Traffic Signs and Pavement Markings

- Delineating curves with chevrons or arrows can make them safer.
- Place signs where they can be seen, not behind bridges or trees.
- Left-side stop signs are one way to emphasize stop control.
- Double arrow signs are effective at T intersections.
- Dead End signs are required on dead-end roads.
- Stop Ahead signs are required if the Stop sign can't be seen from the distance shown in Table ___.

NEW YORK STATE OF OPPORTUNITY
Department of Transportation | Local Technical Assistance Program

Cornell Local Roads Program
New York State LTAP Center
Traffic Signs
and Pavement Markings

by

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Course instructors

CLRP No. 08-03
Preface

Traffic signs and pavement markings are the primary communication devices placed by a highway agency to inform the traveling public of laws and regulations, traffic and roadway conditions, and destinations and other guiding information. This workbook was prepared as part of a NYS LTAP Center - Cornell Local Roads Program (NYSLTAP - CLRP) workshop of the same name.

The original layout and draft for the class was developed by Jim Mearkle when he worked for Cornell as a Traffic Safety Technical Assistance Engineer. Additional thanks for help with the workbook and class go to Dave Woodin and Barbara Abrahamer with the New York State Department of Transportation. As the two primary overseers of the change over to the National MUTCD with a New York State Supplement, their input was very important.

Our workshops and manuals are developed with the help of advisory committees. We generally try to get feedback and input from different levels of government, private industry, and other experts in the field. The committee for this updated version of the workshop includes the following folks. Thank you.

Jim Mearkle, Traffic Engineer, Albany County DPW
Guy James, Deputy Superintendent of Public Works, Allegany County
Jim Dean, Superintendent of Highways, Town of Orangetown
Walter Geidel, Superintendent of Highways, Town of Walton
Greg Feeney, Signs Foreman, Town of Greece
Eugene Hayes, Superintendent of Public Works, City of Watertown
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Sgt. Daniel Correll, Binghamton Police Department
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Support for the training activities of the NYS LTAP Center - Cornell Local Roads Program is provided by the New York State Department of Transportation, the Federal Highway Administration, Cornell University, and by local officials through their workshop registration fees. Responsibility for content and accuracy of this manual is solely that of the NYS LTAP Center - Cornell Local Roads Program.

NYS LTAP Center - Cornell Local Roads Program

March 2008
# Table of Contents

1 - Sign and Marking Fundamentals ........................................................................................................ 1
   Introduction ................................................................................................................................. 1
   The Five Principles of Signing ................................................................................................. 4
   Readability and Retroreflectivity ............................................................................................ 7
   Sign Type and Designation ....................................................................................................... 9
   Sign Priority/Primacy .............................................................................................................. 16
   Meeting Road User Needs ...................................................................................................... 17

2 - Program Administration .............................................................................................................. 19
   Authority ................................................................................................................................ 19
   Intermunicipal Matters ............................................................................................................ 19
   Intermunicipal Agreements ..................................................................................................... 20
   Liability ................................................................................................................................... 20
   Documentation ........................................................................................................................ 21
   Complaints .............................................................................................................................. 22

3 - Sign Studies ............................................................................................................................. 23

4 - Sign Layout and Placement ....................................................................................................... 27
   Sign Layout ............................................................................................................................. 27
   Adjusting Locations ................................................................................................................ 33
   Signing at Intersections ........................................................................................................... 35
   Signing at Curves .................................................................................................................... 38

5 - Sign Materials .......................................................................................................................... 43
   Sign Sheeting .......................................................................................................................... 43
   Signposts ................................................................................................................................ 44
   Signpost Bases ......................................................................................................................... 45
   Sign Panels .............................................................................................................................. 47
   Nuts, Bolts, and Washers ........................................................................................................ 47
   Installing Signs ......................................................................................................................... 48

6 - Sign Management .................................................................................................................... 49
   Inventory ................................................................................................................................. 49
   Evaluation ............................................................................................................................... 50
   Maintenance (Repair or replacement) ...................................................................................... 52
Traffic Signs and Pavement Markings

7 - Pavement Markings ................................................................. 55
   Standards ................................................................................. 55
   Functions ................................................................................ 56
   Materials .................................................................................. 56
   Typical Markings ..................................................................... 57
   Special (Transverse) Markings .................................................... 60
   Maintenance Issues ................................................................. 61

Appendix A - Print References .................................................... 63

Appendix B - Video Resources ...................................................... 64

Appendix C - Glossary ................................................................. 65

Appendix D - Blank Forms ......................................................... 68

Appendix E - Example Section from National MUTCD .................. 71

Appendix F - Example from Standard Highway Signs .................. 72

Appendix G - Retroreflective Sheeting I.D. Guide ......................... 73

Appendix H - Traffic Sign Retroreflectivity Standards .................. 75
   Managing Sign Retroreflectivity ............................................... 75
   Minimum Retroreflectivity Levels .............................................. 76
   References ............................................................................... 77
   Bold Symbol Signs ................................................................. 78

Appendix I - Breakaway Sign Supports ........................................ 79
   Breakaway Supports - General ............................................... 79

Appendix J - How to Use a Ball Bank Indicator ......................... 80

Appendix J - Intersection Ahead Sign Exercise ........................... 82

Appendix J - Yield Ahead & Curve Warning Sign Posting Location Exercise .................. 83

Appendix J - Retroreflectivity demo ............................................ 85

Appendix J - Stop-Yield Decision Class Exercise ........................ 86

ii  NYS LTAP Center - Cornell Local Roads Program
List of Figures

Figure 1 - Oversized, doubled signs ................................................................. 5
Figure 2 - Children At Play sign ................................................................. 5
Figure 3 - Vandalized sign ................................................................. 6
Figure 4 - 'Limited Sight Distance' vs. 'Hill Blocks View' ................. 6
Figure 5 - Inadequate response time ............................................................... 7
Figure 6 - Stop Ahead signs ........................................................................ 8
Figure 7 - Types of reflectivity ................................................................. 8
Figure 8 - Sensitivity to light vs age ............................................................... 8
Figure 9 - Regulatory signs ........................................................................ 12
Figure 10 - Warning signs ........................................................................ 13
Figure 11 - Guide and information signs ....................................................... 15
Figure 12 - Sign location is specified in three dimensions ......... 27
Figure 13 - Examples of acceptable sign groupings ................................ 29
Figure 14 - Lateral spacing of signs .............................................................. 31
Figure 15 - Sign height ........................................................................ 32
Figure 16 - Installing signs at an angle ....................................................... 33
Figure 17 - Before installing signs, visualize what they will look like .... 34
Figure 18 - Intersection regulatory signs ..................................................... 35
Figure 19 - Intersection warning signs ....................................................... 35
Figure 20 - Combination horizontal alignment/intersection sign .......... 36
Figure 21 - Guide signs ........................................................................ 36
Figure 22 - Curve and turn warning signs .................................................. 38
Figure 23 - Curve delineation signs (arrows and chevrons) .......... 40
Figure 24 - Sample of sign layout .............................................................. 42
Figure 25 - Two types of reflector beads ..................................................... 43
Figure 26 - Stiffener bars ........................................................................ 45
Figure 27 - Breakaway ground-level splice base after a crash .......... 46
Figure 28 - Sticker used to discourage vandalism ...................................... 47
Figure 29 - Day and night inspections of the same sign ................. 51
Figure 30 - Inspection panels clipped to two different stop signs ...... 52
Figure 31 - Tape marking ........................................................................ 56
Figure 32 - Thermoplastic marking ............................................................. 56
Figure 33 - Two-lane, two-way marking applications .................... 58
Figure 34 - Limits of no-passing zones at curves ...................................... 59
List of Tables

Table 1 - Sign categories and use

Table 2 - Sign types and colors

Table 3 - Sign shapes, colors and types

Table 4 - Reaction times

Table 5 - Warning sign colors

Table 6 - Guidelines for advance placement of warning signs

Table 7 - Minimum visibility distance in feet for intersection control devices

Table 8 - Sight distance in feet to a vehicle waiting at the intersecting road

Table 9 - Horizontal alignment sign usage

Table 10 - Chevron spacing

Table 11 - Minimum passing sight distances

Table 12 - Retroreflectivity management methods

Table 13 - Minimum maintained retroreflectivity levels

Table 14 - Ball bank safe speed indications
INTRODUCTION
Signs and markings are communication devices. They communicate rules and regulations, warn road users about hazards, and inform people how to get to their destination. These important communication tools, when used properly, provide roadway users with critical information to help them safely navigate the highway system. Understanding this is the key to using signs and markings effectively.

Informing road users what they need to know, and when they need to know it, can make roads and intersections safer and more efficient. By helping to prevent collisions, good sign management and maintenance reduce your liability risk. On the other hand, poor sign management and maintenance can contribute to incidents, thus increasing liability exposure.

Proper signing is a very cost-effective way to improve safety. A California county repaired poor signs and added new signs where they would help improve safety. At a cost of less than $30 per mile per year, crashes on the county’s main roads dropped by 42 percent over six years. Improved sign use prevented $160 to $250 worth of incidents for every dollar they spent on the sign improvements.

Even so, traffic signs cannot cure all traffic problems. Some problems, like speeding, cannot be solved by signs alone. A driver uses other information, including visual and non-visual clues, in addition to the speed limit signs, to decide how fast to go. This information includes the character and conditions of the road, traffic conditions, legal enforcement, and even the noise level inside the vehicle. Lowering the posted speed limit typically has only a slight effect on traffic speeds.

It is often said that signs are meant for someone who is not familiar with the road. That is not entirely true. It is vitally important to inform all road users about changes, such as the type of traffic control at an intersection, a curve or rail crossing. We cannot rely on drivers to get the necessary information from television, newspapers or the internet. Signs have to be used. Also, drivers rely on signs as reminders of important information, so they do not have to memorize everything. Could we expect every road user to memorize whether Smith Street is the fourth or fifth left?

National Manual on Traffic Control Devices
Drivers who see a particular sign should expect it to mean the same thing and be prepared to take the same action whether they are on a town road in New York State or on an expressway in Missouri. Nationwide consistency is the goal of uniform traffic control devices. The intent of the National Manual on Uniform Traffic Control Devices (National MUTCD) is to enhance road safety and operation by requiring uniform, understandable, and effective traffic control devices on all facilities open to public travel.

Traffic control devices installed on such facilities within New York State are required to conform to the National MUTCD, published by the Federal Highway Administration (FHWA).

New York State Vehicle and Traffic Law, §1680(a), requires that “the Department of Transportation shall adopt a manual and specifications for a uniform system of traffic control
Traffic Signs and Pavement Markings

devices consistent with the provisions of this chapter for use upon highways within this state. Such uniform system shall correlate with and so far as practicable conform to nationally accepted standards.”

Effective September 13, 2007, the provisions of the National MUTCD were formally adopted by the State of New York. These regulations provide for a New York State Supplement to the National MUTCD to also become effective on that date. It is published as *Volume 17B of the Official Compilation of Codes, Rules, and Regulations of the State of New York (NYCRR)*. Combined, the two will comprise the “manual and specifications for a uniform system of traffic control devices” required by Section 1680(a).

The National MUTCD is available online in electronic format. Printed copies of the MUTCD and cost information are available from the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE) and the American Traffic Safety Services Association (ATSSA). See Appendix A on page 63 for specific information about obtaining a copy of the National MUTCD.

**New York State Supplement**

Deviations to the National MUTCD are published in the *New York State Supplement* to the National MUTCD, and are justified in cases where:

- New York State law deviates from the National MUTCD.
- More restrictive guidance is desired.
- Traffic control devices unique to New York need to be included.
- Certain devices allowed in the National MUTCD are not allowed in New York State.

These deviations are adopted through the State Administrative Procedures Act (SAPA) process and by permission of the FHWA. Citing the MUTCD alone refers to both the National MUTCD and the New York State Supplement.

The New York State Supplement is published by West Group (800 328-4880), under the title *Transportation Title 17B (NYCRR)*. The National MUTCD, the New York State Supplement (NYCRR 17B), and other New York State Department of Transportation (NYSDOT) traffic control documents are available online at: [www.nysdot.gov/portal/page/portal/divisions/operating/oom/transportation-systems/traffic-operations-section/mutcd](http://www.nysdot.gov/portal/page/portal/divisions/operating/oom/transportation-systems/traffic-operations-section/mutcd).

MUTCD users will need to follow a two step process in order to ascertain the proper design, application, and location of a traffic control device:

1. The user should refer to the National MUTCD for information regarding a particular device.
2. The user should consult the New York State Supplement to determine if alternate or additional guidance is provided for the traffic control device in question.

The State Supplement conforms to the organization and section numbering of the National MUTCD.

The publication *Traffic Sign Handbook for Local Roads*, available from the NYSLTAP Center - Cornell Local Roads Program, covers the basics for many of the signs placed on the local highway system.
The information in the Handbook is based upon both the National MUTCD and the NYS Supplement. This workbook and the Traffic Sign Handbook are primarily teaching tools and are not a regulation or standard. The MUTCD should be consulted for the actual requirements for placing traffic signs and pavement markings.

There are some things you need to know about the MUTCD:

• It is illegal to sell, buy, fabricate or install signs or other traffic control devices that do not comply with the MUTCD.

• Some minor changes to signs are allowed, to meet specific needs, if the basic meaning is unchanged and the sign is still easily understood. Unless the change is mentioned in the MUTCD, it is better to assume the change is not allowed without prior approval. Major changes should be approved by the New York State Department of Transportation (NYSDOT).

• Traffic control devices installed or replaced after September 13, 2007 must conform to the MUTCD upon installation. Unless noted otherwise, existing devices that do not conform to the current National MUTCD must be replaced at end of their useful life.

• The MUTCD also applies to private facilities (such as shopping malls) open to the public.

Many times, exceeding what the MUTCD requires can make a road safer. Additional signs can be used on the left side of the road or on overhead structures. Oversized signs can be used if more visibility is needed. These measures should only be used if they fulfill a need that standard practices cannot meet. Otherwise, they may lose value as drivers get used to them.

The MUTCD has ten chapters, called 'Parts', as follows:

2. Signs
3. Marking
4. Highway Traffic Signals
5. Traffic Control Devices for Low-Volume Roads
6. Temporary Traffic Control
7. Traffic Control for School Areas
8. Traffic Control for Highway-Rail Grade Crossings
9. Traffic Control for Bicycle Facilities
10. Traffic Control for Highway-Light Rail Transit Grade Crossings

Since this course covers traffic signs and pavement markings, we will be focusing on Parts 1, 2, 3, 5, 7, 8, 9, and 10.
Shall, Should, and May

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

**SHALL** – A mandatory condition. Requirements having “shall” stipulations are mandatory. No discretion in following them is allowed. Items marked as “shall” are typically included as a STANDARD in the MUTCD.

**SHOULD** – An advisory condition. Where “should” is used, it is recommended, and normally is to be followed, but is not mandatory. Deviation from such provision is permissible if, and to the extent, there is justifiable cause to do so. The reasons for any deviation should be documented and filed for future reference. Items marked as “should” are typically included as GUIDANCE in the MUTCD.

**MAY** – A permissive condition. No requirement for design or application is intended. Items marked as “may” are typically included as an OPTION in the MUTCD.

The MUTCD contains additional information and background details not included in this workbook. When available, the background information is usually included in a SUPPORT section of the MUTCD.

Using this workbook

This workbook discusses how to effectively use signs to guide traffic, reduce traffic crashes, and thereby reduce your liability exposure. Like the *Traffic Sign Handbook for Local Roads*, it is intended to help you use the MUTCD more effectively, not replace it. In case of any conflicts between the contents of this workbook and the MUTCD, follow the MUTCD.

THE FIVE PRINCIPLES OF SIGNING

Just because a sign is included in the MUTCD does not ensure that it will be effective. It has to be used in the right way. To be effective, signs need to comply with these five basic rules:

1. Fulfill a need
2. Command attention
3. Command respect
4. Have one simple message
5. Provide adequate time for proper response

Fulfill a need

This principle actually has two parts:

1. Only install a sign if there is a need for warning, regulation or guide information
2. Only use signs that fulfill that need

If a sign is needed, install it. If not, do not. If a need exists, but the sign in question does not meet that need, then use something else. If conditions change, and a sign no longer fills a need, remove or change it. A sign that does not fulfill a need is a waste of money and effort. At best, it will be disregarded, and at worst, it could cause more problems than it solves. This principle is especially important for regulatory and warning signs. Overuse of these signs can lead to disrespect for them. Underuse can allow correctable safety problems to persist.
Figure 1 - Oversized, doubled signs

Oversized, doubled signs can be used to command attention. No stop-sign-running crashes have been reported at this intersection since these signs were installed. However, if extra measures like this are overused, they will lose their emphasis value.

Figure 2 - Children At Play sign

Everyone agrees that there is a need to protect children. However, there is no evidence that Children At Play signs fulfill that need. Extensive studies have shown they neither reduce vehicle speeds, nor reduce crashes with children. They may actually hurt by misleading parents into thinking drivers are more alert. No sign can replace attentive parents who teach their children not to play in or near traffic.

Command attention

Signs help only if they are noticed. Using standard signs, proper placement, and well-maintained traffic signs will command attention. Standard signs are designed to catch the attention of road users. The high-contrast color combinations used on signs were chosen because they are eye-catching and easy to read. Sometimes, standard signs may not stand out enough to command attention. If needed, oversized signs, doubled signs, or flashing beacons can be used to add emphasis to the message.

To remain eye-catching, signs need to be kept in good condition. This means they must reflect light at night, and must not be faded, cracked, or peeling. Signs that are dull, battered or vandalized do not command attention, day or night.
Command respect
We rely on road users to willingly obey traffic signs. They will obey warnings and regulations that obviously fulfill a need. Drivers often choose to disregard warning and regulatory signs that seem unneeded or unreasonable. Drivers regularly disobey speed limits that they think are unreasonably low. If many speed limits are set too low, a disrespect of speed limits in general results. Good sign management and maintenance also promote a professional image for your department. Amateurish, homemade or damaged signs reflect poorly on the department, and they are more likely to be disregarded.

![Vandalized sign](image)

Figure 3 - Vandalized sign

Have one simple message
A sign must communicate its message in a way that is easily read and understood. If a sign is not understood or misunderstood, results will be poor. The signs in the MUTCD have been researched and most drivers understand their meanings. For this reason, use standard signs whenever possible.

![Limited Sight Distance vs. Hill Blocks View](image)

Figure 4 - 'Limited Sight Distance' vs. 'Hill Blocks View'

These two signs mean the same thing. Which is easier to understand? Until 2001, the New York State MUTCD included a “Limited Sight Distance” sign. This sign was meant to warn drivers that the distance they could see was less than the stopping distance for the speed of traffic. Research showed that few drivers knew what to do when they saw this sign (slow down and be alert). The 2003 National MUTCD introduced the “Hill Blocks View” sign (W7-6). Research has shown more drivers understand what it means.
Provide adequate time for proper response

Size, placement, and condition of signs should meet or exceed the MUTCD standards so drivers can comply before it is too late. Larger signs can be read further away, which gives more time to respond. Intersection signs need to be large enough to recognize and heed before reaching the intersections. Warning signs are posted before the situation they warn about, so drivers have the time and distance to take the appropriate action before they reach the situation. If not, drivers will not be able to react in time, and crashes may result.

The speed of traffic is an important factor for determining how much time drivers need to respond. Traffic moving at a higher speed needs more time, hence more distance to respond. This increased distance is obtained either by using larger signs that can be read further away, or by placing signs in advance of the point where the information is needed. The relation of traffic speed to signs is discussed in detail in Chapter 4.

![Figure 5 - Inadequate response time](image)

This stop sign does not give adequate time for response. It is too low to be easily seen, and vegetation hides it until drivers are too close to stop.

Using the five sign principles will help make your signs most effective. If you disregard the five principles, you may find that drivers disregard your signs.

READABILITY AND RETROREFLECTIVITY

To comply with the principle of adequate time for response, drivers must be able to read a sign from a distance which will provide sufficient time for the appropriate action to be taken in order to safely travel the highway.

Readability rule of thumb: Text signs can be read from 30 feet away for each inch of letter height. This corresponds to 20/40 visual acuity, the minimum allowed corrected vision to get a drivers license. Most symbol signs can be recognized from fifty percent further away than a text sign the same size.

A sign with four-inch high letters can be read from 120 feet away. At 55 mph (81 feet per second), a driver has less than 1½ seconds to read the sign before passing it. With six-inch high letters, a sign can be read from 180 feet away. Six-inch high letters are becoming the minimum text size for most signs due to easier readability. Many text-based signs are being replaced by symbol signs. Examples include the Stop Ahead sign, seen in Figure 6 on page 8.
Retroreflectivity

Signs and pavement markings reflect light from headlights back towards the driver’s eyes. This is called retroreflectivity. Retroreflective materials use small glass beads or tiny prisms to reflect light back towards its source. Retroreflective signs are more visible because they reflect more light directly back at the viewer. Chapter 5 and Appendix H have more information on maintaining and managing sign retroreflectivity.

Retroreflectivity becomes more important as we get older. Starting around age 20, our eyes gradually become less sensitive to light. The average 33 year-old requires about twice as much light to see at night as a 20 year-old, and a 46 year-old person needs four times as much. The eyes of a 72 year-old person are only 1/16 as sensitive to light as a 20 year-old. As the population of the United States gets older, the average driver gets older, and people continue driving at older ages. Retroreflective signs and pavement markings are becoming much more important to nighttime safety.

Figure 6 - Stop Ahead signs - new (left) and old (right)

Figure 7 - Types of reflectivity

Figure 8 - Sensitivity to light vs age
Minimum retroreflectivity standards
The United States Congress has mandated that the FHWA develop minimum retroreflectivity standards for signs and pavement markings. A new standard on retroreflectivity was released by the FHWA in January 2008. These standards will apply to all public roads, nationwide. Signs that do not meet the minimum standards will have to be replaced. By 2012, all agencies will need to develop a plan to manage sign retroreflectivity. More details are available in Appendix H or from the NYSLTAP Center - Cornell Local Roads Program.

Engineer Grade yellow and orange sign sheeting, even brand new Engineer Grade Sheeting, does not meet the proposed minimums. Remember, all signs, even those not specifically listed in the new standard, need to be retroreflective. Starting a nighttime sign inspection program now will help you to get a handle on the overall condition of your signs before the standards are in place.

Fluorescence
Fluorescent materials absorb ultraviolet energy from sunlight, and re-emit that energy as visible light. That is why they appear brighter. Fluorescent signs appear brighter during daytime, but are no brighter at night. Ultraviolet light penetrates clouds better than visible light, so fluorescent signs stand out in bad weather more than regular signs. Currently, fluorescent orange, fluorescent yellow, and fluorescent yellow-green are available.

SIGN TYPE AND DESIGNATION
The general appearance of a sign is the first visual indicator of a signs designation type or function. Standardized colors and shapes are specified so that the several classes of traffic signs can be promptly recognized. The function of a sign is to provide regulation, warning or guidance information. Signs are divided into five categories, depending on their use, as seen in Table 1.

<table>
<thead>
<tr>
<th>EXAMPLE</th>
<th>CATEGORY</th>
<th>USE</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Stop Sign" /></td>
<td>Regulatory</td>
<td>Requires or prohibits actions by the road user</td>
</tr>
<tr>
<td><img src="image" alt="Warning Sign" /></td>
<td>Warning</td>
<td>Warns user of conditions that may require an action to avoid a hazardous situation</td>
</tr>
<tr>
<td><img src="image" alt="Guide and Information Sign" /></td>
<td>Guide and Information</td>
<td>Helps user find their way, informs user of traveler services, etc.</td>
</tr>
<tr>
<td><img src="image" alt="Recreational and Cultural Interest Sign" /></td>
<td>Recreational and Cultural Interest</td>
<td>Guides user to recreation and cultural areas/facilities</td>
</tr>
<tr>
<td><img src="image" alt="Non-Traffic Control Sign" /></td>
<td>Non-Traffic Control</td>
<td>Not meant for highway use, or contains information not related to highway use or traffic control</td>
</tr>
</tbody>
</table>
Sign Color and Shape

Sign color and shape convey meaning. Specific color and shape combinations are used to inform road users what type of sign they are seeing. The color and shape combinations are chosen to be eye-catching and easy to read. They help to command attention and convey a clear simple message. Table 2 shows the various types of signs and their corresponding legend and background colors. Within the Catskill and Adirondack parks, some guide signs may contain yellow legends on a brown background.

Using non-standard colors, or using a standard color in a non-standard way, can make a sign difficult to understand. For example, people understand that white letters on a red octagon means “stop.” It could be confusing if there were red letters on a white octagon, or a green background on an octagon.

Signs usually have one color for the legend, which includes the symbols, text and border. The legend is typically either black or white, depending on which contrasts better with the background. A few signs have two-color legends, such as prohibition signs, with a red circle and slash over a black symbol. Table 3 on page 11 indicates how sign shape, color and type correlate.

### Table 2 - Sign types and colors (National MUTCD)

<table>
<thead>
<tr>
<th>Type of Sign</th>
<th>Legend</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black</td>
<td>Green</td>
</tr>
<tr>
<td>Regulatory</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Prohibitive</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Permissive</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Warning</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bicycle</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Guide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interstate Route</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>State Route</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>US Route</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>County Route</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Forest Route</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Street Name</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Destination</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Reference Location</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Information</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Evacuation Route</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Road User Service</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Recreational</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Temporary Traffic Control</td>
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<td></td>
</tr>
<tr>
<td>Incident Management</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Changeable Message Signs *</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>School</td>
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<td></td>
</tr>
</tbody>
</table>

* Reverse colors or fluorescent yellow-green pixels may also be used on changeable message signs.
Table 3 - Sign shapes, colors and types

<table>
<thead>
<tr>
<th>Shape</th>
<th>Main color</th>
<th>Sign type</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Octagon" /></td>
<td>Red</td>
<td>Stop sign</td>
</tr>
<tr>
<td><img src="image" alt="Triangle" /></td>
<td>Red</td>
<td>Yield sign</td>
</tr>
<tr>
<td><img src="image" alt="Square" /></td>
<td>White</td>
<td>Regulatory signs</td>
</tr>
<tr>
<td><img src="image" alt="X" /></td>
<td>White</td>
<td>Railroad grade crossing sign</td>
</tr>
<tr>
<td><img src="image" alt="Circle" /></td>
<td>Yellow</td>
<td>Railroad grade crossing ahead sign</td>
</tr>
<tr>
<td><img src="image" alt="Diamond" /></td>
<td>Yellow, yellow-green, orange, or fluorescent pink</td>
<td>Warning signs</td>
</tr>
<tr>
<td><img src="image" alt="Triangle" /></td>
<td>Yellow</td>
<td>No passing zone signs</td>
</tr>
<tr>
<td><img src="image" alt="Square" /></td>
<td>Yellow or yellow-green</td>
<td>School warning signs</td>
</tr>
<tr>
<td><img src="image" alt="Square" /></td>
<td>Blue</td>
<td>County route markers</td>
</tr>
<tr>
<td><img src="image" alt="Square" /></td>
<td>Green, blue or brown</td>
<td>Guide signs</td>
</tr>
<tr>
<td><img src="image" alt="Square" /></td>
<td>Orange</td>
<td>Detours and other work zone guide signs</td>
</tr>
</tbody>
</table>
Regulatory Signs

Most regulatory signs are rectangles taller than they are wide. There are exceptions, such as stop signs, yield signs and railroad crossing signs. White, black, and red are used for regulatory signs.

![Figure 9 - Regulatory signs](image)

Regulatory signs inform road users of traffic regulations and laws. They are used to control the movement of vehicles, pedestrians, and other road users. Properly used and enforced, regulatory signs promote safe, orderly traffic flow. Used incorrectly, they often cause more problems than they solve. For instance, unneeded stop signs cause unnecessary air and noise pollution from braking and accelerating vehicles.

Regulatory signs should only be used if they fulfill a need. Many people may disobey regulations they think are unneeded. Other road users may expect them to obey the regulation, and act accordingly. For example, a pedestrian may cross a street, expecting an approaching driver to stop at the stop sign. If the driver does not stop, the pedestrian may be seriously injured or killed.

According to Vehicle and Traffic Law §1683, certain regulations cannot be enforced without the proper signs and markings. This includes regulations that:

- Designate stop or yield controlled intersections
- Prohibit or regulate turning at intersections
- Designate traffic lanes for left turns, right turns, or through traffic only
- Define the use of the center lane of three-lane highways
- Designate one-way roads
- Prohibit trucks from a road, based on truck type or weight
- Establish truck routes
- Prohibit or regulate stopping, standing or parking
- Allow angle parking
- Designate no-passing zones
- Set speed limits other than the 55 mph state speed limit
- Regulate crossing of roads by pedestrians

Regulatory signs remind drivers of statutory traffic laws. Some laws do not need signs to be enforceable. For example, it is illegal to park in front of a fire hydrant whether or not a sign prohibits it. To prohibit parking where it would otherwise be legal, “No Parking” signs and regulations or local laws are required.
Warning Signs

Most warning signs are diamond-shaped. School signs are pentagons, railroad warning signs are circular, and no passing zone signs are isosceles triangles. Warning signs have black legends on yellow, yellow-green, orange or pink backgrounds, depending on their use.

![Warning Signs]

Figure 10 - Warning signs

Warning signs are used to tell road users they need to react to a condition on or near the roadway. Warning signs are especially helpful to drivers who are not familiar with the road. Studies have shown that forewarned drivers take less time to react. Properly placed signs can reduce incidents by improving drivers reaction times.

Table 4 - Reaction times

<table>
<thead>
<tr>
<th></th>
<th>Reaction time</th>
<th>Distance traveled at 55 mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unexpected hazard</td>
<td>1.5 - 2.5 seconds</td>
<td>120 – 200 feet</td>
</tr>
<tr>
<td>Expected hazard</td>
<td>0.7 – 1.2 seconds</td>
<td>55 – 100 feet</td>
</tr>
</tbody>
</table>

Some warning signs are more effective than others, but on average, you can expect a thirty percent reduction in related incidents. Improper use tends to cause disrespect for all warning signs, and minimizes their effectiveness.

When considering whether a warning sign is needed, first determine if the hazard can be removed. If it is impossible or too costly to remove, a warning sign should be installed. If it will take time to remove the hazard, use a temporary sign to warn traffic until the condition is corrected. The temporary sign should be removed promptly once it is no longer needed.

The background color on warning signs depends on the use, as shown in Table 5 on page 14.

Incident Management Signs

A traffic incident is an emergency road user occurrence, a natural disaster, or other unplanned event that impedes the normal flow of traffic.

The primary function of incident management signs is temporary traffic control to move road users safely past or around the incident and reduce the likelihood of secondary traffic incidents.

An incident management sign has a black legend and border on a fluorescent pink background.
Traffic incidents can be divided into three general classes:

A: Major - expected duration of more than 2 hours
B: Intermediate - expected duration of 30 minutes to 2 hours
C: Minor - expected duration under 30 minutes

Each of these general incident classes may create unique situations. To minimize additional risk to other road users, municipalities and the appropriate local safety, emergency, enforcement, towing and recovery groups should mutually plan their responses for such occurrences.

In the New York Supplement, the operational practices related to emergency incident responses provided in the MUTCD shall apply to police officers and other emergency responders responding to an emergency only in so far as such officers or emergency responders deem compliance with such manual practicable.

**Table 5 - Warning sign colors**

<table>
<thead>
<tr>
<th>Background Color</th>
<th>Purpose</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow</td>
<td>General warning</td>
<td><img src="image" alt="Yellow Sign" /></td>
</tr>
<tr>
<td>Yellow-green</td>
<td>Pedestrian, handicapped, bicyclist, and school signs</td>
<td><img src="image" alt="Yellow-Green Sign" /></td>
</tr>
<tr>
<td>(optional)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>Work zone</td>
<td><img src="image" alt="Orange Sign" /></td>
</tr>
<tr>
<td>Pink (new)</td>
<td>Incident management</td>
<td><img src="image" alt="Pink Sign" /></td>
</tr>
</tbody>
</table>

*Strong yellow-green signs may be used to highlight areas with pedestrian movements*

**Guide and Information Signs**

Guide signs are essential to direct road users along streets and highways, inform them of intersecting routes, or direct them to cities, towns, villages or other important destinations. They also identify nearby rivers, streams, parks and historical sites and give information that guides the road user to their destination in the most simple, direct manner possible.
Guide signs are usually rectangles with white text. They have green, blue, or brown backgrounds. Signs that guide traffic through work zones or detours are black on orange.

![Guide signs](image)

**Figure 11 - Guide and information signs**

Sometimes, the importance of good guidance information to traffic safety is overlooked. Assisting the road user in navigation to their destination, when they need it, can prevent erratic maneuvers by drivers who are lost, confused, or miss a turn, and can minimize potential incidents with other road users.

**Recreational and Cultural Interest Signs**

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

Recreational attractions include:

- Parks
- Campgrounds
- Gaming facilities
- Ski areas

Cultural attractions include:

- Museums
- Art galleries
- Historical buildings or sites

The purpose of recreational and cultural interest signs in New York State is to guide road users to general areas first and then to specific facilities. The signs are: (1) Rectangular with white symbols and borders on a green background; (2) Rectangular with white symbols and borders on a brown background; or (3) Rectangular with white symbols and white borders on a blue background. All recreational and cultural area symbol signs used on highways outside of the recreational interest areas shall have white symbols and borders and brown backgrounds with the exception of:

A: Ferry; Post Office; Airport; Bus Stop; and Helicopter, they shall have white symbols and green backgrounds.

B: Camping Tent and Trailer; Gas; Handicapped; Lodging; Picnic area; Rest Area; Telephone; Rest Room; Trailer Sanitary Station; Group Camping; Group Picnicking; Parking, they shall be white symbols and blue backgrounds.
Unless specifically noted, symbol signs shall not be used along main roadways or freeways in New York. A freeway is defined in the MUTCD in Section 1A.13 (29) as “A divided highway with full control of access.”

**Non-Traffic Control Devices**

Non-traffic control devices are signs or markers that are not used to regulate, warn, or guide traffic. Signs that post non-traffic regulations, like dog leash laws, are non-traffic control devices. Devices like fire hydrant markers or culvert markers are also non-traffic control devices, since they are not meant for the public. Signs for civic groups such as Rotary Clubs also fall into this category.

Non-traffic control devices should not be allowed to interfere with official traffic control devices. Like all signs, they should be installed on crashworthy signposts, so they are not a hazard to the public. For more information on signposts, see Chapter 5.

**SIGN PRIORITY/PRIMACY**

All signs are not created equal. Some deserve higher priority than others. *Primacy* is a term describing the relative importance of different sign types.

The primacy of a sign depends on what could happen if the sign is not seen. Some unseen signs could contribute to critical traffic incidents. These signs are designated as having high primacy. Signs that would simply lead to inconvenience, such as missing a turn or getting a ticket, are designated as having a low primacy.

High primacy signs should get the highest priority for installation and maintenance. If two signs are required to go in the same location, install the sign with the highest priority designation first, and adjust the location of the lesser sign. If time and budget prevent some signs from being replaced, stop signs should have primacy placement before guide signs.

In order of importance, signs fall into these categories:

- Key warning and regulatory signs
- Other warning signs
- Other regulatory signs
- Guide signs

Key warning and regulatory are signs that are the most likely to prevent critical traffic incidents. Examples of signs in this category are:

- Stop and Yield signs
- Stop Ahead, Yield Ahead, Signal Ahead, and intersection warning signs
- Pedestrian, bicyclist and school crossing signs
- Do Not Pass, Do Not Enter, Wrong Way, Keep Right, Keep Left, One Way
- Railroad crossing (cross buck), railroad warning (round)
- Turn signs, curve signs, reverse turn, reverse curve, winding road, curve arrows and chevrons
Examples of regulatory and warning signs that are not in the key sign category are:

**Regulatory:** No Parking signs, Lane Use signs, or Slower Traffic Keep Right signs.

**Warning:** Pavement Ends, Low Flying Planes

These categories are not rigid, and need to be applied with some thought. A no parking sign that prohibits parked vehicles from obstructing the view of children at a school crossing may be more important than many warning signs. Even within a category, some signs will be more important than others. A regulatory sign that could result in a traffic incident if it is disregarded is more important than one that could lead to a driver getting a ticket.

MEETING ROAD USER NEEDS

Understanding the five principles of good signing (listed on page 4), sign types, and visibility is essential to effectively communicate with all road users.

As roadway professionals we must remember that experience has given us a greater knowledge of transportation issues than the average person using the road. Things that are obvious to an experienced highway superintendent or traffic sign crew chief will not be obvious to many people in other lines of work. To make sure they understand what you are trying to tell them, you have to try to think like them.

**Identifying all road users**

The National MUTCD under §1A.13 (67) identifies a road user as; a vehicle operator, bicyclist, or pedestrian within the highway, including persons with disabilities.

The ability to put yourself in their place is important if you intend to meet the needs of everyone using the road. This includes unskilled drivers, novices, older drivers, pedestrians, people in wheelchairs, joggers, roller bladers, bicyclists, or drivers of high profile or lengthy vehicles. If you can meet their needs, you can minimize problems that the average road user may experience.

Sometimes it helps to ask someone that does not work for a highway department what they think your sign plan means. If their understanding is different than your intent, then you may have a problem with your plan and you may wish to reevaluate it. This is especially important for meeting the needs of people with disabilities.

**Compliance With The Americans With Disabilities Act**

Information about meeting special requirements of the disabled can be found in The Americans with Disabilities Act of 1990 (ADA). The ADA website is [www.ada.gov](http://www.ada.gov).

The act establishes regulations to prevent discrimination against the disabled. This impacts municipalities by requiring them to provide specialized signs, sign placements, pavement markings for curb ramps or other access.
2 - Program Administration

This chapter addresses some of the administrative responsibilities for a municipal sign and pavement marking program, including the authority to order the installation of signs and markings, liability, and matters between jurisdictions.

**AUTHORITY**

Authority is given to municipalities by the Vehicle and Traffic Law of the State of New York. It allows municipalities in their respective jurisdictions the right to place and maintain traffic control devices, conforming to the state manuals and specifications. It requires them to comply with the standards discussed in Chapter 1 of this workbook. Speed limits outside of Cities and Villages are controlled by NYSDOT except in Class I Towns or Towns with a population greater than 20,000.

To learn what authority your municipality has, see the following sections of Vehicle and Traffic Law of the State of New York:

- **Cities and Villages:** Article 39 - Section 1640-1646
- **Counties:** Article 40 - Section 1650-1652b
- **Towns:** Article 41 - Section 1660-1664

**INTERMUNICIPAL MATTERS**

Where roads maintained by different agencies intersect, questions often arise about who has responsibility for maintaining them and what are the jurisdictional boundaries.

**Intersection of municipal roads with state highways**

The Vehicle & Traffic Law, §1621, assigns NYSDOT traffic control authority over any highway intersecting or meeting a state highway maintained by the state for a distance not exceeding 100 feet from the state highway.

During contracted construction projects NYSDOT may place intersection signs or pavement markings on non-state roads further than 100 feet from the intersection; typically, jurisdiction for the road (and these signs) returns to the municipality once the construction contract is completed. The contract’s Table of Maintenance should define the post construction maintenance responsibilities.

**Intersection of town and county roads**

Both county superintendents and town boards are given the authority to make traffic control decisions at the same intersections. This may lead to conflicts.

Vehicle and Traffic Law §1651 covers the authority of County Superintendents of Highways to control intersections. §1660 gives very similar authority to Town Boards.

Except at intersections with state highways, both county superintendents and town boards can order stop, yield or signal control at intersections on county roads. They can also designate county roads as “through highways.” All roads intersecting a through highway have to be traffic controlled.
Both the County Superintendent of Highways and the Town Board have the authority to control intersections of county roads and town highways. Whenever work or a study is contemplated at the intersection of one government entity’s roadway with a roadway under the jurisdiction of another government entity, it is important to ensure coordination & cooperation between the entities. Cooperation between the Town Board and County Superintendent of Highways is the best way to solve the situation of a town road intersecting a county highway. Consider what is best for the taxpayer and road user, not just your budget.

Generally, the municipality that issued the regulation controlling traffic is responsible for maintaining the devices or markings. Since the county road will usually (but not always) be the major road, it makes sense for the county to control the intersection and assume responsibility for the devices.

**INTERMUNICIPAL AGREEMENTS**

Working together can reduce costs and increase quality. Vehicle and Traffic Law §1652-a and §1652-b allow municipalities to cooperate. This could have substantial advantages. Uniform signing and pavement marking throughout the county could reduce overall liability costs. Cooperative purchasing of sign and pavement marking materials could reduce total cost to taxpayers.

In counties that provide a traffic engineering unit, the county superintendent can install and maintain signs, signals, and markings on county, town, village, and city streets within the county. This requires written agreement between the County Legislature and the legislature of the town, village or city that owns the roadway. The agreement must describe the authority that is given to the county, as well as who pays for the work.

**LIABILITY**

Roadway defects account for nearly half of all claims against municipalities. Liability claims related to traffic control devices, including signs, are the largest category of road-related cases. Municipalities have a duty imposed by law to maintain roadways and other facilities within their jurisdiction, in a reasonably safe condition, based on the recognized standards discussed in Chapter 1.

Failure to meet the standards can result in a legal claim of liability against the municipality, an individual, or both. Simply put, liability is incurred when one person or organization breaches a duty to someone else, who suffers injury or loss because of the breach. The breach may be an improper action, or a failure to act when necessary.

In highway liability lawsuits, three factors may be involved:

- A defect in the roadway right-of-way breaches the department’s responsibility to keep the road “reasonably safe.”
- The defect contributed to a property damage or injury incident.
- The highway agency knew of the defect, via actual or constructive notice, and had enough time to do something about it.

Traffic control device related lawsuits result from inappropriate choice, installation, or maintenance of signs and markings. Following the standards reduces your risk of liability in two ways.
First, it can significantly reduce the number of incidents, and second, a well-documented inspection program will strengthen the highway department’s defense that the highway department’s practices do not contribute to the incidents that do occur.

Here are some ways to reduce device-related liability claims:

- Proper usage and layout of signs and markings, as described in the National MUTCD, the NYS Supplement and Chapter 4 of this workbook.
- Good maintenance practices, including training, annual inventories, daytime, and nighttime inspections (maintenance for signs and markings are discussed in Chapters 6 and 7).
- Good documentation, so when an incident does happen, you can prove you followed proper usage and maintenance practices.
- If you think a serious injury incident may lead to a lawsuit, immediately check all devices that may be remotely related to the incident. Make sure they are in good condition and in the proper location. Take plenty of pictures, with a date stamp, and keep thorough notes.

In one case, a missing Stop Ahead sign was claimed to be a contributing factor in an incident. The town successfully defended itself because the Superintendent of Highways took a picture soon after the crash showing the sign in place the day of the incident. The next day, the sign was missing.

For more information on liability, see the NYSLTAP Center - Cornell Local Roads Program workbook entitled *Reducing Liability for Local Highway Officials*.

**DOCUMENTATION**

Can you recall with certainty all of the details regarding devices you or someone who has left your department installed years ago? Can you convince a judge or jury that the details you recall are correct? Probably not! That is why documentation is so important.

Good records can save a lot of grief and aggravation in court, if you can demonstrate that your actions were carefully considered and in accordance with standards and common practice. Things to include when documenting are:

- A description of the problem you are trying to solve.
- Information you collected to define the problem.
- How you reached your decision.
- The reasons for any deviations from the National MUTCD or the NYS Supplement, or changes from your initial plan. If the MUTCD states the sign shall be used in a certain manner and you cannot do so, consider getting the documented advice of a licensed professional engineer.
- A sketch showing the sign or pavement marking’s location relative to other signs or road features like curves and side roads, and at least one permanent object such as a culvert or survey benchmark.
- Your post implementation evaluation of whether the devices are working and why you think so.
Traffic Signs and Pavement Markings

Be sure to update your sign inventory (see Chapter 6, Sign Management).

Good records should be kept about any complaints, sign studies, and maintenance practices. It is important to document complaints because they generate the need for sign studies or maintenance work.

**COMPLAINTS**

You need appropriate information in order to maintain roadways in a reasonably safe condition, based on the standards discussed in Chapter 1. Information sometimes comes in the form of a complaint. There are times when you may receive complaints regarding several situations at once. In this case, prioritize the complaints based on the potential seriousness of each complaint and investigate them in that order. Legally, complaints are “notices of defects” and ignoring them may cause you to pay substantial damages in a liability lawsuit.

There are times when the complaints do not come to your office, but go to another office. For example, a town contended that since their highway department had not received any complaints of a problem, they had no notice of the defect. However, the court found that the town’s police department had received complaints of the problem, and therefore that constituted ‘notice’ to the town. Courts have also found that a series of accidents where the town police responded put the town on ‘notice.’ Keep in mind that liability lawsuits are against your municipality, not your department. Establish working relationships with other departments in your municipality that can give you insight into problem locations. To improve the safety of your roads and reduce liability, all complaints should be investigated. You can then decide the best course of action, based on your investigation. This may consist of simply replacing a regulatory sign or doing a study to determine if additional traffic control devices are needed.

**Maintenance**

Maintenance activities related to day and nighttime sign inspections, installations, repairs, and replacements need to be documented. Record any information that relates to the condition, placement, obstructions or observations you make of the devices. Include in the details the “who, what, where, when, why, and how.”

Appendix D (starting on page 68), includes an example of a blank form you can use to make documentation easier.

**Sign Studies**

Based on the information you acquired through investigating complaints or information received during maintenance activities you may need to do an additional study. A sign study will help you to determine if the devices you have in place are adequate or if additional devices need to be installed.
3 - Sign Studies

Section 1A.09 of the National MUTCD states, “The decision to use a particular [Traffic Control] device at a particular location should be made on the basis of either an engineering study or the application of engineering judgment.” Courts have held municipalities liable for not doing adequate studies. This section will answer some questions about sign studies.

What is a study?
A study is the process used to determine what is needed to solve a problem. It includes everything from initial information gathering to final documentation of your actions.

Who can do a study?
Sign studies should be conducted by a competent person trained or experienced with sign layout. If the solution to the problem involves substantial deviation from the National MUTCD and the NYS Supplement (Volume 17B) you should consult with a licensed engineer. If your municipality has one, your municipal engineer should review the sign study results.

Your county’s highway superintendent is another resource. Towns, villages, and cities can ask their county superintendents for assistance. The superintendent is required to help, but the county is allowed to charge for these services.

When are studies required?
As discussed above, no traffic control device should be installed without a study. However, some devices need more careful study than others. When a sign is replaced as a result of an incident or maintenance activities, a study is not required.

Regulatory signs must be authorized by a law or ordinance to be enforceable. Sometimes, state law covers the sign, such as the 55 mph state speed limit, or prohibiting stopping on railroad tracks. Most of the time, municipal legislatures must pass local ordinances authorizing regulatory signs within their jurisdiction. The legislature should base ordinances on studies conducted by someone experienced in traffic control and safety, such as the municipal engineer or highway superintendent. A copy of the ordinance should be filed with the study documentation.

Towns pay for sign hardware out of their general account, so the town board should have some oversight over warning and guide sign studies.

How is a study conducted?
To make sure that a study is adequate, it helps to follow a procedure. This will help ensure you are not missing anything. The steps in sign studies are:

1. Identify the problem and any contributing factors
2. Select the best sign
3. Install the sign
4. Evaluate the sign’s effectiveness
5. Documentation, noting any changes to the sign layout plan or deviations from the National MUTCD or the NYS Supplement (Volume 17B).
Step 1: Identify the problem and contributing factors
You can learn of sign problems in several ways. Many times, it is a complaint from a citizen. Perhaps you noticed something while inventorying your signs, or there may be a series of incidents occurring at a particular location.

Just as knowing why pavement is cracking is necessary to prevent a crack from returning, understanding the problem and any contributing factors are key to successful sign studies. You need to understand what is happening and why. The NYSLTAP Center - CLRP workbook, Road Safety Fundamentals, has more information on highway safety investigations to guide you.

What are road users doing, or failing to do, that needs to be changed? Based on careful observation, accident reports, and other information, decide what behavior needs to be encouraged or prevented, and then choose a sign that will help road users. Pay attention to contributing factors on accident reports. If the same factors keep appearing, this may point to a need for a sign to help prevent driver errors. For example, if rear-end crashes keep happening at a Stop sign, check whether a Stop Ahead sign is needed.

Emergency service personnel are good sources of information. Police and emergency medical technicians are often called to accident scenes. They may notice accidents tend to happen at certain locations.

Step 2: Select the best sign
Many conditions that contribute to incidents can be eliminated or improved by proper use of signs. For example, oversized stop signs have been shown to reduce crashes by up to 15 percent. Chevrons can reduce run-off-road crashes on curves by 30 percent.

Choose the sign that best conveys the information the driver needs. Read the sections of the National MUTCD, the NYS Supplement (Volume 17B) or the NYSLTAP Center - Cornell Local Roads Program Traffic Sign Handbook, that identifies signs that may apply to your problem. Will any of the signs you are considering help to solve the problem? Is one the best sign for the problem? Would a combination of signs be best?

Answering these questions should help you select the best sign.

- Which sign offers the best results for the least cost?
- Will a possible improvement solve the problem, or just move it down the road?
- Will potential improvements cause problems of their own? If so, are they worse than the problem you are trying to solve?

Step 3: Install the sign
Remember the five principles of good signing? Two of these specifically relate to sign layout:

- Command attention - Signs need to be placed where they catch the eye of the people that need to see them.
- Provide adequate time for proper response.

Sign size, design, and location need to work together so that road users can see, read, and react to the sign in time.
Sign layout is discussed in more detail in Chapter 4. Sections 2A.18 & 2A.19 of the MUTCD and Chapter 1 of the Traffic Sign Handbook contain general guidance on sign placement. Also, read the MUTCD’s section regarding the particular sign you are installing for specific instructions for that sign.

After installing the signs, drive through the site and check the locations of the signs. Can all of them be seen? If not, you may need to adjust locations. It can be helpful to have an objective person perform a final drive-through and inspection, to make sure you have not missed anything.

**Step 4: Evaluate effectiveness**

Evaluating effectiveness of signs is important and is often the least appreciated step. You are looking for two things:

- Is the sign you installed helping?
- Is it causing any unforeseen problems?

When evaluating a new sign to see if it helped solve a problem, do not rush the judgment. It will take time to see if it is helping. What appears to be an increase or decrease in crashes may only be a short-term random fluctuation. On low-volume roads, it may take five to ten years to see a difference in crash rates. Consider making traffic observations at these locations, looking for conflict indications such as brake lights, abrupt maneuvers, etc. Be sure to document the observation even if no conflict indications were observed.

Signing changes will often cause unforeseen results. A No Left Turn sign at one intersection may increase turning traffic at others or induce U-turns. This may increase congestion, crashes, or both at the other locations, which may or may not be worse than the problem you are trying to solve.

If sign changes do not help, or if other problems are created, go back to step one. Make sure you understand the problem, and try again. You may need to do more than install a sign.

**Step 5: Documentation**

Can you recall with certainty all of the details about a sign you installed five years ago? Can you convince a jury that the details you recall are correct? Probably not! That is why documentation is so important. Things to include in your documentation are listed in Chapter 2.

Documentation is listed here as the last step, but it is easier to keep records as you go through the sign study process.

Traffic studies, including sign studies, are also discussed in more detail in Chapter 2 of the NYSLTAP Center - Cornell Local Roads Program publication, Road Safety Fundamentals. The National MUTCD, Section 1A.11 lists other publications that are useful sources of information.

It is worth stressing the importance of good documentation, it may be the single most important step of good traffic control device management.
Once you have decided that a sign should be installed, the next step is determining where to place it. This section discusses how to make sign placement decisions as well as sign applications to intersections and curves, the two locations where most crashes occur.

Remember the five principles of good signing discussed in Chapter 1. Two principles specifically relate to sign layout. Signs should:

- **Command attention** - Signs need to be placed where they are eye-catching to the people that need to see them.
- **Provide adequate time for proper response** - Sign size, design, and location need to work together so that road users can see, read and react to the sign in time.

General guidance on sign placement can be found in Chapter 2 of the MUTCD. Specific instructions can also be found by reading the sections corresponding to the sign(s) you are installing, in the MUTCD.

In the field or on a road plan, plot the preferred location of the sign. Look for any potential problems. Avoid placing signs in these areas:

- In dips in the road or just beyond hillcrests.
- Where parked vehicles will block the view of the sign.
- Where the sign will block a sidewalk or otherwise be a hazard to pedestrians.
- Where the sign will block the view of other signs.
- Where the sign may block sight distance for drivers at intersections or driveways. Remember, truck drivers’ eyes are at about the same height as most signs.
- Where vegetation is likely to grow and cover the sign.

To describe where a sign will be installed, specify its location in three dimensions: Height, Longitudinal and Lateral:

![Figure 12 - Sign location is specified in three dimensions](Image)
Traffic Signs and Pavement Markings

**Longitudinal placement (location along the roadway)**
Signs need to be carefully placed so that the road user has enough time to respond, while not overloading the user with information. This is accomplished using sign spreading and sign grouping.

**Eighty-fifth percentile speed**
As described in the principles of signing, signs must be placed so that drivers have enough time to respond to them. This depends on the speed of traffic. At higher speeds, drivers need a greater distance to react to the sign.

If the average speed of traffic were used to locate signs, then half of the traffic may not be given adequate time to respond. Using the speed of the fastest traffic is often excessive. It is not reasonable to cater to a small percentage of all traffic. So, a value in between the average speed and the fastest speed is used. Many years of research and experience has shown that the eighty-fifth-percentile speed is an effective compromise.

The eighty-fifth-percentile speed is the speed that eighty-five percent of traffic is not exceeding, and fifteen percent is exceeding. In other words, if you measure the speed of one hundred vehicles and rank them in order from slowest to fastest, the eighty-fifth-percentile speed would be the speed of the eighty-fifth vehicle on the list. It is sometimes called the **prevailing speed** or **operating speed**. The approach speed is the eighty-fifth-percentile speed of traffic moving towards the sign, disregarding the speed of traffic moving in the other direction.

The placement of most warning signs and some other signs depend on the eighty-fifth-percentile speed. Often, the posted speed limit is close enough to the eighty-fifth-percentile speed for sign placement purposes, but if you suspect traffic is moving significantly faster or slower than the speed limit, it might be worthwhile to measure the eighty-fifth-percentile speed.

**Information spreading**
When unrelated information is presented at the same time, it becomes difficult to understand. Unrelated signs should be spread apart so that the driver can read one sign at a time. When signs are too close together, it is more likely that the driver will not be able to read them all. The distance in feet between the signs should be 5 to 7 times the speed limit. For example, at 35 mph, sign separation would be 5 times 35, or 175 feet. The MUTCD recommends a minimum distance of 100 feet between signs where possible.

**Information grouping**
Related information can be grouped together without causing confusion. This can be useful in areas where there are few good places to install signs. Related signs can be used together to reinforce a message.

Signs should only be grouped if they are related. R1-4 “All Way” signs can go under a Stop sign. Hill signs can be supplemented with W7-3 “% Grade” signs or a W7-3b “Next 2 Miles” sign. Unrelated signs should be spread apart. Curve signs and speed limit signs should not be on the same post.
Figure 13 - Examples of acceptable sign groupings

Signs for traffic moving in opposite directions can be mounted back to back on the same post. Do Not Enter signs are often mounted on the back of stop signs or yield signs on one-way streets. Make sure the Do Not Enter sign does not detract from the Stop sign’s octagon shape.

Sign types and longitudinal placement
Placement of signs depend on the sign type. Regulatory signs are placed where the regulation applies. Warning signs are placed in advance of the location they demark. Guide signs are placed where users get the information before they need it, without distracting users from regulatory and warning signs.

Longitudinal placement of regulatory signs
Placement locations of regulatory signs may vary widely with the type of sign. For guidance, read the applicable sections of the MUTCD or the Traffic Sign Handbook regarding the sign you are installing.

Longitudinal placement of warning signs
The MUTCD defines advanced longitudinal placement distances for warning signs as Conditions A or B. Condition A concerns speed reduction and lane changing in heavy traffic while Condition B addresses the need for a motorist to decelerate from a posted or 85th percentile speed to an advisory speed that would be appropriate for the condition. See Table 6 (Table 2C-4 from the NYS Supplement), Guidelines for advance placement of warning signs. Note that the distances in the NYS Supplement are different than the National MUTCD.

Condition A relates to locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical applications are Merge and Right Lane Ends signs.

Specific warning signs are used when drivers should be prepared to stop. Stop Ahead and School Crossing signs are examples of these, and are treated as a Condition B with an advisory speed of 0 (zero) mph.

Appendix J (page 80) includes information on selecting advisory speeds for curves. Use this advisory speed along with the posted or 85th percentile speed to determine this type of sign’s advance posting distance.

Slippery When Wet (W8-5), Traffic Circle (W2-6), Soft Shoulder (W8-4) are a few warning signs that may not have obvious associated advisory speeds. The previous NYS MUTCD used an advisory speed of 15 mph less than posted or 85th percentile speed for these types of warnings.
Table 6 - Guidelines for advance placement of warning signs

<table>
<thead>
<tr>
<th>Condition A: Speed reduction and lane changing in heavy traffic</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
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<th>45</th>
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<th>55</th>
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<th>75</th>
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<td>410</td>
<td>115</td>
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<td>105</td>
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<td>75</td>
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<td>515</td>
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<td>160</td>
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<td>95</td>
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<td>-</td>
</tr>
<tr>
<td>30</td>
<td>620</td>
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<td>195</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>35</td>
<td>720</td>
<td>250</td>
<td>255</td>
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<td>215</td>
<td>190</td>
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<td>225</td>
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<td>775</td>
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<td>570</td>
<td>515</td>
<td>460</td>
<td>400</td>
<td>325</td>
<td>260</td>
</tr>
<tr>
<td>75</td>
<td>1545</td>
<td>820</td>
<td>880</td>
<td>870</td>
<td>855</td>
<td>840</td>
<td>810</td>
<td>785</td>
<td>750</td>
<td>705</td>
<td>660</td>
<td>605</td>
<td>550</td>
<td>495</td>
<td>420</td>
<td>350</td>
</tr>
</tbody>
</table>

Notes:

1. The distances have not been modified to account for sign legibility.
2. Typical conditions are locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical signs are Merge and Right Lane Ends. The distances are taken from the 2001 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E.
3. Typical condition is the warning of a potential stop situation. Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and Intersection Warning signs. The distances are taken from the 2001 AASHTO Policy, Stopping Sight Distance, Exhibit 3-1.
4. Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn, Curve, Reverse Turn, or Reverse Curve. The distances are determined by providing a 2.5 second PIEV time and a vehicle deceleration rate of 10 ft/second.
**Longitudinal placement of guide and information signs**

Guide sign locations vary widely with the type of sign. Read the section of the MUTCD regarding the sign you are using. The locations of guide signs are less critical than the location of regulatory or warning signs.

As long as road users have adequate time to respond to them, and the location does not create confusion (for example, placing a route marker with a right arrow several blocks before the intersection), or block warning or regulatory signs, any location is probably acceptable.

Since guide signs usually have the most flexibility, their location should be adjusted before regulatory or warning signs.

**Longitudinal placement priority of ‘warning’, ‘regulatory’, and ‘guide and information’ signs**

Except on freeways, warning signs should generally take precedence over regulatory and guide signs, with a warning message for a greater hazard taking priority over one for a lesser hazard. Regulatory signs should be next in importance, with the sign posting the most important regulation superseding others. Guide signs should normally be the lowest in priority, as their locations are generally more flexible than those for other types of signs. On freeways, guide signs should have highest priority, followed by warning and regulatory signs.

**Lateral placement (distance from the roadway)**

The closer a sign is to the road, the easier it is to see, but the more likely it is to be hit. If it is further from the road, it is less vulnerable, but harder to read. These guidelines should help you reach a good compromise.

On uncurbed roads, signs should have a lateral clearance of at least 12 feet from the edge of the travel lane to the near edge of the sign, or 6 feet from the edge of the stabilized shoulder if the shoulder is more than six feet wide. On many roads, this could cause the sign to be blocked by vegetation or positioned off the right-of-way. Install the sign where it will have good visibility, and still be as far from traffic as possible. Avoid placing signposts in the ditch bottom or foreslope.

On curbed roads, the edge of the sign should be not less than two feet from the face of the curb. This is so that parked vehicle doors may be opened safely. Place the sign farther back if you can, to minimize the chance that it will be struck by vehicles. Be careful not to block a sidewalk.

![Figure 14 - Lateral spacing of signs](image)
Height above the roadway

The height of a sign is important for several reasons. It affects sign visibility, safety in run-off-road incidents, and accessibility for pedestrians.

- Single mounted signs in urban areas or locations where other vehicles may obstruct a driver’s view should not be less than seven feet (7 ft) above the edge of the roadway.
- Single mounted signs in rural areas, should not be less than five feet (5 ft) above the edge of the roadway.
- If the sign has a supplementary panel, the height to the bottom of the supplementary panel may be six feet (6 ft) above the roadway in urban areas and four feet (4 ft) in rural areas.
- In sidewalks or other pedestrian areas, the bottom of the sign must be seven feet (7 ft) above the sidewalk so pedestrians will not hit their heads on the sign panel. This is required by Americans with Disabilities Act regulations.
- The top of the sign should be nine feet (9 ft) or more above the ground. This makes it much less likely that the sign will come through the windshield of a car that hits the post.

The MUTCD does not specify a maximum height for sign assemblies. At hillcrests, it may be useful to place the sign higher than normal so that it can be seen. If it is too high, the sign will not be very visible at night, since little light from headlights will reach it.

Figure 15 - Sign height
Angle to the roadway
To reduce headlight glare reflecting from the sign face, signs should be turned slightly away from traffic. An angle of 93 degrees from the road works well. On curves, the sign should be 93 degrees from approaching traffic, not the edge of the roadway next to the sign. One exception is parking signs, which are normally installed at a 45 degree angle to the roadway.

![Diagram showing sign angles](image)

Figure 16 - Installing signs at an angle

Call Dig Safely NY or the One-Call Center
Signposts are driven far enough into the ground to hit underground utilities. To make sure you will not be puncturing a gas main, buried electrical cable, or other utility, call for an underground facilities check before driving posts. The One Call Center, (800) 272-4480, serves New York City and Long Island, and Dig Safely NY, (800) 962-7962, covers the rest of the state. Call, “it’s the law!” Both centers may also be reached by dialing 811. This number was approved for all ‘call before you dig’ activities nationwide in the Spring of 2007.

ADJUSTING LOCATIONS
Occasionally, a sign cannot or should not be placed at the location specified by the MUTCD. Visibility may be poor where it is supposed to be, or more than one sign may be needed at the same location. Perhaps a sign would be confusing if it is installed at the specified location.

Before installing signs, double-check your layout. This is especially useful when several signs need to be installed near each other. For each sign, ask yourself:

- Will the sign meet the five principles of signing from Chapter 1?
- Will the sign be visible to the traffic it is meant to serve?
- Will anything obstruct the view of the sign?
- Will some signs block the views of other signs?
- Will vegetation need to be pruned?
- Will the sign cause sight distance problems for traffic on a side road or driveway?

Adjust sign locations as needed and mark any changes on your layout plan, along with the reason for the change.
Stakeout checks help you to avoid confusing installations like the example above.

**Stakeouts**

Once you have completed making the proposed changes to your layout plan, it is time to stake out your location. Spraypaint a mark, drive a stake or drop a cone at every proposed sign location. Drive through the site several times using the marks to visualize where the signs will be.

As previously mentioned, the space in feet between unrelated signs should be five to seven times the speed limit, in order to allow them to be read one at a time. If this cannot be done, then consider the primacy of the signs, and the consequences for each sign if it is not seen. Prioritizing the sign locations would be an appropriate way to address this concern. For example, a Stop sign would have priority over a No Parking sign. The first priority order of signs would then be:

1. Regulatory signs where the location is critical, like the Stop sign.
2. Warning signs.
3. Regulatory signs where the location is not critical, like speed limits or No Parking signs.

Sometimes, placing a sign in the standard location would be confusing. For example:

- Intersection warning signs should not be installed more than one block from the intersection they refer to, or drivers may think the sign refers to the first intersection.
- Guide signs should either be on the block before the intersection to which they refer, or they should include a message such as “second intersection” or “second left.”
- Curve signs can be misleading if the posting distance exceeds the space between curves. Drivers may be confused as to whether the sign pertains to the curve they are in or a curve they are approaching.

Sign locations can be adjusted slightly to avoid placing them in driveways or behind trees and other obstacles. In residential areas, some agencies install signs on property lines rather than in a resident’s front yard. Remember, it is better to increase the distance slightly and warn too early, than to warn too late.
If the location is more than a few feet from where the MUTCD says the sign should go, the reason for the adjustment should be documented.

SIGNING AT INTERSECTIONS

On local roads, many incidents will occur at intersections. Good signing at intersections can do a lot to improve safety and promote efficient traffic flow. A sign study at a particular intersection could be started for several reasons. Maybe there have been a number of incidents there. Perhaps a citizen has complained. You may have noticed problems during an annual sign inspection. Or possibly a new subdivision or business is being built, and you want to make sure the intersection is ready for the additional traffic.

Signs used at intersections

*Intersection regulatory signs* are used to assign right-of-way, designate one-way roads, and inform road users of lane usage. If you are requiring or prohibiting an action, a regulatory sign is needed. Many traffic ordinances cannot be enforced without them.

![Figure 18 - Intersection regulatory signs](image1)

*Intersection warning signs* are used to warn about other intersection-related factors, like dead ends. Warned drivers react more quickly, and are more likely to react appropriately than unsuspecting drivers. The most common intersection warning sign informs drivers that the intersection they are approaching is beyond their sight distance.

![Figure 19 - Intersection warning signs](image2)

*Combination horizontal alignment/intersection signs* are used in locations where side roads intersect a main road at a curve. It is an option where separate signs for the intersection and the curve might be misleading. The following is from Section 2C.08 of the National MUTCD:

**Option:** The turn sign or the curve sign may be combined with the crossroad sign or the side road sign to create a combination horizontal alignment/intersection that depicts the condition where an intersection occurs within a turn or curve.

**Guidance:** Elements of the combination horizontal alignment/intersection sign related to horizontal alignment should conform to Section 2C.06, and elements related to intersection configuration should conform to Section 2C.37.

No more than one crossroad or two side road symbols should be shown on any one combination horizontal alignment/intersection sign.
Figure 20 - Combination horizontal alignment/intersection sign

Guide signs help drivers reach their destinations. Drivers use them to decide where to turn.

Figure 21 - Guide signs

Solving intersection sign problems

Good signing can solve many intersection safety problems. Correcting safety problems at intersections may eliminate critical incidents before they occur and prevent potential lawsuits. Here are some things to check if safety problems are occurring at an intersection:

1. Check the locations of intersection-related signs. Relocate any that do not comply with the MUTCD or are not easily visible.

2. Check the conditions of all intersection signs. Repair or replace any that are damaged or faded. Inspect and replace mounting posts and hardware as well. Remember to also check nighttime retroreflectivity.

3. At stop, yield and signal controlled intersections, can you see the signs or signal heads before you get to the intersection? If they cannot be seen from a sufficient distance, this should be fixed. See Table 7 for the minimum visibility distances required. Can you clear brush or relocate signs so they can be seen from a sufficient distance? If not, Stop Ahead, Yield Ahead or Signal Ahead signs are required.

4. For approaches without a Stop sign, Yield sign or signal, how far away can the intersection be seen? Use Table 8 (page 37) to see if intersection warning signs are needed on the main road.

Table 7 - Minimum visibility distance in feet for intersection control devices

<table>
<thead>
<tr>
<th>Intersection Control</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>55</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Signal Heads</td>
<td>175</td>
<td>215</td>
<td>270</td>
<td>325</td>
<td>390</td>
<td>460</td>
<td>540</td>
<td>625</td>
<td>715</td>
</tr>
<tr>
<td>Stop or Yield Sign</td>
<td>200</td>
<td>260</td>
<td>355</td>
<td>450</td>
<td>545</td>
<td>640</td>
<td>735</td>
<td>830</td>
<td>920</td>
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</tbody>
</table>
Table 8 - Sight distance in feet to a vehicle waiting at the intersecting road

<table>
<thead>
<tr>
<th>Prevailing speed (mph)</th>
<th>Sight distance (in feet) to a vehicle waiting at the intersecting road</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>570', 1200'</td>
</tr>
<tr>
<td>55</td>
<td>495', 1100'</td>
</tr>
<tr>
<td>50</td>
<td>425', 1000'</td>
</tr>
<tr>
<td>45</td>
<td>360', 900'</td>
</tr>
<tr>
<td>40</td>
<td>305', 800'</td>
</tr>
<tr>
<td>35</td>
<td>250', 700'</td>
</tr>
<tr>
<td>30</td>
<td>200', 600'</td>
</tr>
<tr>
<td>25</td>
<td>155', 500'</td>
</tr>
<tr>
<td>20</td>
<td>115', 400'</td>
</tr>
</tbody>
</table>

Black area: an intersection sign should be used
Grey area: an intersection sign may be used
White area: an intersection sign is not normally used, but may be used if other factors warrant it

5. If everything in steps 1 through 4 is okay and drivers are still having problems, consider these measures:

A. Add emphasis to the stop sign. This can be done in several ways:
   - Add stop lines or a strip of reflective material to the post
   - Use oversized stop signs
   - Use flashing beacons on the sign or suspended overhead

B. Left side stop signs or stop ahead signs

C. Double-headed arrows on the far side of T intersections are very effective at reducing stop-sign running incidents at those locations.

D. Crosswalk markings do not make pedestrians safer. Use pedestrian crossing or school crossing signs where needed.

6. Guide signs are used to provide information to drivers and help them reach their destination.

A. Street name signs should be provided at all intersections.
   - Street name signs are normally placed on the near left and far right corners of the intersection, from the point of view of traffic on the major road.
   - On high-speed roads, advance guide signs, such as “Main St 800 Ft” can be helpful.
   - To aid older drivers, the minimum letter height for street name signs has changed to 6 inches from 4 inches.
   - 4 inch height letters may still be used on low-volume roads (<400 ADT) or roads with speed limits of 30 mph or less.

B. If the road carries a significant amount of traffic to a tourist destination or population center, directional signs can be helpful.
C. Route marker assemblies should be used at intersections with numbered county or state routes.

7. Dead end and no outlet signs:
   A. Dead end signs are required by law on dead end roads.
   B. No Outlet signs are used when a road leads into an isolated neighborhood with no other exit. They are primarily used when road users are confusing the road for a through street.

8. If all the appropriate signs are in place, yet the intersection is still operating poorly, further steps can be taken to improve safety or operations:
   A. Clear sight lines at intersections.
   B. Street lighting can help prevent nighttime incidents, at the expense of maintenance and power costs.
   C. Pavement markings, especially left turn lanes, can reduce confusion and crashes. Stop lines can be used to emphasize stop control, and to show drivers where they should stop. Further information on this is available in Chapter 7, Pavement Markings.
   D. The intersection control used may not be the best for the intersection. If you suspect this may be the case, consult with a civil engineer.

SIGNING AT CURVES

After intersections, curves are the next most likely locations for serious incidents. Run-off-road incidents are especially common on curves to the left, and head-on incidents are common on curves to the right. Both types often result in injuries or deaths. These types of incidents occur when vehicle drivers drift out of their lane. Good signing and pavement markings can assist guiding drivers through curves without leaving their lane.

Curve signs

A variety of warning signs can be applied to curves. Some common ones are shown below. They fall into three categories: curve warning signs, curve delineation signs (chevrons and arrows), and combination curve/intersection signs.

![Figure 22 - Curve and turn warning signs](image)

Which curve warning sign to use depends on the alignment of the first curve, the advisory speed of the sharpest corner, and whether it is a single curve or if there are several curves close together.
Table 9 - Horizontal alignment sign usage
(Source: Table 2C-5 from the NYS Supplement)

<table>
<thead>
<tr>
<th># of Curves</th>
<th>Advisory Speed (mph)</th>
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<tr>
<td></td>
<td>Less than or</td>
<td>25 or 30</td>
<td>Greater than or</td>
</tr>
<tr>
<td></td>
<td>equal to 20 mph</td>
<td>mph</td>
<td>equal to 35 mph</td>
</tr>
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<td>1</td>
<td>W1-1</td>
<td>Turn or Curve</td>
<td>W1-2</td>
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<td></td>
<td>L</td>
<td>signs may be</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>used.*</td>
<td>R</td>
</tr>
<tr>
<td>2</td>
<td>W1-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 or more</td>
<td>W1-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The decision should be based on the geometry and general appearance of the particular curve(s)

For single curves, if the advisory speed is 20 mph or less, W1-1 turn signs are used. If the advisory speed is greater than or equal to 35 mph, W1-2 curve signs are used. For advisory speeds of 25 or 30 mph, the type of sign to use is based upon the geometry and general appearance of the curve. Note that the MUTCD allows engineering judgment to determine if W1-1 or W1-2 signs should be used.

**Multiple curves**

Two curves with the same alignment (both right-handed or left-handed) separated by less than 200 feet of straight road may be signed as a single curve. The lower advisory speed of the two curves should be used. The individual curves should be signed separately if the second curve is sharper than the first. Curves in the same direction separated by 200 feet or more shall be signed separately.

If two curves with opposite alignments are separated by less than 600 feet of straight road, they may be signed together using a W1-3 or W1-4 sign. The lower advisory speed of the two curves should be used.

Where the lower advisory speed of the two curves is 20 mph or slower, a W1-3 reverse turn sign shall be used. If the lower advisory speed is 25 or 30 mph, either W1-3 reverse turn or W1-4 reverse curve signs may be used. If the advisory speed is 35 mph or higher then W1-4 reverse curve signs shall be used.

For groups of three or more curves less than 600 feet apart, W1-5 winding road signs can be used. The W1-5L should be used if the first curve is to the left, and the W1-5R should be used if the first curve is to the right.
Within the series of curves, additional W1-1 through W1-4 signs may be used for individual curves. Additional signs should be used if there are more than four curves in the series.

For W1-5 signs, the advisory speed on the sign should be the lowest advisory speed in the set of curves.

*Figure 23 - Curve delineation signs (arrows and chevrons)*

Curve delineation provides guidance to drivers and helps guide them through curves. They provide more information on the location and sharpness of the curve than a curve warning sign can give. This can reduce crashes by 30 percent on problem curves.

If a curve is still experiencing run-off-road or head-on crash incidents after a curve warning sign is installed, chevrons or arrows may help. Chevrons or arrows can be useful on sharp curves after long straight sections, or curves that are sharper than their neighbors. Where curves are hidden by hillcrests, chevrons can be mounted on higher posts to be seen over the hilltop.

Chevron signs should be visible for a sufficient distance to provide the road user with adequate time to react to the alignment change. At least two chevrons should be visible throughout the curve. If three or more can be seen, it is easier for the driver to visualize the alignment change. Table 10 can be used to set chevron spacing. Before using the table, make sure the advisory speed is correct.

*Table 10 - Chevron spacing*

<table>
<thead>
<tr>
<th>Advisory speed value (mph)</th>
<th>Chevron spacing in curve (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>25</td>
<td>80</td>
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<td>30</td>
<td>80</td>
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<td>35</td>
<td>120</td>
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<td>40</td>
<td>120</td>
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<tr>
<td>45</td>
<td>160</td>
</tr>
<tr>
<td>50</td>
<td>160</td>
</tr>
<tr>
<td>55</td>
<td>160</td>
</tr>
<tr>
<td>60</td>
<td>200</td>
</tr>
</tbody>
</table>

*Source: Guidelines for the Use and Spacing of Delineators and Chevrons*

*Paul J. Carlson, Elisabeth R. Rose, Susan T. Chrysler,*

*Texas Transportation Institute, April, 2004*
If arrow signs are used, one or more should be used in each direction. It should be visible for a sufficient distance to provide the road user with adequate time to react to the alignment change.

**Solving curve safety problems**

The most common safety problems on curves are lane departures. These are mostly single vehicle run-off-road incidents, crossover incidents, head-on and opposite-direction sideswipe incidents. Run-off-road incidents are more likely on curves to the left. The causes of these are very similar – the driver has trouble staying in their lane, and either crosses the centerline or drifts off the side of the road. The preventive countermeasures are also similar – warn drivers of the curve with curve warning signs, and guide them through it with chevrons or arrows.

When deciding whether to add signing to a curve, here are some things to consider:

1. Determine the speed of traffic approaching the curve. Normally, the speed limit is close enough, but if you suspect that traffic is approaching the curve substantially faster than the speed limit, you may want to measure the eighty-fifth-percentile speed. If you choose an approach speed lower than the speed limit, carefully document your reasoning. A speed study showing that the eighty-fifth-percentile speed is lower than the speed limit is the best way to justify using an approach speed lower than the speed limit.

2. Determine the advisory speed.
   a. If the advisory speed is lower than the speed limit, advance signs and advisory speed panels are required.
   b. If the advisory speed is equal to the speed limit or to the speed limit plus 5 mph, advance curve signs are recommended and advisory speed panels should not be used.
   c. Curve signs are not usually used on curves where the advisory speed is more than five mph over the speed limit, but may be useful if run-off-road or cross over crashes are occurring there.

3. Are chevrons, arrows or delineators needed? Consider using them at:
   b. Isolated curves.
   c. First curve after a long straightaway.
   d. Curves that are sharper than neighboring curves.

Signing for curves can increase safety, but sometimes curve incidents will persist. Additional measures can be applied to improve the safety of the curve. These are usually more expensive than signing. Here are some things to remember when signing curves:

- Centerlines and edge lines help drivers stay in their lane, at the expense of ongoing maintenance costs.
- Superelevation (banking) reduces the cornering force required to steer around the curve.
- Curve widening gives more room for error, and is cheaper than widening the whole road. It is most effective on tight curves on narrow roads.
• Street lighting can reduce the number of nighttime incidents, at the expense of ongoing maintenance and power costs. The light poles should be on the inside of the curve.
• If incidents still occur, roadside improvements like removing trees, flattening slopes, or installing guiderail can reduce the severity of incidents.
• As an expensive last resort, the curve can be rebuilt with a larger radius.

Figure 24 - Sample of sign layout
Signs are used to communicate your message to the roadway user. It is essential that proper materials or products are used to accomplish that goal. Since many types of sign materials, posts, and bases are available it is important to have a basic understanding of the materials. It is equally important to decide when to use the most cost efficient materials.

This chapter discusses sign sheeting, sign panel materials, posts, bases and other hardware.

**SIGN SHEETING**

Sign sheeting is a complex product made from clear and colored plastics, metallic or glass reflective elements, and adhesive backing.

The MUTCD requires that regulatory, warning and guide signs shall be retroreflective or illuminated to show the same shape and similar color by both day and night. The requirement for sign illumination shall not be considered to be satisfied by street or highway lighting.

Unless the message on a sign will only be needed in daylight, signs need to be retroreflective. Since winter sunset occurs as early as 4:15 PM in some parts of New York State, very few permanent signs do not have to be retroreflective.

There are two main types of retroreflective sign materials: spherical reflector beads or microprisms. In both, tiny, nearly microscopic beads or tiny prisms reflect light back towards its source. Appendix G, page 73, shows how to identify the various types of sheetings, based on appearance.

**Bead retroreflectivity**

Pavement markings and older types of sign sheeting use tiny glass beads to reflect light. Light from headlights enters the bead, reflects off the rear surface of the bead, and is directed back along the path it came from. Engineering grade and super engineering grade sheeting materials use glass bead reflectors.

![Figure 25 - Two types of reflector beads](image-url)
Microprismatic retroreflectivity

Microprismatic sheeting uses tiny prisms to reflect light. These prisms are like bicycle reflectors, but much smaller. There are hundreds of prisms per square inch. The prisms are much more efficient than the beads used in older sheeting types, so microprismatic signs appear much brighter than engineering grade or high intensity signs. Microprismatic sign sheetings include 3M VIP or LDP “Diamond Grades” and Avery Dennison Series 7500 sheetings. High intensity sheeting may use either beads or prisms.

Lifetime costs

While microprismatic sheeting is brighter, it is more expensive, which is a factor to take into consideration. It takes longer to weather to the point that its retroreflectivity is ineffective, so it can actually be cheaper in the long run. Barring vandalism or crash damage, a microprismatic sign’s retroreflectivity property can last two or three times as long as an engineering grade sign. Also note that for some signs, such as warning signs, engineering grade materials will not meet the new retroreflective standards being proposed by the Federal Highway Administration (see Appendix H, page 75).

Signs mounted well away from the road, to the left of traffic, or overhead

Headlights direct most light down and to the right, so these signs do not receive as much light from headlights. Microprismatic sheeting reflects more of the light that reaches it back to the eyes of the driver.

Key warning and regulatory signs

These signs need to command attention because of the safety consequences if they are not seen. Microprismatic sheeting gives signs a greater target value at night. NYSDOT is requiring a high grade of microprismatic sheeting on stop signs and other high primacy signs on state roads.

SIGNPOSTS

Signposts have to have two important properties. First, they need to be strong enough to hold the sign in place without bending or breaking in high winds. They also need to yield or break away when struck, so that they do not pose a danger to vehicle occupants in run-off-road incidents. All sign supports located within the clear zone of the roadway or street must meet acceptable breakaway standards.

The Clear Zone is an unobstructed area adjacent to the traveled way that is provided to enable a driver of an errant vehicle to return the vehicle to the road or stop without potential for serious incident. Criteria for determining clear zone width is contained in AASHTO’s Roadside Design Guide, 2002.

Choosing sign posts and supports

Signposts and supports come in a variety of materials in different shapes and different sizes. Small signs (less than 50 square feet) are commonly supported with either wood or steel. Larger signs (greater than 50 square feet) may be mounted on specifically designed steel or aluminum structures such as trusses or cantilevered supports. There are many types of signposts and supports. The most common types are steel U-channel, square tube or round tube. Wood posts are also used. Sometimes theft of wood posts can be a problem, since they are made from valuable, rot-resistant redwood, cedar or pressure-treated lumber.
The majority of small steel sign posts include the U-channel, round pipe and square tube. Posts are listed by how much a foot-long piece of the post weighs. For example, common U-channel post weights are 2 lb/ft, 2.5 lb/ft, 3 lb/ft, and 4 lb/ft. The larger a sign is, and the higher it is off the ground, the greater the force that will be exerted on the post due to wind. Larger signs present more area for the wind to push against, and higher signs generate more leverage on the post.

Heavy posts can withstand greater wind loads associated with larger signs and higher winds, but they cost more and are more hazardous in run-off-road crashes. Square or round tubular posts resist twisting better than U-channels. They may be useful in windy areas, or when large signs are used. They are usually more expensive than U-channels.

Stiffener bars are used to support the sign panel in high winds and keep it from bending. Not all agencies use them. They are useful on wider signs. Figure 26 shows two acceptable examples of stiffener bars.

![Figure 26 - Stiffener bars](image)

*The example on the left uses a single strap stiffener attached to a square steel tube post.*  
*The example on the right shows Z-Bars being used to stiffen a stop sign with a supplemental all-way plaque attached to a U-channel post.*

**SIGNPOST BASES**

A signpost base can have significant impact on whether the post will injure vehicle occupants during a crash. Non-breakaway or non-slip-impact bases often result in vehicle rollover incidents or serious injuries to vehicle occupants.

There are three main ways to attach a signpost to the ground. These are:

1. Direct embedment: driving the post directly into the ground.
2. Ground-level splice: designed to break away in a controlled manner in a crash.
3. Slip impact base: designed to come apart when struck.
**Direct embedment**

This is the simplest way to install a post. A signpost is driven into the ground, and the sign is bolted to the post’s top. This is acceptable in the following situations:

- In strong soils, U-channel posts up to 3 lb/ft will break off at the base when hit.
- In weak or sandy soils, a soil plate is needed so that the post will break off as intended. Without the plate, the post may pull out of the ground. The force needed to pull the post out is enough to stop a vehicle suddenly and injure the occupants.
- Wood posts 4 by 6 inches or larger need holes drilled in them in order to break away safely when hit in a run-off-road crash. Drill two holes one third of the width of the post, at 4 and 18 inches above the ground. The holes should be perpendicular to traffic.

The sign and the upper part of the post can become a high-speed projectile, so direct embedment may not be the best choice in areas where pedestrians may be present.

U-channels heavier than 3 lb/ft should not be direct embedded if they will be exposed to traffic. For other metal posts, see the manufacturer’s information. If three or more posts will be within seven feet of each other, breakaway bases should be used.

**Ground-level splice**

These systems include a base post that is driven into the ground and a signpost that is bolted to it. Some types include retaining straps or spacers between the base post and the signpost.

- Ground-level splices work better than direct embedment in weak and sandy soils.
- They allow 4 lb/ft posts to be exposed to traffic.
- Some are designed to prevent the upper post from becoming a projectile when struck.
- Some are designed to make repair easier after the sign is hit.
- The base post should not stick out of the ground more than four inches, to avoid puncturing a vehicle’s gas tank or causing other undesirable results in a crash.

*Figure 27 - Breakaway ground-level splice base after a crash*

*Only the retainer strap (the piece with the long narrow slot), two bolts (the broken one and the bent one remaining in the base), one nut, and two washers need to be replaced.*
Slip impact bases
Slip impact bases are designed so the upper post will disconnect from the lower base on impact. On multi-post slip impact base sign supports, the post has a hinge point just below the sign panel. This is so one post can break away while the other holds the sign up and allows the vehicle to pass underneath. Slip impact bases are used on large guide signs, within the clear area, that are not behind guiderail. They are also available for small sign supports. The bolt torque of slip impact bases and hinge points is important. If the bolts are too tight, the base will not work as intended. If they are too loose, the wind may trigger the slip base or hinge point, and the sign will fall over.

SIGN PANELS
Sign panels have to withstand wind and weather. The most common sign panel is sheet aluminum. Older signs are sometimes steel. Plywood and fiberglass are also used, and plastic composites are starting to come onto the market. Plastic composites may be more crashworthy because they are lighter.

NUTS, BOLTS, AND WASHERS
Grade 9 bolts are usually specified for signs. Combined with nylon or neoprene washers, they help keep the sign from breaking free of the sign post and penetrating the windshield of a vehicle that hits the post.

Vandal-resistant hardware
Sign theft and vandalism are costly to highway departments, and can increase the risk of crashes. Some methods to discourage theft include vandal-resistant nuts, thread-locking compound on bolts, and bending the end of the bolt that extends past the nut. Another method is to cover the back of the sign with an unpleasant material like axle grease.

Several companies sell clear overlay materials that protect sign faces from most paints. These materials are designed so paint does not stick to them. They are more resistant to cleaning solvents than most sign sheeting materials.

One way to discourage theft is marking sign backs with the agency’s name. The markings can be engraved into the metal, written in permanent ink, or on stickers, which should be difficult to remove. A theft deterrent message is often added, as shown in Figure 28:

![Figure 28 - Sticker used to discourage vandalism](image)

The numbers are punched out to record the installation date.
INSTALLING SIGNS

Signposts may be driven in by hand, but a pneumatic or hydraulic post driver makes the work much faster and easier. Remember to contact an underground locating service for a ‘mark out’ of any possible underground utilities prior to installing signposts.

If you are installing a direct-embedded post, first drive the post, then attach the sign with bolts, nylon washers, and nuts.

If using ground level splices or slip impact bases, make sure the top of the base is less than 4 inches above the ground. To protect the sign face during installation, place a soft cloth on the ground. Put nylon washers on the sign panel bolts, and put them through the holes in the sign panel. Place the sign face down on the cloth, and attach the stiffeners (if used) and the posts, with nuts and washers. Lift up the sign and post. Have a helper hold it up while bolting the post to the base.

After installing the signs, drive through the site and check the locations of each sign. Can all of them be seen? If not, you may need to adjust locations. It helps to have an objective person do a final drive-through inspection, to make sure you have not missed anything.
6 - Sign Management

Traffic signs are a vital aspect of the traffic safety of your community. The large number of liability lawsuits related to the condition and placement of traffic signs emphasizes the importance of a good sign management program.

All signs will eventually need replacement, even the best ones. Posts and sign assemblies may fail as a result of vehicle damage, vandalism, fading or wind.

Proper sign management will allow you to maintain a reasonable standard of care for your roadways and will assist in protecting your municipality against potential liability.

There are three parts to an effective sign management program: Inventory, Evaluation and Maintenance (repair or replacement).

INVENTORY

Maintaining a good inventory of standing road signs is an essential part of sign management. It is difficult to manage something if you are unsure of what you have. With an accurate inventory, you can quickly identify which sign was stolen or damaged, rather than guessing what sign was originally in place.

Sign inventories need not be complex. Smaller agencies often use a paper or index card system. Larger highway departments often use computer database inventories. These range from basic applications to sophisticated proprietary software packages.

If you have large numbers of standing signs, the initial inventory can be time consuming. It is easier to break it into smaller sections and do one at a time. Scheduling a sign inventory for days when weather prevents other maintenance activities may also help maximize limited resources. Some departments use student interns to compile the sign inventory. Whatever method you use, start with your most heavily traveled roads first, since higher volume roads have a greater potential for incidents.

A good inventory should include the following:

- Sign type
- Sign size
- Location
- Facing direction
- Installation date
- Sheeting material type
- Backing material type
- Post type
- Sign condition
- Post condition
- Any deviations from the MUTCD, with an explanation why
EVALUATION

During the initial inventory, the condition of the sign should be evaluated. The evaluation should include sign condition, post condition, and conformance with the MUTCD. Sign inspection forms are included in the Appendices, to assist you in the accuracy of details.

Daytime inspection

Daytime inspections should be conducted twice a year. In early spring, inspect for damage from weather or snowplows. In mid-summer, check signs again to make sure that vegetation has not blocked their lines of sight.

During daytime inspections, check the following items:

- **Sign condition** - look for missing signs, damage to the sign legend or panel. Is the sign readable? Has the face of the sign been vandalized, scratched, or cracked? Some agencies shine a high-power spotlight on the sign. If the sign does not “flash,” they note that the retroreflectivity of that sign should be checked during the next night inspection.

- **Post condition** - look for missing bolts or accident damage. Look to see if the post is leaning, indicating weak soil conditions. Make sure that breakaway devices are in good condition and will work as designed. Look for erosion around the base that could leave the breakaway device more than four inches above ground height. Make sure slip bases have not been buried, and bolt torque is neither too tight nor too loose. Look for corrosion that could weaken posts or cause breakaway bases to malfunction.

- **Obstructions** - is anything blocking the view of the sign, including other sign assemblies? If so, remove the obstruction or relocate the sign if possible.

Nighttime inspection

Nighttime inspections should be done at least annually. Nighttime inspections are one of the retroreflectivity management techniques allowed in the new FHWA standard (see Appendix H, page 75). Weather and sunlight degrade retroreflective materials until they are no longer effective at night, even though the sign may still look good by daylight. For example, look at Figure 29 and compare the two pictures of the same sign. By day, all of the sign panels look good, but at night, the W7-1 Hill sign on top is noticeably dimmer than the auxiliary signs beneath it, demonstrating the importance of nighttime inspections.

Signs and markings need to be replaced before they lose their retroreflectivity and become too dim to be recognized by the road user. Several methods can be employed to determine whether action is needed. Five different methods will be allowable under the new standard proposed by the FWHA. More details can be found in Appendix H, page 75.

The most accurate method uses a retroreflectometer. These devices measure the retroreflectivity of signs or pavement markings. Unfortunately, they are expensive. Several neighboring agencies could share ownership of a retroreflectometer to reduce the cost per agency. Since it is only needed for a few days per year during annual sign inspections, this makes more sense than having an expensive piece of equipment sitting in a closet most of the time.
The least expensive method relies on a sign inspector’s judgment. A sign inspector conducts nighttime visual inspections, and if, in their judgment, signs should be replaced, they are replaced. Having a trained sign inspector is critical to improve consistency and accuracy. If the inspector is properly trained, nighttime inspection will be allowed as a management technique in the new retroreflectivity standard.

Here are some guidelines for nighttime sign inspection:

- Use a pick-up truck or SUV to do the inspection. Since truck drivers sit farther back from the headlights than car drivers, signs can appear dimmer to truck drivers.
- Make sure the vehicle’s headlights are properly adjusted. If headlights are aimed too low or to the left, you may reject good signs. If they are aimed too high or to the right, you may keep bad signs.
- Use low beams. A sign that needs to be replaced may look okay when illuminated by high beams.
- Be conservative. It is better to replace a sign early than to leave up a bad sign that could result in an incident. If possible use an older inspector during nighttime inspections. A 46-year old driver needs 4 times more light in order to see than a 20-year old driver does. Signs and markings will not look as bright to older drivers.

For more consistent inspections you might consider using comparison panels. These are small pieces of retroreflective sheeting that meet the current standards for retroreflectivity. The new sheeting is applied to small blanks of metal and placed against the sign panels being inspected. Any difference in brightness will indicate how much fading has occurred and will assist in determining whether the sign should be replaced. If the sign is equal in brightness to the comparison strip, there is no need to replace it.
Figure 30 shows the same comparison strips clipped to the lower left edges of two different stop signs. In the example on the left, the comparison strip is brighter than the sign, indicating that this sign has experienced a large degree of fading. This sign should be replaced. The comparison strip applied to the sign on the right indicates a minimal amount of fading and thus this sign does not require replacement.

Some agencies use replacement cycles. Replacements on the life cycle of each individual sign, life cycle of signs of a particular type or in certain areas of the municipality are allowable methods under the new retroreflectivity standard. For example, high-intensity grade sheeting has an expected life of fourteen years. Users of this method replace 1/14 of all high-intensity signs each year, whether they need it or not. An advantage to this method is you can ask sign vendors for a package deal on that year’s signs, and perhaps get a better price per sign. It does not end the need for annual inspections, since occasionally signs will not last as long as the expected average.

Whichever method you use, document your inspection process and findings. This will help defend against lawsuits.

Conformance with the MUTCD

Signs should be evaluated to make sure they conform to the requirements of the MUTCD. Check whether it is the appropriate sign, and that it is in the correct location. Remember that after September 13, 2007, all traffic control devices repaired or replaced must conform upon installation. Refer to Chapter 4 for more details.

MAINTENANCE (REPAIR OR REPLACEMENT)

Highway departments need an adequate supply of signs, posts, and hardware on hand, so signs can be replaced if they fail inspection or are damaged. The size of this inventory will depend on the road type and lane miles the department maintains. It should include several replacement stop signs and key warning signs, as well as posts and hardware to install them.

When a sign inspection reveals a damaged sign, it needs to be repaired or replaced. The technique used will depend on the nature and amount of damage. Sign panels that are removed may be recycled, sent to a sign shop to be refaced, or kept as spares for emergency replacement if they are not too badly damaged.
If a sign is not badly bent, it can sometimes be repaired. Place a soft cloth on a flat sturdy surface. Place the sign face down on the cloth, and tap the back of the sign with a rubber mallet to flatten it. Check the condition of the sign sheeting. Reinstall the sign if the sheeting is not too badly scratched or cracked. Depending on the degree of damage, it may be more time-effective to replace a sign, and bring it back to the shop for straightening later.

Scratches can be repaired with patches of self-adhesive sign sheeting. Clean the sign face with a cleaner recommended by the sign sheeting manufacturer. Take a patch of the same material that you are repairing, and cut it to a size somewhat larger than the scratch. Make sure the patch is the same material that you are repairing. Covering a scratch in Diamond Grade sheeting with a patch made of high intensity sheeting may look fine by daylight, but it will be difficult to read at night because of the difference in brightness.

To repair shot holes, first flatten the sign panel as described above. Patch the front as described above. Then, use aluminum foil tape or a similar material to seal the back of the hole so water does not enter.

Remember repairs of this nature are temporary and the sign will need to be inspected more often. Look for possible bubbling on the surface of the sheeting or the sheeting peeling away from the sign itself, especially in areas where sign puncture repairs were made. Frequent inspection will insure that the repair is holding up to the elements and the sign is functioning as required.
7 - Pavement Markings

Pavement markings help regulate and guide traffic along and across the highway in an orderly and safe manner. They effectively convey regulatory information and vehicle-path guidance to a driver without requiring them to divert their attention from the roadway. Pavement markings also encourage orderly traffic flow and optimize highway capacity.

All pavement markings should be maintained and re-applied as needed to assure good visibility both during the day and at night. Once the decision has been made to install a pavement marking, it is the municipality’s responsibility to maintain that marking. If the municipality decides that the marking is not needed, then a record of the study or decision process should be filed. Any markings that are not applicable and/or may cause confusion shall be removed as soon as practical.

STANDARDS

Highway pavement marking is more than just applying lines to the pavement surface. It is the installation of a traffic regulation and guidance system. Just like signs, in order to be effective, pavement markings must be readily recognized and understood. Also in common with signs, a uniform system of color, shape, and application has been developed so that motorists see the same type of markings whenever they travel through a particular situation. These markings convey the same message each time they are encountered. For example:

- White longitudinal lines are used to separate traffic flow in the same direction and for right edge line delineation.
- Yellow longitudinal lines are used to separate opposing lanes of traffic, left edge line delineation, two-way left turn lanes and reversible lanes.

Centerline pavement markings are required on:

- All paved urban arterials and collectors where the travelled way is twenty feet wide or greater and has an ADT (average daily traffic) of 6,000 vehicles or greater.
- All paved two-way streets or highways that have three or more lanes.

Centerline markings should be placed on all rural arterials and collectors with a travel way eighteen feet or wider and an ADT of 3,000 vehicles per day or greater.

Chapter 3 of the National MUTCD and corresponding section of the State Supplement provide full direction for the correct use of pavement markings.

It is a good idea to develop pavement marking patterns for new roadways during the design stage so pavement edges and construction joints can conform as closely as possible to pavement markings.
**FUNCTIONS**

Pavement markings can be broken into two groupings, longitudinal lines and transverse lines.

Longitudinal lines, commonly called long lines, are applied in white and yellow. The dashed lines, also known as broken lines, permit vehicles to pass or change lanes. These lines, also white or yellow, are four to six inches wide and applied with ten foot painted dashes and thirty foot spaces between dashes. Thus it is forty feet from the beginning of one dash to the beginning of the next dash. These lines give us a good tool to estimate distances along highways. For instance, if there are five dashes between two driveways; then there is an estimated distance of 200 feet separating the driveways (5 x 40).

Solid lines in conjunction with parallel broken lines prohibit passing or crossing from the solid side to the broken side while passing or crossing is permitted from the broken to the solid side. Double solid lines prohibit passing or lane changing. The dimensions of passing zones are based on sight distance and prevailing speeds. Consult the National MUTCD, Table 3B-1 (see Table 11 in this workbook, page 60).

Transverse lines are lines that are perpendicular to the travel path, such as stop and yield lines and crosswalks, as well as special markings that include symbols, word marking and channeling or hatching (shoulder) markings. These markings are typically white, with the exception of channeling or hatching (shoulder) marking along the left side of a one-way roadway.

**MATERIALS**

Paint is the most commonly used material for pavement markings. However, paint alone would have very poor visibility at night. Nighttime visibility is improved by dropping glass beads into the wet paint. The beads add retroreflectivity. Paint is the easiest and cheapest marking material, but it is also the least durable.

The New York State Department of Transportation (NYSDOT) uses epoxy with glass beads for long lines. This material can be placed on asphalt or concrete pavements with an anticipated life of at least three years. Tape is typically used by NYSDOT for transverse and special marking. The tape is manufactured with either glass beads or prisms encapsulated in the material for retroreflectivity.
Thermoplastic pavement markings use a temperature-setting plastic material that is used primarily on asphalt pavements. There is some reluctance to use this material on concrete pavements, based on the temperature-related expansion and contraction differentials between the plastic and concrete, which can result in separation of the thermoplastic from the pavement. Southern locations in New York State which do not experience the extreme winter temperatures, such as New York City and Long Island, have had success with this material on concrete pavement. The thermoplastic material must be heated to melting point. To provide the retroreflectivity, glass beads are dropped into the molten material as it is applied to the pavement.

TYPICAL MARKINGS

Color, pattern, and orientation of pavement markings convey information to the roadway user. Compliance to the standards is critical in order to provide positive guidance.

Longitudinal Markings

As noted in the previous section, longitudinal markings guide traffic along the roadway by providing visual clues to the travel path.

The widths and patterns of longitudinal lines shall be as follows:

A. A normal line is 4 to 6 inches wide.
B. A wide line is at least twice the width of a normal line. The width of the line indicates the degree of emphasis.
C. A double line consists of two parallel lines separated by a discernible space.
D. A broken line consists of normal line segments (10 feet) separated by (30 feet) gaps.
E. A dotted line shall consist of noticeably shorter line segments (typically 2 feet) separated by shorter gaps (typically 2 feet) than used for a broken line. The width of a dotted line shall be at least the same as the width of the line it extends.

Passing Zones

Pavement marking that indicates passing is permitted on two lane highways carrying two-way traffic is shown in Figure 33 on page 58 (Figure 3B-1 from the National MUTCD).

When centerline markings are used, no-passing zone marking shall be used on two-way roadways at lane reduction transitions and on approaches to obstructions that must be passed on the right. **Note: The Do Not Pass (R4-1) shall be used only with standard markings. Signing may be used on the left side of the roadway for additional emphasis, if needed, using a No Passing Zone (W14-3) sign.**

Where centerline markings are used, no-passing zone markings shall be used on approaches to highway-rail grade crossings.

On two-way, two-lane 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 distance or other special conditions. Adequate passing sight distance is defined as the minimum sight distance necessary for reasonably safe passing at the 85th-percentile speed or at the posted or statutory speed limit as shown in Table 11 on page 60 (Table 3B-1 from the National MUTCD).
Figure 3B-1. Examples of Two-Lane, Two-Way Marking Applications

a - Typical two-lane, two-way marking with passing permitted in both directions

b - Typical two-lane, two-way marking with no passing zones

Legend
→ Direction of travel

Note:
See Section 3B.07 for edge line warrants.

Figure 33 - Two-lane, two-way marking applications
(Figure 3B-1 from the National MUTCD)
Figure 34 - Limits of no-passing zones at curves
(Figure 3B-5 from the National MUTCD)
Table 11 - Minimum passing sight distances
(Table 3B-1 from the National MUTCD)

<table>
<thead>
<tr>
<th>85th-Percentile or Posted or Statutory Speed Limit (mph)</th>
<th>Minimum Passing Sight Distance (feet)</th>
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</thead>
<tbody>
<tr>
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<td>30</td>
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<td>1,100</td>
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<tr>
<td>70</td>
<td>1,200</td>
</tr>
</tbody>
</table>

The passing sight distance on a vertical curve is the distance at which an object 3.5 feet (42 inches) above the pavement surface can be seen from a point 3.5 feet (42 inches) above the pavement. 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 3.5 feet (42 inches) 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 34 on page 59 (Figure 3B-5 from the National MUTCD).

SPECIAL (TRANSVERSE) MARKINGS

Pavement marking letters, numerals, and symbols shall be installed in accordance with the pavement marking chapter of the Standard Highway Signs book, which can be found online at: http://mutcd.fhwa.dot.gov/ser-shs_millennium.htm.

Stop & Yield Lines

Stop lines should be 12 to 24 inches wide while yield lines consist of a row of solid white isosceles triangles pointing toward approaching traffic extending across approach lanes to indicate the point at which the yield is intended or required to be made. When used, stop and yield lines should be placed a minimum of 4 feet in advance of the nearest crosswalk at controlled intersections, except for yield lines at roundabouts and at mid block crosswalks. In the absence of a marked crosswalk, the stop line or yield line should be placed at the desired stopping or yield point, but should be placed no more than 30 feet nor less than 4 feet 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.
Crosswalks
The New York State Vehicle & Traffic Law (see NYS V&T crosswalk definition), states that a crosswalk exists at an intersection whether or not it is marked. Pedestrians have the right-of-way at unsignalized crosswalks.

The MUTCD permits several crosswalk marking schemes, including the ladder. Transverse lines with cross hatching, the most common marking, consists of two parallel lines, 6 inches to 24 inches wide, that are 6 feet apart.

Turning Lanes
Symbol markings (arrows) that inform the motorist of mandatory movements are considered supplemental. This means that the mandatory movement must be posted by standard regulatory sign(s). Although these markings help motorists to understand an intersection operation, the signs are needed because queued vehicles may cover the symbols and obscure them from view by other approaching vehicles. If lanes approaching an intersection become mandatory turn lanes, the arrow marking should be accompanied by the word marking “ONLY”.

Railroads
Pavement marking in advance of a highway-rail grade crossing shall consist of an X, the letters RR, a no-passing marking (two-lane highway where centerline markings are used), and 24-inch transverse lines placed 25 feet before and after the RR centerline, along with a stop line approximately 15 feet before the track crossing. These markings are not required at crossings where the posted or statutory highway speed is less than 40 miles per hour, or in urban areas if an engineering study indicates that other installed devices provide suitable warning and control.

For more information, refer to Part 8 of the National MUTCD.

MAINTENANCE ISSUES
If you have made a decision to install a pavement marking, then you are also committed to maintaining the marking.

Just as with signs, pavement markings should be reviewed periodically to ensure that they are serving their intended function.

Durable markings (thermoplastic or epoxy) and tape should be replaced when necessary or as recommended by the manufacturer. Water based markings have a shorter life expectancy. They should be considered for repainting once each 12-month period or as often as needed.

Maintaining an up-to-date inventory of pavement markings is essential. The inventory serves as a record of the markings that should be in place, and will also aid the municipality’s estimating task when it is time to replace the markings. Inspections should be conducted both during daylight and at night. Pavement markings that appear serviceable during daylight may completely lack retroreflectivity, making them useless at night. Additionally, consider reviewing pavement markings under wet road conditions, by day and at night. Puddles or runoff that covers the pavement markings will severely affect retroreflectivity. In these conditions, tarred joints and sealed cracks may appear more dominant than the pavement markings. Bright sunlight at low angles, especially near sunrise and sunset, can also have this effect, even on dry pavement.
Appendix A - Print References


mutcd.fhwa.dot.gov

https://www.nysdot.gov/portal/page/portal/divisions/operating/oom/transportation-systems/traffic-operations-section/mutcd

New York State Standard Sheets, New York State Department of Transportation, Albany, NY

Official Compilation, Codes, Rules and Regulations of the State of New York, 17 Transportation (B), Department of State, Albany, NY, 2001

Road Safety Fundamentals, Cornell Local Roads Program, Ithaca, NY, 2002

mutcd.fhwa.dot.gov/ser-shs_millennium.htm


Guiderail V, Design Quality Assurance Bureau, September 2002


public.leginfo.state.ny.us/menuf.cgi


Handbook of Simplified Practice for Traffic Studies, Center for Transportation Research and Education, Iowa State University Ames, Iowa, 2002
www.ctre.iastate.edu

United States Road Symbol Signs, USDOT, Federal Highway Administration, Washington, DC, 2002, FHWA-OP-02-084

Appendix B - Video Resources

The following videos are available for loan from the NYSLTAP Center - Cornell Local Roads Program:

A Striper’s Survival Guide, ATSSA (12 minutes)
Highway Safety: The Silent Factor, FHWA (30 minutes)
Inspector’s Guide to Pavement Markings: Traffic Paint, ATSSA (14 minutes)
New Directions in Sign Management, ATSSA (17 minutes)
Night Lights: How Retroreflectivity Makes Our Roads Safer, ATSSA (11 minutes)
Right Before Your Eyes, ATSSA (9 minutes)
Safe Roadside Signs, FHWA (16 minutes)
Sign Maintenance and Installation, USDOT/FHWA (30 minutes)
Signs, Signals & Markings - Understanding the Language, AAA/Foundation for Traffic Safety (17 minutes)
The Best Defense is a Good Road, FHWA/CLRP (16 minutes)
Traffic Control: What Works, Minnesota LRRB (14 minutes)
Appendix C - Glossary

AASHTO – American Association of State Highway and Transportation Officials. An association of transportation departments in the 50 states, the District of Columbia, and Puerto Rico.

AADT – “Annual Average Daily Traffic” A general unit of measure for traffic, which represents the annual average traffic per day, corrected for seasonal changes in traffic volumes.

ADT – “Average Daily Traffic” The number of vehicles that use a road on an average day.

Clear area – The area available to a vehicle that goes off the road. It is the area free of obstacles or dangerous slopes. It gives drivers an opportunity to recover control before hitting anything. See also Clear zone.

Clear zone – The distance from the edge of the road to the nearest roadside hazards. More clear zone width is desired on high–speed or high–volume roads. If the road is on top of a fill slope, more should be provided. If the roadside slopes upwards, less clear zone is needed. Wider clear zones are desired on the outside of curves.

• Desired clear zone width – The width recommended in national standards, based on speed, volume, curvature, and roadside slopes.
• Design clear zone width – What you actually decide to provide when designing a road project, considering cost, ROW, etc. It also represents a commitment to maintain a clear area at least this wide.

Corner angle – The included angle between two roadways, or a road and a driveway. It should be between 75 and 105 degrees. Angles close to 90 degrees are safest.

Critical slope – A slope parallel to the road steeper than one on three. There is a good chance that a vehicle on a critical slope will roll over. Critical slopes higher than five feet should be either shielded with guide rail, or fill should be added to make the slope traversable or recoverable.

DOT – Department of Transportation

Expectancy – What drivers expect the road ahead of them to be like, based on the road they have just driven, and all of their lifelong driving experience. Violations of expectancy often cause driver error.

FHWA – Federal Highway Administration

Fixed object – A roadside object that is massive enough to injure vehicle occupants, such as trees, utility poles, boulders, etc.

Functional class – A way of characterizing roads based on the role they play in the transportation network:

• Local roads primarily provide access to adjacent land. Through traffic is usually a small percentage of total traffic.
• Collectors provide access to neighborhoods and carry traffic from local neighborhood road networks to arterials. They also provide access to adjacent properties.
Arterials carry large amounts of traffic. They usually serve traffic traveling regionally. Intersections are generally at grade, but driveway access to adjacent properties may be restricted.

Freeways primarily carry through traffic. Junctions with other roads occur at interchanges. Driveways are not allowed. Interstate highways are freeways.

Geometry or Geometrics – Collective term for alignment, lane widths, curve radius, etc.

ITE – Institute of Transportation Engineers

Low-volume road – A road with an ADT of less than 400 vehicles per day.

MUTCD – Manual on Uniform Traffic Control Devices

Obstruction – Any object that blocks a driver’s sight line of approaching conflicting vehicles.

NCHRP – National Cooperative Highway Research Program

NYSDOT – New York State Department of Transportation

Opportunity cost – The other choices you give up when selecting one alternative over others. In other words, what you could have done instead.

Retroreflective – a property of material that reflects light back roughly in the direction it comes from, rather than the equal and opposite angle. It is used on traffic control devices to reflect the light from vehicle headlights back to the driver’s eyes.

Roadside hazard – Conditions near the road that present a danger to vehicles that leave the road. Common types include:

- Fixed objects like trees, buildings, or guiderail
- Spearing hazards that could enter the passenger compartment
- Slopes steep enough to launch a vehicle into the air or to roll it over

Road safety audit – A formal examination of an existing road, or a future road or traffic project by an independent team of trained specialists. The team assesses the safety of a roadway project and prepares a report that identifies potential safety problems.

Recoverable slope – A slope parallel to the road that is flatter than one on four. If the clear zone is wide enough, a driver on a critical slope may be able to regain control and return to the roadway.

Sight distance – The maximum distance of unobstructed vision in a horizontal or vertical plane from within an automobile located at any given point on a roadway.

Sight triangles – Specified areas along intersection approach legs and across their included corners. An approach sight triangle is a sight triangle that provides a clear unobstructed view of any approaching conflicting vehicles to the driver of a vehicle approaching an intersection. A departure sight triangle is a sight triangle that provides sufficient sight distance to depart from the intersection and enter or cross the major road for a stopped vehicle on a minor road.

Speed percentiles – A tool used to determine effective and adequate speed limits. The 50th percentile speed is the median (average) speed of the observed traffic. The 85th percentile speed is the speed at which 85% of the observed vehicles are traveling at or below.
Speeding – Exceeding the posted speed limit or driving too fast for conditions.

Superelevation – “Banking” of a curve

Traffic control device (TCD) – Signs, signals, markings, and devices placed on, over, or adjacent to a street or highway to regulate, warn, or guide traffic.

Traffic study – An investigation that gathers information on traffic flow or safety, and uses it to solve a traffic problem. The information gathered, techniques used, and decisions made during traffic studies should be documented for future use.

Traversable slope – A slope steeper than a recoverable slope, but not as steep as critical slope. A vehicle on a traversable slope probably will not overturn, but it is unlikely that the driver will be able to return to the road. The vehicle will probably continue down to the bottom of the slope.

TRB – Transportation Research Board

Source for some of the glossary contents: Handbook of Simplified Practice for Traffic Studies, Center for Transportation Research and Education, Iowa State University, Ames, Iowa, 2002
## WORK ZONE TRAFFIC CONTROL INSPECTION FORM

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### COMMENTS PAGE 1
### FLAGGING

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<td>flags</td>
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### OTHER TRAFFIC CONTROL

| inadequately pedestrian travel path    |                                     |
| inadequate protection from hazards     |                                     |
| poor worker access                     |                                     |
| unprotected operations or equipment in |                                     |
| the roadway                            |                                     |
| original signs/delineation in poor     |                                     |
| condition                               |                                     |

### COMMENTS PAGE 2
Appendix E - Example Section from National MUTCD

The section below illustrates the concepts of SHALL, SHOULD, and MAY as used in the MUTCD. Typically the term Standard is a SHALL condition and must be followed. Guidance is typically a SHOULD condition and is recommended. Option is a MAY condition that can be used in some situations. The term Support is used when there is additional information for use by the highway agency.

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.

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).

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.
Appendix F - Example from Standard Highway Signs

<table>
<thead>
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<th>C</th>
<th>D</th>
<th>E</th>
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COLORS: LEGEND - WHITE (RETROREFLECTIVE)  BACKGROUND - RED (RETROREFLECTIVE)
## Appendix G - Retroreflective Sheeting I.D. Guide

### Retroreflective Sheeting Materials for Rigid Sign Surfaces Made with Prisms

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**NOTES:**
- Several
- ASTM Type
- See note A

### Retroreflective Sheeting Materials for Rigid Sign Surfaces Made with Glass Beads

**NOTES:**
- FHWA does not endorse or approve any material that does not meet the requirements of the guide.
- Materials should be selected by the manufacturer using ASTM D4955-04 for design.
- AS TM types are shown as listed by the manufacturer using ASTM D4955-04 for design.

FHWA Retrospective Sheeting Identification Guide – September 2005

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This side of the sheeting I.D. guide is for rigid surfaces only. The other side is for flexible surfaces and non-signing applications.

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NYS LTAP Center - Cornell Local Roads Program

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Appendix G - Retroreflective Sheeting I.D. Guide
### Contact Information

<table>
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<th>Roll-up Sign</th>
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### Roll-up Signs

- **Material:** High Performance Flexible Sign
- **Material:** Reflective Material
- **Material:** Fluorescent Material

### Flexible Roll-up Signs

- **Material:** Flexible Roll-up Sign
- **Material:** Reflective Material
- **Material:** Fluorescent Material

### Roll-up Signs

- **Material:** Roll-up Sign
- **Material:** Reflective Material
- **Material:** Fluorescent Material

### Typical Use

- **NYS:** Roll-up Sign
- **NYS:** Flexible Roll-up Sign
- **NYS:** Reflective Roll-up Sign

### NYS LTAP Center - Cornell Local Roads Program

#### Retractable Sheeting Materials for Flexible Signs

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<td>I-191</td>
<td>I-201</td>
<td>I-211</td>
</tr>
</tbody>
</table>

#### Retractable Sheeting Materials for Non-Signing Applications

- **ASTM Type:** I-395
- **ASTM Type:** I-495
- **ASTM Type:** I-595
- **ASTM Type:** I-695
- **ASTM Type:** I-795
- **ASTM Type:** I-895
- **ASTM Type:** I-995

#### Notes:

- ASTM Types are shown as selected by the manufacturer using ASTM D4955-98 (Type IV) specifications.
Appendix H - Traffic Sign Retroreflectivity Standards

New standards on retroreflectivity were released by the FHWA in January 2008. While NYSDOT may make some changes to the standard before final adoption, the overall concepts and requirements will still be part of the MUTCD.

By January 2012, all agencies need to establish the method to be used to maintain the minimum levels of sign retroreflectivity. By January 2015, all regulatory, warning, and ground mounted guide signs (except street name signs) must be in compliance. Street name signs must be in compliance by January 2017. The lead time is being given to allow agencies time to develop and implement management plans for their signs. It will take a fair amount of time to develop and implement a management plan, so don’t wait until the last minute!

MANAGING SIGN RETROREFLECTIVITY

These new additions to the MUTCD do not require that an agency measure the retroreflectivity of every sign. Instead, agencies are allowed to choose from several different methods to maintain sign retroreflectivity. These are generally classified as either ‘Assessment’ or ‘Management’ techniques. They may be used separately or combined together. Table 12 shows the basic concepts behind the different methods.

Table 12 - Retroreflectivity management methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment Techniques</strong></td>
<td></td>
</tr>
<tr>
<td>Visual Assessment</td>
<td>A qualified and trained inspector performs a nighttime inspection of all signs while driving at normal highway speeds. The procedure includes viewing qualifying signs prior to the inspection, and using comparison panels for signs with marginal retroreflectivity.</td>
</tr>
<tr>
<td>Measured Sign Retroreflectivity</td>
<td>Signs are measured according to the applicable ASTM standard using a retroreflectometer.</td>
</tr>
<tr>
<td><strong>Management Techniques</strong></td>
<td></td>
</tr>
<tr>
<td>Expected Sign Life</td>
<td>Each individual sign is inventoried and replaced based upon expected service life criteria such as manufacturer’s warranties. As an example, a High Intensity Sign from 3M has an expected service life of 10 years. Signs with High Intensity sheeting would need to be replaced within ten years of initial installation.</td>
</tr>
<tr>
<td>Blanket Replacement</td>
<td>Similar to the Expected Sign Life method, signs are replaced based upon an expected service life. However, instead of each sign being managed separately, all signs in a given area, or of a given type (such as stop signs or critical warning signs), must be replaced within the expected life cycle.</td>
</tr>
<tr>
<td>Control Signs</td>
<td>A few specific signs are measured using one of the two Assessment Techniques (visual assessment or measured retroreflectivity). These signs, designated as ‘control signs,” can be either in the field or at the garage, but they must be exposed to the elements. Replacement of all signs is based upon the retroreflectivity of the control signs. The number, type and location of control signs needs to be determined as part of the overall management plan.</td>
</tr>
</tbody>
</table>
The following information is from the FHWA. It explains the reasons for the new standards and the background on why the particular values for retroreflectivity were chosen. More details can be found at the following website:


**MINIMUM RETROREFLECTIVITY LEVELS**

Since the early 1990s, the FHWA has sponsored several different efforts to develop research recommendations for minimum retroreflectivity levels for traffic signs. These efforts represent various attempts to define and refine the concept of minimum maintained sign retroreflectivity. Initial minimum retroreflectivity levels were developed through research in 1993 (1). These levels were revised in 1998 through further research (2). Updated minimum levels were developed in 2003 (3) and are the ones that FHWA proposes for use. A paper describes the evolution of the research to develop minimum levels of sign retroreflectivity (4).

The updated minimum levels of sign retroreflectivity are generally similar in magnitude to levels published previously, but represent several refinements and updates. The following improvements were incorporated into the 2003 updated levels:

- An improved computer model was used to develop the minimum levels.
- Additional sheeting types were incorporated into the minimum levels.
- Headlamp (headlight) performance was updated to represent the model year 2000 vehicle fleet.
- Vehicle size was increased to represent the greater prevalence of sport utility vehicles and pick-up trucks.
- The luminance level needed for legibility was increased to better accommodate older drivers.
- Minimum retroreflectivity levels were consolidated across more sheeting types to reduce the number of minimum levels.

The updated minimum maintained retroreflectivity levels are shown in the Table 13 on page 77. They represent the most current research recommendations, and are recommended by FHWA, but are limited to the current knowledge of the nighttime luminance requirements of traffic signs. The assumptions and limitations associated with the development of these levels are described in the research report (3). It should be noted that there may be situations where, based on engineering judgment, an agency may want to provide greater retroreflectivity.
# REFERENCES


## Table 13 - Minimum maintained retroreflectivity levels (cd/lx/m²)

<table>
<thead>
<tr>
<th>Sign Color</th>
<th>Criteria</th>
<th>Sheeting Type (ASTM D4956-01a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>White on Red</td>
<td>See Note 3</td>
<td>Legend: 35/ Background: 7</td>
</tr>
<tr>
<td>Black on Orange or Black on Yellow</td>
<td>See Notes 4 &amp; 6</td>
<td>*2</td>
</tr>
<tr>
<td>Black on White</td>
<td>—</td>
<td>Legend: n.a. / Background: 50</td>
</tr>
<tr>
<td>White on Green</td>
<td>Overhead</td>
<td>Bkg:25</td>
</tr>
<tr>
<td></td>
<td>Shoulder</td>
<td>Bkg:7</td>
</tr>
</tbody>
</table>

**NOTES:**

1. Levels in cells represent legend retroreflectivity // background retroreflectivity (for positive contrast signs). Units are cd/lx/m² measured at an observation angle of 0.2° and an entrance angle of -4.0°.

2. Sheeting type should not be used for cells and items marked with a *. Engineering grade sheeting (ASTM Grade I) should not be used for Orange or Yellow backgrounds. White legends need to be Grade IV or higher for Overhead mounted signs on green backgrounds. White legends should be Grade II or higher for shoulder or ground mounted signs on green backgrounds.

3. In addition to the minimum retroreflectivity, the minimum contrast ratio between the white legend and the red background is 3:1 (white retroreflectivity + red retroreflectivity).

4. For text signs measuring 48 inches or more and all bold symbol signs. See below for examples of bold symbol signs. A complete list will be published as part of the final standard. Signs not listed as bold symbols should be assumed to be fine symbols.

5. For text signs measuring less than 48 inches and all fine symbol signs. Signs not listed as bold symbols should be assumed to be fine symbols.

6. Use largest sign dimension to find proper category in the table for the following signs:
   - W14-3 - No Passing Zone,
   - W4-4p - Cross Traffic Does Not Stop
   - W13-2, -3, -1, -5 - Ramp & Curve Speed Advisory Plaques

7. Black legends do not need to be retroreflective.
BOLD SYMBOL SIGNS

This list of signs is based upon information from the FHWA and shows the correct sign designations from the National MUTCD. All symbol signs not listed in the bold category are considered fine symbol signs. This list does not include any signs in the NYS Supplement. Check the National MUTCD and the NYS Supplement for additional details.

- W1-1: Turn
- W1-2: Curve
- W1-3: Reverse Turn
- W1-4: Reverse Curve
- W1-5: Winding Road
- W1-6: Large Single Arrow
- W1-7: Large Double Arrow
- W1-8: Chevron
- W1-10: Horizontal Alignment & Intersection
- W2-1: Cross Road
- W2-2, W2-3: Side Road
- W2-4: T Intersection
- W2-5: Y Intersection
- W2-6: Circular Intersection
- W3-1: Stop Ahead
- W3-2: Yield Ahead
- W3-3: Signal Ahead
- W4-3: Added Lane
- W6-1: Divided Highway Begins
- W6-2: Divided Highway Ends
- W6-3: Two-Way Traffic
- W10-1, -2, -3, -4: Highway-Railroad Intersection Advance Warning
- W11-2: Pedestrian Crossing
- W11-3: Deer Crossing
- W11-4: Cattle Crossing
- W11-5: Farm Equipment
- W11-8: Fire Station
- W11-10: Truck Crossing
- W12-1: Double Arrow
- W16-5p, -6p, -7p: Pointing Arrow Plaques
Appendix I - Breakaway Sign Supports

The following is a selection from the FHWA website on breakaway sign supports. The site lists supports with acceptance letters from the Federal Highway Administration. For more details, visit the website at: [safety.fhwa.dot.gov/roadway_dept/road_hardware](http://safety.fhwa.dot.gov/roadway_dept/road_hardware).

**BREAKAWAY SUPPORTS - GENERAL**

**Omni-directional**

Breakaway supports that are placed near intersections or other locations where errant vehicles may come at them from all directions must be of an omni-directional design. “Omni-directional” means that the support is symmetrical and will break safely when struck from any direction, or it has been specifically designed to function properly at all angles. Certain generic bases like the rectangular four-bolt slip base, or the inclined slip base are not designed to be omni-directional and will act like a non-breakaway support if struck from the side. Triangular three-bolt slip bases, wood supports, perforated square steel tube, spliced U-channel supports, and breakaway couplings, among others, are omni-directional.

**Delineators**

Because most delineator posts are shorter and smaller gauge versions of crash-tested sign supports, no separate listing has been made. A few proprietary delineator supports of other materials have been crash tested and have received FHWA acceptance letters.

**MUTCD**

The FHWA has mandated breakaway supports within the clear zone on National Highway System (NHS) routes since 1998. In 2000 the MUTCD made breakaway sign supports a “shall” condition for supports within the clear zone of all streets and highways in the United States. FHWA intends to limit the mandate for breakaway supports on non-NHS routes to those posted at 50 mph or greater, and has set a deadline of January 2013 to accomplish the retrofit. Any retrofit of sign supports should be done in conjunction with the establishment of retroreflectivity requirements.
Appendix J - How to Use a Ball Bank Indicator

1. **Mount the ball bank indicator on the dashboard of a standard automobile.**
   Sports cars, trucks, and SUVs are not recommended for use. They tend to over or underestimate the curve speeds. Since one of the primary goals of signage is uniformity, a sedan or other typical automobile is recommended for speed studies.

2. **Level the ball bank indicator.**
   This is done on a level surface with two people in the car. Two people are recommended for safety reasons. One person drives and the other person records the ball bank reading.

3. **Take a series of ball bank readings at various speeds.**
   The driver should drive in the center of the lane at a relatively slow speed. The maximum ball bank reading should be recorded. Additional runs should be made, increasing the speed 5 mph each time, until the maximum speed is found. The safe speed indications from the NYS Supplement are shown below.

4. **Be sure to check both directions of the curve.**
   The posted speed may be different in opposite directions. If so, post each direction separately. Drivers only can use the signs they see.

**Table 14 - Ball bank safe speed indications (NYS Supplement)**

<table>
<thead>
<tr>
<th>Ball Bank Reading</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>16°</td>
<td>24 mph or less</td>
</tr>
<tr>
<td>14°</td>
<td>25-34 mph</td>
</tr>
<tr>
<td>12°</td>
<td>35-49 mph</td>
</tr>
<tr>
<td>10°</td>
<td>50 mph or more</td>
</tr>
</tbody>
</table>
Intersection Ahead Class Exercise

The following figure shows several intersections that may have an Intersection Ahead sign placed due to sight distance and other traffic concerns. Please answer the following questions using the advanced posting distances from Table 2C-4 from the MUTCD (also Table 6 in the workbook) and Table 8 - *Sight distance in feet to a vehicle waiting at the intersecting road* (page 37) in the workbook.

These questions only need to be answered for the Northbound traffic for this exercise. In the real world situation, all the incoming directions should be reviewed.

1. What is the sight distance where an Intersection Ahead sign is recommended?
2. What signs should be posted (assuming sight distance or other concerns advocate the placement of Intersection Ahead signs for both intersections)?
3. Where should they be placed?

Major Road
- Posted Speed Limit = 45 mph
- Prevailing Speed = 60 mph
Yield Ahead & Curve Warning Sign Posting Location Class Exercise

On the next page is a roadway layout with a yield sign. There is evidence that a Yield Ahead sign is needed. In addition, the curve sign needs to be replaced. Please answer the following questions.

1. What is the advance posting distance for the Yield Ahead sign?
2. What is the advance posting distance for the curve sign?
3. Does the curve sign need an advisory plate? If so, what speed should be on the sign?
4. What is the lateral and vertical offset for each sign?
   a. Yield?
   b. Yield Ahead?
   c. Curve Warning with Advisory Plate?
5. What other factors may affect the location of the sign?
Traffic Signs & Pavement Markings
Instructors: Ken Swain & Al Bachner

Shoulders all less than 6 feet wide

Curve Starts Here

Posted Speed Limit 55 mph
Prevailing Speed 60 mph (tangent ahead of curve)

Ball Bank Readings

<table>
<thead>
<tr>
<th>Speed Driven (mph)</th>
<th>Reading (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 mph</td>
<td>10°</td>
</tr>
<tr>
<td>40 mph</td>
<td>11°</td>
</tr>
<tr>
<td>45 mph</td>
<td>12°</td>
</tr>
<tr>
<td>50 mph</td>
<td>13°</td>
</tr>
</tbody>
</table>
Retroreflectivity demo

Goals
1. Show how retroreflectivity works
   - Returns light
   - Works best near 90°, but also works at other angles
2. Show that better materials have more retroreflectivity
3. Show how various colors reflect back to the light source

Items Needed (kept in plastic folder)
- Mini Maglite Halogen Flashlight
- Spare AA batteries
- Plastic holder with thumb screw
- White prismatic retroreflective sheeting with elliptical hole
- Clamp and stand to hold flashlight assembly
- Signs and sheeting as needed

**Mini Signs**
Super Engineering Grade; ASTM Grade 2
Engineering Grade; ASTM Type 1
Diamond Grade NAP; ASTM VIII
High Intensity; ASTM III

**Reflective Sheeting** (Various colors)
Engineering Grade – yellow
Engineering Grade – white
Scotchlite Brand, Barricade sheeting
3M Diamond Grade™ D3, Series 4090 – white
3M Diamond Grade™ D3, Series 4091 – yellow
3M Diamond Grade™ D3, Series 4081 – fluorescent yellow
3M Diamond Grade™ D3, Series 4084 – fluorescent orange
3M Diamond Grade™ D3, Series 4095 – blue
3M Diamond Grade™ D3, Series 4083 – fluorescent yellow green
3M Diamond Grade™ D3, Series 4097 – green
3M Diamond Grade™ D3, Series 4092 – red
Prismatic High Intensity Grade – orange
Prismatic High Intensity Grade – white
Prismatic High Intensity Grade – yellow
Reflective vest material – pink
Reflective vest material – orange

Setup
![Flashlight and stand](image)

Flashlight and stand  Target sign

This can be done on the front tables or across the room. The distance depends on the ambient light. In darker rooms, the light and target can be further apart.

Place flashlight with holder in stand. Use the folder to focus on the target location.
Stop-Yield Decision Class Exercise

Below is a drawing of an intersection of a minor road that tees into a major road. The current sign is a yield sign. The minor road was recently rebuilt and the citizens are asking for a stop sign. Please use the information provided on these sheets (or elsewhere) to decide if the sight distance is long enough to continue the use of a yield sign.

Please answer the following questions.

1. Should the intersection be controlled by a Stop Sign or a Yield Sign based on sight distance only?
   a. Does Prevailing Speed make a difference?
   b. Which corner is the more critical sight distance location?

2. What, other than sight distance and vehicle speeds, might help make this decision?
Figure 1-1 and Table 1-1 are aids for making stop/yield determinations. After making the measurements for distances ‘a’ and ‘b’, as shown in Figure 1-1, locate the value of ‘b’ in the left column of Table 1-1. Then in the column for the appropriate prevailing speed for the major highway, compare the measured value of ‘a’ with the distance shown in the column. If the measured value is greater than the Table value, then a yield sign may be used. If the measured ‘a’ value is equal to or less than the Table value, a stop sign should be used.

**Table 1-1 Guide for stop or yield sign determination**

<table>
<thead>
<tr>
<th>b (feet)</th>
<th>a (feet) (Minimum distance to closest obstruction parallel to major road)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>180 225 275 325 385 445 515</td>
</tr>
<tr>
<td>15</td>
<td>170 215 260 305 360 420 485</td>
</tr>
<tr>
<td>20</td>
<td>160 200 245 290 340 395 455</td>
</tr>
<tr>
<td>25</td>
<td>150 190 230 270 320 370 425</td>
</tr>
<tr>
<td>30</td>
<td>140 175 215 250 295 345 395</td>
</tr>
<tr>
<td>35</td>
<td>130 165 200 235 275 320 370</td>
</tr>
<tr>
<td>40</td>
<td>120 150 180 215 255 295 340</td>
</tr>
<tr>
<td>45</td>
<td>110 135 165 195 230 270 310</td>
</tr>
<tr>
<td>50</td>
<td>98 125 150 180 210 245 280</td>
</tr>
<tr>
<td>55</td>
<td>90 110 135 160 190 220 250</td>
</tr>
<tr>
<td>60</td>
<td>80 100 120 140 165 195 220</td>
</tr>
<tr>
<td>65</td>
<td>70 85 105 125 145 170 195</td>
</tr>
<tr>
<td>70</td>
<td>60 75 90 105 125 145 165</td>
</tr>
<tr>
<td>75</td>
<td>50 60 75 85 100 120 135</td>
</tr>
<tr>
<td>80</td>
<td>40 50 60 70 80 90 105</td>
</tr>
</tbody>
</table>

b = Distance from centerline of critical lane to closest obstruction parallel to minor road.

1. All obstructions at the intersection should be investigated. The one causing the shortest sight distance should be used for the stop/yield sign determination. Each side road approach should be evaluated separately.

2. Sight distance is measured between two points 42 inches above the roadway. This is the average eye height of a driver in a passenger car.

3. If the highways intersect at an angle other than 90 degrees, the measurements for “a” and “b” should be parallel to the paths for the approaching vehicles, as shown in Figure 1-1.

4. Parked vehicles and seasonal changes such as snowdrifts or tall seasonal crops like corn should be kept in mind when sight obstructions are being located.

5. Many times sight distances can be improved by permanently removing brush or other obstructions from the areas adjacent to the approaches.