given category of signs (regulatory, warning, or guide) shall not be used for a different category of signs, except as specifically authorized in this Manual.

Section 2A.13 Word Messages

Standard:

01 Except as provided in Section 2A.06, all word messages shall use standard wording and letters as shown in this Manual and in the "Standard Highway Signs and Markings" book (see Section 1A.11).

Section 2A.14 Sign Borders

Standard:

01 Unless otherwise provided, each sign illustrated in this Manual shall have a border of the same color as the legend, at or just inside the edge.

02 The corners of all sign borders shall be rounded, except for STOP signs.
Guidance:
03 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 sign. A border for 30-inch signs with a light background should be from 1/2 to 3/4 inch in width, 1/2 inch from the edge. For similar signs with a light border, a width of 1 inch 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 72 x 120 inches in size, the border should be 2 inches wide, or on larger signs, 3 inches wide. Except for STOP signs and as otherwise provided in Section 2E.16, the corners of the sign should be rounded to a radius that is concentric with that of the border.

04 LEDs used in the border of a sign should be the same color as the background of the sign with some variations permitted as noted in Section 2A.07. The number of LEDs should be sufficient to outline the shape of the sign.

Section 2A.15 Enhanced Conspicuity for Standard Signs

Option:
01 Based upon engineering judgment, where the improvement of the conspicuity of a standard regulatory, warning, or guide sign is desired, any of the following methods may be used, as appropriate, to enhance the sign’s conspicuity (see Figure 2A-1):

J. Adding light emitting diode (LED) units within the symbol, legend or border of a standard regulatory, warning, or guide sign, as provided in Section 2A.07.

Section 2B.01 Application of Regulatory Signs

Standard:
01 Regulatory signs shall be used to inform road users of selected traffic laws or regulations and indicate the applicability of the legal requirements.

02 Regulatory signs shall be installed at or near where the regulations apply. The signs shall clearly indicate the requirements imposed by the regulations and shall be designed and installed to provide adequate visibility and legibility in order to obtain compliance.

03 Regulatory signs shall be retroreflective or illuminated (see Section 2A.07) to show the same shape and similar color by both day and night, unless specifically stated otherwise in the text discussion in this Manual for a particular sign or group of signs.

Section 2B.02 Design of Regulatory Signs

Standard:
01 Regulatory signs shall be rectangular unless specifically designated otherwise.

Regulatory signs shall be designed in accordance with the sizes, shapes, colors, and legends contained in the "Standard Highway Signs and Markings" book (see Section 1A.11).

Guidance:
05 Changeable message LED signs displaying a part-time regulatory message incorporating a prohibitory message that includes a red circle and slash on a static sign should display a red symbol that approximates the same red circle and slash as closely as possible. The prohibited
movement symbol should be a white LED symbol on a black background or a black symbol on a full matrix white LED background.

Option

06 The LEDs in the border of regulatory signs may be static, or flash at rates per Section 2A.07 (09).

Standard:

07 A regulatory sign displayed entirely with LEDs and incorporated within the border of a larger full matrix changeable message sign shall display the regulatory sign legend in the size, shape, color and legend of the standard regulatory sign.

A full matrix LED display shall not be used for a STOP (R1-1) sign or a YIELD (R1-2) sign.

Section 2B.13 Speed Limit Sign (R2-1)

Option:

18 A changeable message LED part-time regulatory variable speed limit sign that changes the speed limit for traffic and ambient conditions may be installed provided that the appropriate speed limit is displayed at the proper times and locations in accordance with paragraph (04) and (05) (Council 1/19/13).

Standard:

19 The variable speed limit sign legend “SPEED LIMIT” shall be a black legend on a white retroreflective background.

Option:

20 The variable speed limit legend may be indicated by white LEDs on a opaque black background

Option:

21 A changeable message driver feedback sign (WX-XX) that displays to approaching drivers the speed at which they are traveling may be installed in conjunction with a Speed Limit sign. to supplement the Speed Limit sign (See Section 2C.XX)

Guidance:

20 If a changeable message sign displaying approach speeds is installed, the legend YOUR SPEED XX MPH or such similar legend should be displayed. The color of the changeable message legend should be a yellow legend on a black background or the reverse of these colors.

Section 2B.18 Movement Prohibition Signs (R3-1 through R3-4, R3-18, and R3-27)
When the movement restriction applies during certain time periods only, the following Movement Prohibition signing alternatives may be used and are listed in order of preference:

A. **Changeable message** A part-time regulatory sign that displays prohibitive movement showing for the hours during which the prohibition is applicable, especially at signalized intersections.

B. Permanently mounted signs incorporating a supplementary legend showing the hours and days during which the prohibition is applicable

C. Portable signs, installed by proper authority, located off the roadway at each corner of the intersection. The portable signs are only to be used during the time that the movement prohibition is applicable.

**Standard:**

The blank-out LED part-time prohibitive movement sign shall consist of a red LED circle and slash with white LED prohibited movement on an opaque black background.

### Section 2B.26 Reversible Lane Control Signs (R3-9e through R3-9i)

**Option:**

A reversible lane may be used for through traffic (with left turns either permitted or prohibited) in alternating directions during different periods of the day, and the lane may be used for exclusive left turns in one or both directions during other periods of the day as well.

Reversible Lane Control (R3-9e through R3-9i) signs (see Figure 2B-6) may be either static type or changeable message type. These signs may be either post-mounted or overhead.

**Standard:**

- Post-mounted Reversible Lane Control signs shall be used only as a supplement to overhead signs or signals. Post-mounted signs shall be identical in design to the overhead signs and an additional legend such as CENTER LANE shall be added to the sign (R3-9f) to indicate which lane is controlled. For both word messages and symbols, this legend shall be at the top of the sign.

- Where it is determined by an engineering study that lane-use control signals or physical barriers are not necessary, the lane shall be controlled by overhead Reversible Lane Control signs (see Figure 2B-7).

**Option:**

Reversing traffic flow may be controlled with pavement markings and Reversible Lane Control signs (without the use of lane control signals), when all of the following conditions are met:

A. Only one lane is being reversed,

B. An engineering study indicates that the use of Reversible Lane Control signs alone would result in an acceptable level of safety and efficiency, and

C. There are no unusual or complex operations in the reversible lane pattern.

**Standard:**

Reversible Lane Control signs shall contain the legend or symbols designating the allowable uses of the lane and the time periods such uses are allowed. Where symbols and legends are used, their meanings shall be as shown in Table 2B-2.
06 Reversible Lane Control signs shall consist of a white background with a black legend and border, except for the R3-9d (9e) sign, where the color red is used.

07 Symbol signs, such as the R3-9d(9e) sign, shall consist of the appropriate symbol in the upper portion of the sign with the appropriate times of the day and days of the week below it. All times of the day and days of the week shall be accounted for on the sign to eliminate confusion to the road user.

08 In situations where more than one message is conveyed to the road user, such as on the R3-9d (9e) sign, the sign legend shall be arranged as follows:

A. The prohibition or restriction message is the primary legend and shall be on the top for word message signs and to the far left for symbol signs,

B. The permissive use message shall be displayed as the second legend, and

C. The OTHER TIMES message shall be displayed at the bottom for word message signs and to the far right for symbol signs.

Option:

09 The symbol signs may also include a downward pointing arrow with the legend THIS LANE. The term OTHER TIMES may be used for either the symbol or word message sign.

Standard:

14 Flashing beacons, if used to supplement the overhead Reversible Lane Control signs, shall comply with the applicable requirements for flashing beacons in Chapter 4L.

Section 2B.37 DO NOT ENTER Sign (R5-1)

Standard:

01 The DO NOT ENTER (R5-1) sign (see Figure 2B-11) shall be used where traffic is prohibited from entering a restricted roadway.

Guidance:

02 The DO NOT ENTER sign, if used, should be placed directly in view of a road user at the point where a road user could wrongly enter a divided highway, one-way roadway, or ramp (see Figure 2B-12). The sign should be mounted on the right-hand side of the roadway, facing traffic that might enter the roadway or ramp in the wrong direction.

03 If the DO NOT ENTER sign would be visible to traffic to which it does not apply, the sign should be turned away from, or shielded from, the view of that traffic.

Option:

04 The DO NOT ENTER sign may be installed where it is necessary to emphasize the one-way traffic movement on a ramp or turning lane.

05 A second DO NOT ENTER sign on the left-hand side of the roadway may be used, particularly where traffic approaches from an intersecting roadway (see Figure 2B-12).

Red LEDs may be installed within the border of the DO NOT ENTER sign to enhance the conspicuity of the sign. The LEDs may be vehicle actuated to flash at the rates as shown in Section 2A.07(09).
Support:

Section 2B.41 contains information regarding an optional lower mounting height for DO NOT ENTER signs that are located along an exit ramp facing a road user who is traveling in the wrong direction.

Section 2B.38 WRONG WAY Sign (R5-1a)

Option:

01 The WRONG WAY (R5-1a) sign (see Figure 2B-11) may be used as a supplement to the DO NOT ENTER sign where an exit ramp intersects a crossroad or a crossroad intersects a one-way roadway in a manner that does not physically discourage or prevent wrong-way entry (see Figure 2B-12).

Guidance:

02 If used, the WRONG WAY sign should be placed at a location along the exit ramp or the one-way roadway farther from the crossroad than the DO NOT ENTER sign (see Section 2B.41).

Support:

Section 2B.41 contains information regarding an optional lower mounting height for WRONG WAY signs that are located along an exit ramp facing a road user who is traveling in the wrong direction.

Option:

Red LEDs may be installed within the border of the WRONG WAY sign to enhance the conspicuity of the sign. The LEDs may be vehicle actuated to flash at the rates as shown in Section 2A.07(09).

Section 2B.54 No Turn on Red Signs (R10-11 Series, R10-17a, and R10-30)

Standard:

01 Where a right turn on red (or a left turn on red from a one-way street to a one-way street) is to be prohibited, a symbolic NO TURN ON RED (symbolic circular red) (R10-11) sign (see Figure 2B-27) or a NO TURN ON RED (R10-11a, R10-11b) word message sign (see Figure 2B-27) shall be used.

Guidance:

02 If used, the No Turn on Red sign should be installed near the appropriate signal head.

03 A No Turn on Red sign should be considered when an engineering study finds 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;
E. More than three right-turn-on-red accidents reported in a 12-month period for the particular approach; or
F. The skew angle of the intersecting roadways creates difficulty for drivers to see traffic approaching from their left.

Option:

04 A supplemental R10-20aP plaque (see Figure 2B-27) showing times of day (similar to the S4-1P 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.

05 Alternatively, a supplemental R10-20aP plaque (see Figure 2B-27) showing times of day (similar to the S4-1P 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.

White LEDs may be used in the border and activated during periods of turn prohibition to enhance the sign conspicuity.

06 On signalized approaches with more than one right-turn lane, a NO TURN ON RED EXCEPT FROM RIGHT LANE (R10-11c) sign (see Figure 2B-27) may be post-mounted at the intersection or a NO TURN ON RED FROM THIS LANE (with down arrow) (R10-11d) sign (see Figure 2B-27) may be mounted directly above the approximate (Council 1/11/13) center of the lane from which turns on red are prohibited.

Guidance:

07 Where turns on red are permitted and the signal indication is a steady RED ARROW, the RIGHT (LEFT) ON RED ARROW AFTER STOP (R10-17a) sign (see Figure 2B-27) should be installed adjacent to the RED ARROW signal indication.

Option:

08 A RIGHT TURN ON RED MUST YIELD TO U-TURN (R10-30) sign (see Figure 2B-27) may be installed to remind road users that they must yield to conflicting u-turn traffic on the street or highway onto which they are turning right on a red signal after stopping.

Section 2C.03 Design of Warning Signs

Standard:

01 Except as provided in Paragraph 2 or unless specifically designated otherwise, all warning signs shall be diamond-shaped (square with one diagonal vertical) with a black legend and border on a yellow background. Warning signs shall be designed in accordance with the sizes, shapes, colors, and legends contained in the "Standard Highway Signs and Markings" book (see Section 1A.11).

Option:

02 A warning sign that is larger than the size shown in the Oversized column in Table 2C-2 for that particular sign may be diamond-shaped or may be rectangular or square in shape.

04 Word message warning signs other than those provided in this Manual may be developed and installed by State and local highway agencies.
Warning signs regarding conditions associated with pedestrians, bicyclists, and playgrounds may have a black legend and border on a yellow or fluorescent yellow-green background.

Warning signs may be enhanced with static or flashing LEDs at acceptable rates (See Section 2A.07) in the sign border matching the background color of the sign.

Section 2C.08 Advisory Speed Plaque (W13-1P)

Option:

The Advisory Speed (W13-1P) plaque (see Figure 2C-1) may be used to supplement any warning sign to indicate the advisory speed for a condition.

Standard:

The use of the Advisory Speed plaque for horizontal curves shall be in accordance with the information shown in Table 2C-5. The Advisory Speed plaque shall also be used where an engineering study indicates a need to advise road users of the advisory speed for other roadway conditions.

If used, the Advisory Speed plaque shall carry the message XX MPH. The speed displayed shall be a multiple of 5 mph.

Except in emergencies or when the condition is temporary, an Advisory Speed plaque shall not be installed until the advisory speed has been determined by an engineering study.

The Advisory Speed plaque shall only be used to supplement a warning sign and shall not be installed as a separate sign installation.

The advisory speed shall be determined by an engineering study that follows established engineering practices.

Section 2C.xx Driver Feedback Sign (WX-XX):

Option:

A supplemental driver feedback LED sign indicating YOUR SPEED XX MPH (WX-XX) sign may be used near the point of curvature of a horizontal curve to supplement the standard alignment warning sign or used downstream of a posted speed limit sign. The vehicle speed display may be static or flash at acceptable rates (See Section 2A.07).

Standard:

The legend, YOUR SPEED, on a YOUR SPEED XX MPH (WX-XX) sign shall be a black legend with a font size in conformance with the appropriate facility type on a yellow retroreflective background. The LED legend displaying the speed value shall be a
yellow illuminated legend with not less than 20 mm pitch LEDs covering the stroke width of a 10 inch series numeral on an opaque black background.

Option:

A driver feedback LED sign that displays the legend “SLOW TO XX MPH” may be used to activate the sign speed legend when the approaching vehicle speed exceeds the posted speed.

Section 2C.09 Chevron Alignment Sign (W1-8)

Standard:

01 The use of the Chevron Alignment (W1-8) sign (see Figures 2C-1 and 2C-2) to provide additional emphasis and guidance for a change in horizontal alignment shall be in accordance with the information shown in Table 2C-5.

Option:

02 When used, (Council 1/19/12) Chevron Alignment signs may be used instead of or in addition to standard delineators.

Standard:

03 The Chevron Alignment sign shall be a vertical rectangle. No border shall be used on the Chevron Alignment sign.

06 If used, Chevron Alignment signs should be visible for a sufficient distance to provide the road user with adequate time to react to the change in alignment.

Option:

07 LEDs may be used to enhance chevron signs and if vehicle activated the LEDs may be flashed concurrently but not sequentially within the sign panel.

Standard:

08 The LEDs used in the chevron alignment sign shall consist of yellow LEDs outlining the chevron symbol.

Section 2C.13 Truck Rollover Warning Sign (W1-13)

Option:

01 A Truck Rollover Warning (W1-13) sign (see Figure 2C-1) may be used to warn drivers of vehicles with a high center of gravity, such as trucks, tankers, and recreational vehicles, of a curve or turn where geometric conditions might contribute to a loss of control and a rollover as determined by an engineering study.

Standard:

03 If a Truck Rollover Warning (W1-13) sign is used, it shall be accompanied by an Advisory Speed (W13-1P) plaque indicating the recommended speed for vehicles with a higher center of gravity.
Option:
04 The Truck Rollover Warning sign may be displayed as a static sign, as a static sign supplemented by a flashing warning beacon, or as a driver feedback changeable message LED sign activated by the detection of an approaching vehicle with a high center of gravity that is traveling in excess of the recommended speed for the condition. The driver feedback -LED sign may be yellow LEDs in the warning sign border or a flashing advisory speed legend in the advisory speed plaque.

Guidance:
05 The driver feedback LED sign should be a yellow LED legend on a black opaque background displaying the vehicle speed approaching the change in horizontal alignment. The detected speed should have a steady or flashing message displaying the vehicle speed approaching the change in horizontal alignment.

Section 2C.36 Advance Traffic Control Signs (W3-1, W3-2, W3-3, W3-4)

Standard:
01 The Advance Traffic Control symbol signs (see Figure 2C-6) include the Stop Ahead (W3-1), Yield Ahead (W3-2), and Signal Ahead (W3-3) signs. These signs shall be installed on an approach to a primary traffic control device that is not visible for a sufficient distance to permit the road user to respond to the device (see Table 2C-4). The visibility criteria for a traffic control signal shall be based on having a continuous view of at least two signal faces for the distance specified in Table 4D-2.

Option:
05 An Advance Traffic Control sign may be used for additional emphasis of the primary traffic control device, even when the visibility distance to the device is satisfactory.

06 An advance street name plaque (see Section 2C.58) may be installed above or below an Advance Traffic Control sign.

07 A warning beacon or yellow LEDs within the border of the sign may be used with an Advance Traffic Control sign.

08 A BE PREPARED TO STOP (W3-4) sign (see Figure 2C-6) may be used to warn of stopped traffic caused by a traffic control signal or in advance of a section of roadway that regularly experiences traffic congestion.

Standard:
09 When a BE PREPARED TO STOP sign is used in advance of a traffic control signal, it shall be used in addition to a Signal Ahead sign and shall be placed downstream from the Signal Ahead (W3-3) sign.

Option:
10 The BE PREPARED TO STOP sign may be supplemented with a warning beacon (see Section 4L.03) or yellow LEDs within the border of the sign.

Guidance:
11 When the warning beacon or sign border LEDs are interconnected with a traffic control signal
or queue detection system, the "BE PREPARED TO STOP" sign should be supplemented with a WHEN FLASHING (W16-13P) plaque (see Figure 2C-12).

Section 2G.03 Regulatory Signs for Preferential Lanes – General

Standard:
01 When a preferential lane is established, the Preferential Lane regulatory signs (see Figure 2G-1) and pavement markings (see Chapter 3D) for these lanes shall be used to advise road users.

Option:
05 Changeable message signs may supplement, substitute for, or be incorporated into static Preferential Lane regulatory signs where travel conditions change or where multiple types of operational strategies (such as variable occupancy requirements or vehicle types) are used and varied throughout the day or week, or on a real-time basis, to manage the use of, control of, or access to preferential lanes.

Support:
06 Figure 2G-1 illustrates examples of changeable messages incorporated into static Preferential Lane regulatory signs. The LED sign legends are normally the variable text such as the open and closed lane legends.

Standard:
07 When changeable message signs (see Chapter 2L) are used as regulatory signs for preferential lanes, they shall be the required sign size and shall display the required letter height and legend format that corresponds to the type of roadway facility and design speed.

Standard:
23 The provisions of Sections 2G.03 through 2G.07 regarding regulatory signs for Preferential lanes shall apply to managed lanes operated at all times or at certain times by varying vehicle occupancy requirements (HOV) or by using vehicle type restrictions as a congestion management strategy. Such managed lanes shall use changeable message signs or changeable message elements within static signs to display the appropriate regulatory sign messages only when they are in effect.

Section 2G.10 Preferential Lane Guide Signs – General

22 Changeable message signs may supplement, substitute for, or be incorporated into static guide signs (See Figure 2G-6) where travel conditions change or where multiple types of operational strategies (such as variable occupancy requirements, vehicle types, or pricing policies) are used and varied throughout the day or week to manage the use of, control of, or access to preferential lanes.

Standard:
23 When changeable message signs (see Chapter 2L) are used as guide signs for preferential lanes, they shall be the required sign size and shall display the required letter height and legend format that corresponds to the type of roadway facility and design speed.

Section 2G.17 Regulatory Signs for Priced Managed Lanes
Standard:
01 Except as otherwise provided in this Section, the provisions of Sections 2G.03 through 2G.07 regarding regulatory signs for Preferential lanes shall apply to priced managed lanes operated at all times or at certain times with a toll payment requirement of some or all vehicles to use the lane(s). Such managed lanes shall use changeable message signs or changeable message elements within static signs to display the appropriate regulatory sign messages only when they are in effect.

02 Regulatory signs for preferential lanes shall be appropriately modified for adaptation to a priced managed lane, where applicable, as shown in Figure 2G-17.

03 Regulatory signs shall be used to indicate the toll charged. If the toll varies, regulatory signs that include changeable message elements, such as the R3-48 and R3-48a signs that are shown in Figure 2G-17, shall be used to display the actual toll amount in effect at any given time.

Section 2G.18 Guide Signs for Priced Managed Lanes

Option:
06 Changeable message signs may also be used on non-managed highways to display comparative travel times or congestion levels for a nearby managed highway.

Section 2H.03 Traffic Signal Speed Sign (I1-1)

Option:
01 The Traffic Signal Speed (I1-1) sign (see Figure 2H-1), reading SIGNALS SET FOR 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.

02 If different system progression speeds are set for different times of the day, a changeable message element may be used for the numerals of the Traffic Signal Speed (I1-1) sign. If the system is operated in coordinated mode only during certain times, a blank-out version of the Traffic Signal Speed (I1-1) sign may be used to display the message only during those times.

Standard:
04 The Traffic Signal Speed sign shall be a minimum of 24 x 36 inches with the longer dimension vertical. It shall have a white message and border on a green background.

Guidance:

The LED message panel on a green Traffic Signal Speed sign shall be a white LED legend on a black opaque background

Section 2L.01 Description of Changeable Message Signs

Support:
01 A changeable message sign (CMS) is a traffic control device that is capable of displaying one or more alternative messages. Some changeable message signs have a blank mode when no message is displayed, while others display multiple messages with only one of the messages displayed at a time (such as OPEN/CLOSED signs at weigh stations).
02 The provisions in this Chapter apply to both permanent and portable changeable message
signs with electronic displays. Additional provisions that only apply to portable changeable
message signs can be found in Section 6F.60. The provisions in this Chapter do not apply to
changeable message signs with non-electronic displays that are changed either manually or
electromechanically, such as a hinged-panel, rotating-drum, or back-lit curtain or scroll CMS.

Standard:
03 Except as provided in Paragraph 2 of Section 2L.02, changeable message signs shall
display only traffic operational, regulatory, warning, and guidance information.
Advertising messages shall not be displayed on changeable message signs or its
supports or other equipment.

Guidance:
05 Blank-out signs that display only single-phase, predetermined electronic-display legends that
are limited by their composition and arrangement of pixels or other illuminated forms in a fixed
arrangement (such as a blank-out sign indicating a part-time turn prohibition, a blank-out or
changeable lane-use sign, or a changeable OPEN/CLOSED sign for a weigh station) should
comply with the provisions of the applicable Section for the specific type of sign, provided that
the letter forms, symbols, and other legend elements are duplicates of the static messages as
detailed in the "Standard Highway Signs and Markings" book (see Section 1A.11). Because such
a sign is effectively an illuminated version of a static sign, the size of its legend elements, the
overall size of the sign, and placement of the sign should comply with the applicable provisions
for the static version of the sign.

Section 2L.02 Applications of Changeable Message Signs
01 Changeable message signs have a large number of applications including, but not limited to,
the following:

A. Incident management and route diversion
B. Warning of adverse weather conditions
C. Special event applications associated with traffic control or conditions
D. Control at crossing situations
E. Lane, ramp, and roadway control
F. Priced or other types of managed lanes
G. Travel times
H. Warning situations
I. Traffic regulations
J. Speed control
K. Destination guidance
Section 2B.13 contains information regarding the design of changeable message signs that are used to display variable speed limits that change based on ambient or operational conditions, or that display the speed at which approaching drivers are traveling.

Section 2L.03 Legibility and Visibility of Changeable Message Signs

Support:
- The maximum distance at which a driver can first correctly identify letters and words on a sign is called the legibility distance of the sign. Legibility distance is affected by the characteristics of the sign design and the visual capabilities of drivers. Visual capabilities, and thus legibility distances, vary among drivers.
- For the more common types of changeable message signs, the longest measured legibility distances on sunny days occur during mid-day when the sun is overhead. Legibility distances are much shorter when the sun is behind the sign face, when the sun is on the horizon and shining on the sign face, or at night.
- Visibility is the characteristic that enables a CMS to be seen. Visibility is associated with the point where the CMS is first detected, whereas legibility is the point where the message on the CMS can be read. Environmental conditions such as rain, fog, and snow impact the visibility of changeable message signs and can reduce the available legibility distances. During these conditions, there might not be enough viewing time for drivers to read the message.

Guidance:
- Changeable message signs used on roadways with speed limits of 55 mph or higher should be visible from 1/2 mile under both day and night conditions. The message should be designed to be legible from a minimum distance of 600 feet for nighttime conditions and 800 feet for normal daylight conditions. When environmental conditions that reduce visibility and legibility are present, or when the legibility distances stated in the previous sentences in this paragraph cannot be practically achieved, messages composed of fewer units of information should be used and consideration should be given to limiting the message to a single phase (see Section 2L.05 for information regarding the lengths of messages displayed on changeable message signs).

Guidance:
- The changeable message regulatory and warning signs used individually or as part of the legend for a larger Changeable Message sign should meet the standard size and legend requirements for those specific signs in Parts 2B and 2C.

Section 2L.04 Design Characteristics of Changeable Message Signs

Standard:
- Changeable message signs shall not include advertising, animation, rapid flashing, dissolving, exploding, scrolling, or other dynamic elements.

Support:
- Section 6F.61 contains information regarding the use of arrow boards that use flashing or sequential displays for lane closures.

Guidance:
- Except in the case of a limited-legend sign (such as a blank-out or a part-time regulatory sign) that is used in place of a static regulatory sign or an activated blank-out warning sign that supplements a static warning sign at a separate location, the signs should be used as a
supplement to and not as a substitute for conventional signs and markings except as noted herein.

Support:

09 The width-to-height ratio is commonly accomplished using a minimum font matrix density of five pixels wide by seven pixels high.

Standard:

10 Changeable message signs shall automatically adjust their brightness under varying light conditions to maintain legibility.

Standard:

14 The colors used for the legends and backgrounds on changeable message signs shall be as provided in Table 2A-5.

Guidance:

15 If a black background is used, the color used for the legend on a changeable message sign should match the background color that would be used on a standard sign for that type of legend, such as white or red for regulatory, yellow for warning, orange for temporary traffic control, red for stop or yield, fluorescent pink for incident management, and fluorescent yellow-green or yellow for bicycle, pedestrian, and school warning.

Standard:

16 If a green background is used for a guide message on a CMS or if a blue background is used for a motorist services message on a CMS, the background color shall be provided by green or blue lighted pixels such that the entire CMS would be lighted, not just the white legend.

Support:

17 Some CMS that employ newer technologies have the capability to display an exact duplicate of a standard sign or other sign legend using standard symbols, the Standard Alphabets and letter forms, route shields, and other typical sign legend elements with no apparent loss of resolution or recognition to the road user when compared with a static version of the same sign legend. Such signs are of the full-matrix type and can typically display full-color legends. Use of such technologies for new CMS is encouraged for greater legibility of their displays and enhanced recognition of the message as it pertains to regulatory, warning, or guidance information.

Guidance:

18 If used, the CMS described in the preceding paragraph should not display symbols or route shields unless they can do so in the appropriate color combinations. For a single-phase message where the Standard Alphabets and other legend elements of standard designs are used, the lettering style, size, and line spacing should comply with the applicable provisions for the type of message displayed as provided elsewhere in this Manual. For two-phase messages, larger legend heights should be used as described previously in this Section because of the need for such messages to be legible at a greater distance. Regardless of the number of phases, the CMS should comply with the legibility and visibility provisions of Section 2L.03.

Section 7B.15 School Speed Limit Assembly (S4-1P, S4-2P, S4-3P, S4-4P, S4-6P, S5-1) and END SCHOOL SPEED LIMIT Sign (S5-3)
The School Speed Limit assembly shall be either a fixed-message sign assembly or a changeable-message part-time regulatory LED sign.

The fixed-message School Speed Limit assembly shall consist of a top plaque (S4-3P) with the legend SCHOOL, a Speed Limit (R2-1) sign, and a bottom plaque (S4-1P, S4-2P, S4-4P, or S4-6P) 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:
The part-time regulatory Changeable message LED signs (see Chapter 2L and Section 6F.60) may be used to inform drivers of the school speed limit. The sign is internally illuminated or an LED speed legend with a white legend on a black opaque background. The part-time regulatory speed Changeable message LED signs with flashing beacons may be used for situations to enhance 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 part-time regulatory changeable message LED signs conform in all respects to the standards in this Manual for fixed-message signs, during the periods that the school speed limit is in effect, their basic shape, message, legend layout, and colors should comply with the standards for fixed-message signs.

A confirmation light, flasher or device to indicate that the speed limit message is in operation should be considered for inclusion on the back of the part-time regulatory changeable message LED sign.

Standard:
Fluorescent yellow-green or yellow LEDs shall be used when the "SCHOOL" message is displayed on a part-time regulatory changeable-message LED sign for a school speed limit.

Option:
The part-time regulatory Changeable message LED signs may rest in the dark mode use blank-out messages or other methods in order to display the school speed limit only during the periods of time where the school speed limit does not apply, it applies.

Driver feedback Changeable message LED signs that display the speed of approaching drivers (see Section 2B.132C.08) may be used to supplement in a school speed limit zone.

A Speed Limit Sign Beacon (see Section 4L.04) also may be used, with a WHEN FLASHING legend, to identify the periods that the school speed limit is in effect.

Section 8B.08 Turn Restrictions During Preemption

Guidance:
At a signalized intersection that is located within 200 feet 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 should be prohibited during the signal preemption sequences.
Option:
02 A blank-out turn prohibition or changeable message LED 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-1 may be used for this purpose.

Support:
03 LRT operations can include the use of activated blank-out sign technology for turn prohibition signs. The signs are typically used on roads paralleling a semi-exclusive or mixed-use LRT alignment where road users might turn across the LRT tracks. A blank-out sign displays its message only when activated. When not activated, the sign face is blank.

Guidance:
04 An LRT-activated blank-out turn prohibition (R3-1a or R3-2a) sign should be used where an intersection adjacent to a highway-LRT crossing is controlled by STOP signs, or is controlled by traffic control signals with permissive turn movements for road users crossing the tracks.

Option:
05 An LRT-activated blank-out turn prohibition (R3-1a or R3-2a) sign may be used for turning movements that cross the tracks.

06 As an alternative to LRT-activated blank-out turn prohibition signs at intersections with traffic control signals, exclusive traffic control signal phases such that all movements that cross the tracks have a steady red indication may be used in combination with No Turn on Red (R10-11, R10-11a, or R10-11b) signs (see Section 2B.53).

Standard:
07 Turn prohibition signs that are associated with preemption shall be visible or activated only when the grade crossing restriction is in effect.

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RWSTC Vote following sponsor comments 6-26-14 For: 22 Opposed: 3 Abstentions: 1

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