University of Massachusetts
Transportation Center

Massachusetts Traffic Safety Toolbox

The Massachusetts Traffic Safety Toolbox is intended to be dynamic in nature with valuable references and new fact sheets being added regularly.

Massachusetts Transportation Research Program

EOT Massachusetts Executive Office of Transportation

MASS HIGHWAY

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16. Abstract

Providing a safe driving environment and implementing safety improvements at the local level can pose significant challenges for municipal governments. Similar to challenges faced by federal and state agencies, financial and personnel limitation can make it difficult for local agencies to develop and implement safety initiatives. Information is available to help local governments identify options and develop action plans for implementing safety measures.

The purpose of this Traffic Safety Toolbox is to provide a resource of information for municipal practitioners. Specifically, the series of fact sheets provide guidance and information regarding selected traffic safety and engineering topics. These fact sheets provide information about valuable resources, including links to web pages as applicable. The fact sheets are presented in this Final Report and are available online at www.mass.gov/mhd/safetytoolbox.

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Massachusetts Traffic Safety Toolbox
Final Report

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January 2008

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Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Massachusetts Executive Office of Transportation and Public Works or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Executive Summary

The Massachusetts Traffic Safety Toolbox was undertaken as part of the Massachusetts Executive Office of Transportation and Public Works Research Program. This program is funded with Federal Highway Administration (FHWA) Statewide Planning and Research (SPR) funds. Through this program, applied research is conducted on topics of importance to the Commonwealth of Massachusetts transportation agencies.

In 2004 138,635 motor vehicle crashes occurred along Massachusetts roadways. These crashes resulted in 476 fatalities and 5,554 nonfatal traffic-related injuries requiring hospitalizations. These numbers represent an outstanding toll both in terms of the life lost as well as financial burden borne by the Massachusetts residents.

In order to improve safety and reduce injuries, The Massachusetts Highway Department (MassHighway) of the Executive Office of Transportation and Public Works has created, with key involvement from many other state partners, a Massachusetts Strategic Highway Safety Plan (SHSP). This plan, which is currently being implemented, will guide highway safety programming. Its mission is to develop, promote, implement, and evaluate data-driven, multi-disciplinary strategies to maximize safety for users of the roadway system. Specific goals of the Massachusetts SHSP include the following:

- Reverse the increasing trend of traffic-related fatalities and injuries upon implementation of the Massachusetts SHSP (towards zero fatalities and injuries).
- Achieve a 20 percent reduction from 476 (2004) lives lost in traffic-related fatal crashes by 2010.
- Achieve a 20 percent reduction from 5,554 (2004) in non-fatal traffic-related injuries requiring hospitalizations by 2010.

To achieve these goals, the Commonwealth of Massachusetts, including all SHSP stakeholders will work to assure the plan's implementation. Specifically, the implementation will be based upon the identified strategies outlined in the SHSP. One specific strategy aimed at improving roadway safety was the creation of a Massachusetts Traffic Safety Toolbox. Specifically, the Massachusetts' Safety Toolbox was developed as a resulting strategy from the Massachusetts Strategic Highway Safety Plan (SHSP) (Tier II, strategy 1) to provide technical assistance to local communities in the area of roadway safety. As stated in Massachusetts Highway Department's *Project Development and Design Guide*, the Toolbox will encourage practitioners, "to ensure that the safety and mobility of all users of the transportation system (pedestrians, bicyclists, drivers, etc.) are considered equally through all phases of a project."

During the SHSP process, local and regional transportation professionals emphasized that providing a safe driving environment and implementing safety improvements at the local level can pose significant challenges for municipal governments. Similar to challenges faced by federal and state efforts, limitations, including financial and personnel constraints, can make it

difficult for local agencies to develop and implement safety initiatives. As a result, the local practitioners were seeking information to help local governments identify options and develop action plans for implementing safety countermeasures.

The objective of this research was to develop a traffic safety-related resource for municipal practitioners. Specifically, the series of fact sheets provide guidance and information regarding selected traffic safety and engineering topics. These fact sheets provide information about valuable resources, including links to web pages as applicable.

Topical areas for inclusion in the Traffic Safety Toolbox were identified through a multifaceted approach that provided an opportunity for local input, with an interest in providing topics resulting in the greatest impact. A preliminary list was developed based upon existing literature and known areas of difficulty within traffic safety. Simultaneously, the Bay State Roads Program which is the Local Technical Assistance Program (LTAP) in Massachusetts, was sought out to provide input related to frequent requests for information that they receive from local practitioners. Specifically, the Bay State Roads Program was asked to provide information about requests they receive asking for either additional information or for training on a topic.

Following the development of a list of topical areas a meeting was held with stakeholders of the Traffic Safety Toolbox to decide upon the specific fact sheets to be created. Fact sheets topics were selected by the group based in part on several factors including, the prevalence of this topic as a reported challenge at the local level, the potential impact of this topic safety, and the feasibility of readily available resources for inclusion in the fact sheets.

A general traffic safety fact sheet was created to serve as both a template fact sheet for approval as well as to provide general safety information about the nature of the safety issues and ongoing efforts within the United States and in Massachusetts. Following approval of the initial template an additional 12 fact sheets were created for inclusion in the Traffic Safety Toolbox.

The fact sheets are presented in this Final Report and are available online at www.mass.gov/mhd/safetytoolbox/. The fact sheets in this Final Report include the following:

- General Traffic Safety Facts & Information
- Crosswalks
- Low Cost Intersection Safety Improvements
- Low Cost Non-Intersection Safety Improvements
- Pavement Markings: Centerlines and Edgelines
- Pavement Markings: Other
- Retroreflectivity
- Road Safety Audits
- Sight Distance
- Speed Limits & Speed Limit Setting
- Stop Sign Installation
- Warning Signs
- Work Zone Safety

The resulting Traffic Safety Toolbox is intended to provide a valuable resource for local traffic practitioners and will result in improved safety conditions across the Commonwealth of Massachusetts. Implementation and longevity of the Traffic Safety Toolbox are undoubtedly critical aspects of its ultimate success. As a result, two recommendations for consideration include the following:

- Utilize the Bay State Roads Program as a means of dissemination for the Traffic Safety Toolbox. The LTAP has a direct connection with local practitioners, and has multiple mediums for dissemination which should be considered including formal training courses, the *Mass Interchange* newsletter, and via there interactive website.
- Frequently provide updates to the Toolbox, including both existing and new fact sheets. As feasible it is recommended that additional fact sheets be added to the Toolbox in an effort to increase the benefit for local practitioners and traffic safety. Similarly, it is also critical to update information on the current fact sheets that may be updated or changed.

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1.0 Introduction

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To achieve these goals, the Commonwealth of Massachusetts, including all SHSP stakeholders will work to assure the plan's implementation. Specifically, the implementation will be based upon the identified strategies outlined in the SHSP. One specific strategy aimed at improving roadway safety was the creation of a Massachusetts Traffic Safety Toolbox. Specifically, the Massachusetts' Safety Toolbox was developed as a resulting strategy from the Massachusetts Strategic Highway Safety Plan (SHSP) (Tier II, strategy 1) to provide technical assistance to local communities in the area of roadway safety. As stated in the MassHighway's *Project Development and Design Guide*, the Toolbox will encourage practitioners, "to ensure that the safety and mobility of all users of the transportation system (pedestrians, bicyclists, drivers, etc.) are considered equally through all phases of a project."

During the SHSP process, local and regional transportation professionals emphasized the importance of providing a safe driving environment and implementing safety improvements at the local level. The challenges faced by local agencies, including financial and personnel constraints, can make it difficult to develop and implement safety initiatives. As a result, the

local practitioners were seeking information to help local governments identify options and develop action plans for implementing safety countermeasures.

2.0 Methodology

The objective of this research was to develop a traffic safety-related resource for municipal practitioners, specifically, a series of fact sheets that provide guidance and information regarding selected traffic safety and engineering topics. These fact sheets provide information about valuable resources, safety countermeasures, including references to additional resources and web pages as applicable.

Specific topic areas for inclusion in the Traffic Safety Toolbox were identified in consultation with MassHighway and additional input from the Baystate Roads Program. The Baystate Roads Program which is the Local Technical Assistance Program (LTAP) in Massachusetts was asked to provide input related to frequent requests for information that they receive from local practitioners. A preliminary list was developed based upon existing literature and known areas of difficulty within traffic safety. The fact sheets topics were then selected based in part on several factors including, the prevalence of this topic as a reported challenge at the local level, the potential impact of this topic safety, and the feasibility of readily available resources for inclusion in the fact sheets.

An introductory fact sheet titled "General Traffic Safety Facts and Information" was created to serve as both a template for approval as well as to provide general safety information about safety issues. Following approval of the initial template 12 topical fact sheets were created for inclusion in the Traffic Safety Toolbox.

The fact sheets are included in this Final Report and are available on MassHighway's website at www.mass.gov/mhd/safetytoolbox. The fact sheets include the following:

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- Sight Distance
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- Stop Sign Installation
- Warning Signs
- Work Zone Safety

3.0 Recommendations

The goal of the Traffic Safety Toolbox is to provide information to local practitioners that can be used to improve traffic safety within the Commonwealth. The value of the Traffic Safety Toolbox will only be realized through the widespread use. In order to assure widespread use, practitioners need to know that the Traffic Safety Toolbox exists and that it is factual and up to date. As a result, two recommendations for consideration include the following:

- Utilize the Baystate Roads Program to increase awareness of the Traffic Safety Toolbox among local practitioners. This can be accomplished through workshops, the *Mass Interchange* newsletter, and posting information on the Baystate Roads website.

- This project was an initial step towards the creation of a comprehensive traffic safety resource for municipalities. As such, it will require the development of additional fact sheets in order to realize the full potential. The fact sheets should be reviewed regularly to insure that they reflect current state of the art practice.

4.0 Traffic Safety Toolbox

General Traffic Safety Facts & Information

General Traffic Safety Facts & Information

According to the National Highway Traffic Safety Administration (NHTSA), more than 43,000 people were killed on U.S. roadways, costing more than $230 billion in 2005. That same year, crashes killed 442 people on Massachusetts roads.

What are the Odds?

- Being attacked by a bear: 1 in 36 million
- Being attacked by a shark: 1 in 11. 5 million
- Dying from bee, hornet or wasp sting: 1 in 5.33 million
- Dying in a tornado: 1 in 5 million
- Being struck by lightning: 1 in 240,000
- Being bitten by venomous snake: 1 in 37,250

- **Being Killed in a Car Crash (Lifetime): 1 in 84**

(Source: National Safety Council – http://www.nsc.org)

Basic Principles of Highway Safety

When considering the safety of a roadway, it is important to think about the roadway, the vehicle, and the roadway users, including drivers, pedestrians, and bicyclists. In terms of these components contributing to crashes, research indicates that the vehicle, the roadway, and the driver contribute to approximately, 10, 33, and 93 percent of crashes, respectively. As a result, it is imperative that the approach to safety solutions be multidisciplinary in nature. Arguably the most common application of this multidisciplinary approach exists in the form of the four Es of highway safety:

- **Engineering** to deploy safety countermeasures (improvements);
- **Education** on roadway safety;
- **Enforcement** of safety laws and regulations; and
- Effective **emergency medical services**.

What's Being Done to Save Lives in the US?

The Federal Highway Administration (FHWA) has designated "improving roadway safety and mobility" as one of its top priorities. FHWA's safety programs are focused on high risk areas such as roadway departures, intersections, and pedestrian safety. Their efforts include work in the areas of engineering, enforcement, and education.

Learn more about FHWA's safety efforts on the web at http://safety.fhwa.dot.gov

For more information contact:
MassHighway
Traffic Engineering
(617) 973-8484

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January 2008

General Traffic Safety Facts & Information

What's Being Done to Save Lives in Massachusetts?

Efforts to improve highway safety are as important at the state level as they are at the national level. MassHighway has worked with partners throughout the state to develop a Strategic Highway Safety Plan (SHSP). A SHSP is developed with the goal of identifying the state's safety needs and guiding decision-making aimed at reducing fatalities and injuries on public roads.

This statewide document, developed by MassHighway in a cooperative process, includes input from public and private safety stakeholders. The SHSP is a data-driven, comprehensive plan that integrates the four Es - engineering, education, enforcement, and emergency medical services (EMS). The SHSP establishes statewide goals, objectives, and key emphasis areas.

As part of the SHSP process, several emphasis areas and primary focus points were identified, as shown in the table below.

Emphasis Area	Primary Focus
Data Systems	Crash, Roadway Characteristic, Medical Record, Vehicle Registration, Driver History, Citation
Infrastructure	Lane Departures, Intersection Crashes
At-Risk Driver Behavior	Occupant Protection, Speeding, Alcohol, Impaired Driving
Higher-Risk Transportation System Users	Young Drivers, Older Drivers, Pedestrians, Bicyclists
Public Education and Media	Statewide Safety Marketing, Media Messages, Public Awareness
Safety Program Management	Process for Institutionalizing the SHSP

Goals, performance measures, and strategies were identified for each of the emphasis areas. Safety partners at all levels are involved in implementing programs aimed at addressing these areas.

Learn more about Massachusetts' Strategic Highway Safety Plan at http://www.mhd.state.ma.us/default.asp?pgid=content/traffic/shsp&sid=level2

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January 2008

General Traffic Safety Facts & Information

Safety Improvements at the Local Level

Safety improvements at the local level can pose significant challenges for local governments responsible for roadway networks ranging from several blocks to many miles. Similar to challenges faced by federal and state efforts, limitations, including financial and personnel constraints, can make it difficult for local agencies to develop and implement safety initiatives. Nevertheless, information is available to help local governments identify options and develop action plans for implementing safety countermeasures, some of which is highlighted in this series of fact sheets.

There are several steps in the process for implementing safety improvements at the local level.

1. **Identify your roadway safety problems:** Where are the most crashes happening? Where are the most serious crashes happening?

2. **Identify possible countermeasures:** Which countermeasures will mitigate the identified problem?

3. **Identify resources for implementation:** How will you pay for these improvements and do you have the personnel necessary for implementation?

4. **Implement your countermeasure:** How does your countermeasure implementation fit with your general project schedule? Have you allocated the human resources necessary to implement?

5. **Examine countermeasure effectiveness:** Does the issue addressed by the countermeasure seem to be resolved? Are fewer crashes happening on the road segment where the countermeasure was implemented?

Considering the Benefits and Costs

Deciding what countermeasures to consider will often depend on how much you have to spend and what the anticipated benefits are. One important aspect of the decision should be the expected benefit-to-cost ratio. Ideally, any selected improvements have benefits that outweigh the associated costs.

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Resources

For safety practitioners, a number of resources are readily available that provide valuable insight regarding safety. Below is a list of selected resources referenced throughout this series of fact sheets. In many instances the information is available online.

Massachusetts Traffic Safety Toolbox Series
This series of fact sheets provides information on safety improvements that can be implemented at the local level. Information on problem areas, possible countermeasures, and implementation considerations is included in each fact sheet which can be found at www.mass.gov/mhd/safetytoolbox/

Countermeasures That Work
This publication developed by the U.S. Department of Transportation and the National Highway Traffic Safety Administration includes a list of easy solutions to keep our roadways safe, which can be found at http://www.nhtsa.dot.gov/people/injury/airbags/Countermeasures/

Federal Highway Administration Office of Safety
The Office of Safety works to reduce both the number and severity of crashes along U.S. roadways. The Office of Safety supports the development, testing and implementation of technologies and procedures to improve the physical safety of the Nation's roadway infrastructure, and can be found at http://safety.fhwa.dot.gov/

Institute of Transportation Engineers (ITE)
ITE is an international educational and scientific association of transportation professionals who are responsible for meeting mobility and safety needs of society. Among ITE activities is the development of public awareness programs and to serve as a conduit for the exchange of professional information. ITE can be found at http://www.ite.org/

The Manual on Uniform Traffic Control Devices (MUTCD)
Published by the FHWA, the MUTCD defines the standards used by transportation professionals nationwide to install and maintain traffic control devices on all streets and highways. The most recent version (2003) can be found at http://mutcd.fhwa.dot.gov/

Massachusetts Project Development & Design Guide
This guide, developed by MassHighway, provides guidelines for project development that may be helpful when determining various geometric design features, and can be found at http://www.mhd.state.ma.us/default.asp?pgid=content/designGuide&sid=about

Procedures for Speed Zoning on State and Municipal Roads
These procedures provide specifications for speed zoning in Massachusetts and can be found at http://www.mhd.state.ma.us/downloads/manuals/speedZoning.pdf

A Policy on Geometric Design of Highways and Streets
The American Association of State Highway & Transportation Officials (AASHTO) Policy, also known as the AASHTO "Green Book", is based upon established design practices, and is intended to provide guidance in roadway design. This document is available for purchase through AASHTO at https://bookstore.transportation.org/

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Crosswalks

Crosswalks

Background

In 2006, pedestrians accounted for fourteen percent of total roadway fatalities in Massachusetts. Nationwide there were 4,784 pedestrian fatalities accounting for eleven percent of all roadway fatalities. Based upon these statistics, pedestrian accommodation should be a critical element of transportation safety, and, in fact, is required under Massachusetts General Law. One common practice for accommodating pedestrians is the use of crosswalks.

Roadways must accommodate a wide variety of pedestrians who behave differently and have a variety of physical, cognitive, and sensory abilities. From a crossing perspective, this is important as some pedestrians may require more time to cross a street and desire more predictable surfaces. Similarly, pedestrians who are visually impaired may require audible and tactile cues. Pedestrians using wheelchairs may cross the street more quickly, but are also more difficult to see from a vehicle.

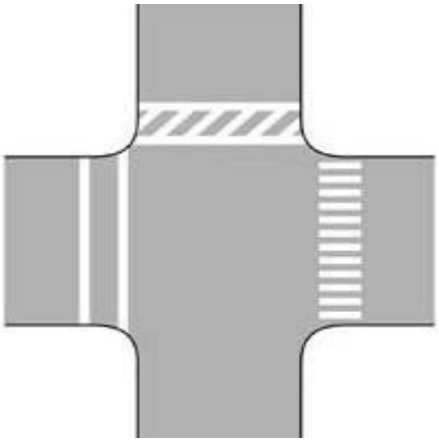
Installing Crosswalks

Crosswalks are typically installed at intersections where pedestrian delineation proves beneficial. At non-intersection locations, crosswalks should only be added when there is both a significant pedestrian presence and after an engineering study deems it safe.

Continental Crosswalk Markings *(Source: www.pedbikeimages.org)*

Design of a Crosswalk

Crosswalk markings provide guidance for pedestrians who are crossing roadways. Minimally, crosswalks must consist of two parallel lines that shall not be less than 6 inches or greater than 24 inches in width. The crosswalk should have a width of no less than six feet.



Source: MUTCD

For added visibility additional marking opportunities exist. For example, the preferred type of crosswalk marking in many municipalities is the ladder, or "continental" pattern consisting of white longitudinal lines parallel to traffic flow, however "zebra" (diagonal) striping may also be used. Longitudinal or diagonal lines should be 12 to 24 inches wide and spaced 12 to 60 inches apart. Crosswalk markings should be spaced so that the lines are not in wheel paths. In addition, the spacing should not exceed 2.5 times the width of the lines. See the Manual on Uniform Traffic Control Devices (MUTCD Section 3B.17) for more information.

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Crosswalks

Pedestrian Crossing Warning Sign

When to Install Crosswalks

Crosswalks should be marked at all intersections with substantial conflicts between vehicles and pedestrians, as well as at other appropriate points of pedestrian concentration, including non-intersection locations with a significant pedestrian presence. As per the MUTCD Section 3B.17, an engineering study should be performed before installing marked crosswalks away from traffic signals or STOP signs. Warning signs should be installed at non-intersection crosswalks, and added visibility should be provided through parking prohibitions on the crosswalk approaches. Worth noting is that some municipalities have established quantitative guidelines (e.g., number of pedestrians per some specified time period) for installing crosswalks at non-intersection locations.

Crosswalks at Intersections

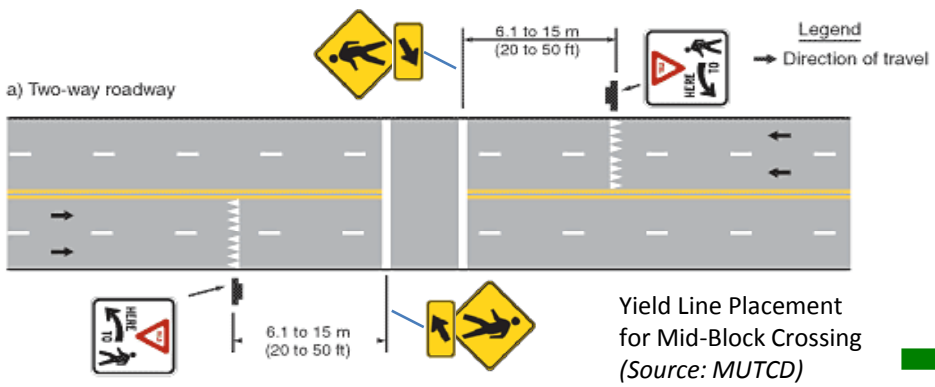
Crosswalks should be marked at intersections when they:

- Help pedestrians find their way across a complex intersection;
- Show pedestrians a safe route across traffic;
- Minimize exposure to motor vehicles, bicycles, and traffic conflicts; and
- Position pedestrians where they can best be seen by oncoming traffic.

Crosswalks located at intersections should be no more than 26 feet from the edge of the intersections. When crosswalks are located on a street with a stop line or with traffic signals, there should be a minimum spacing of 4 feet between the outer edge of the crosswalk and the nearest edge of the stop bar.

Non-Intersection Crosswalks

At non-intersection locations, in addition to the crosswalk markings, yield lines may be used to indicate the point at which vehicles should yield to pedestrians. Yield lines consist of solid white isosceles triangles pointing toward approaching vehicles and extend across the approach lane. The individual triangles have a base 12 to 24 inches wide and a height of 1.5 times the base, and are spaced 3 to 12 inches apart. If used, yield lines should be placed next to a "Yield Here to Pedestrians" (R1-5) sign. Please see MUTCD Section 3B.16 for additional details at these locations.



Yield Line Placement for Mid-Block Crossing
(Source: MUTCD)

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Crosswalks

Post-mounted Regulatory Pedestrian Sign
(Source: MassHighway Traffic Engineering)

Unsignalized Pedestrian Crossing Sign
(Source: MUTCD)

Pedestrian Laws and Regulations

•Massachusetts General Law (MGL) Chapter 89, Section 11 requires, among other things, that when traffic control signals are not in place or not in operation the driver of a vehicle shall yield the right of way to a pedestrian crossing the roadway within a marked crosswalk;

•Regulations promulgated under MGL Chapter 90, Section 18A, by MassHighway, require every pedestrian crossing a roadway at any point other than a marked crosswalk shall yield the right-of-way to all vehicles upon the roadway;

•As per the MUTCD Section 2B.12 in-street pedestrian crossing signage shall not be used at signalized intersections, and if it is placed in the roadway the sign support shall comply with the breakaway requirements.

Crosswalk Enhancements on Local Roadways

Raised Crosswalks

Raised crosswalks bring the roadway up to the level of the sidewalk at the crosswalk. They improve the visibility of the crosswalk and pedestrian, and by acting as a speed hump they can be effective at reducing vehicle speeds.

In-Roadway Warning Lights

In-roadway warning lights are amber lights embedded in the roadway on both sides of a crosswalk that begin flashing when activated by a pedestrian, thereby alerting drivers that a pedestrian is in the vicinity of the crosswalk.

Roadway Lighting

Although street lighting provides a benefit at many locations, it is particularly beneficial at crosswalks where lighting increases the visibility of pedestrians to passing motorists.

Refuge Islands and/or Medians

The addition of refuge islands and/or medians may be an effective design technique that affords pedestrians the opportunity to cross a roadway in stages.

Resources

The Manual on Uniform Traffic Control Devices (MUTCD)

Published by the FHWA, the MUTCD defines the standards used by transportation professionals nationwide to install and maintain traffic control devices on all streets and highways. The most recent version (2003) can be found at http://mutcd.fhwa.dot.gov/

The Pedestrian and Bicycle Information Center (PBIC)

The PBIC is a national clearinghouse for information about health, safety, engineering, advocacy, education, enforcement, access, and mobility for pedestrians and bicyclists. Information can be found at http://www.walkinginfo.org/index.cfm

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Low Cost Intersection Safety Improvements

Low Cost Intersection Safety Improvements

Background

An intersection, a place where two or more roads meet, may be one of the most complex environments a driver will encounter along the roadway. Intersections can present conflicts for vehicles and pedestrians alike. In the U.S., over 2.8 million intersection-related crashes occurred in 2000 representing 44 percent of all crashes. Approximately 8,500 fatalities (23 percent of total fatalities) and one million injury crashes occurred at intersections, costing society about $40 billion. As a result, intersection safety is continually a priority in the U.S. and in Massachusetts, however, in many instances there is an inherent tradeoff between mobility and safety. Low cost safety improvements provide the opportunity to implement countermeasures at intersections where resources are limited.

Did you know?
In Massachusetts, intersection crashes account for 29% of fatal crashes & 47% of incapacitating injury crashes *(Source: Massachusetts Strategic Highway Safety Plan).*

Intersections and Countermeasures

Four major types of crashes occur at intersections: (1) angle collisions, (2) rear-end collisions, (3) vehicles improperly changing lanes collisions, and (4) pedestrian and bicycle collisions. Reducing the frequency and severity of crashes can be accomplished through analyzing intersection crash patterns and applying appropriate countermeasures. Intersection crashes have many causes including, but not necessarily limited to, poor geometry and design, deficient operational control, insufficient maintenance, and human error. Considering all of these elements, the optimal approach to improved intersection safety is multidisciplinary in nature; however, many low cost countermeasures focused on the intersection design and operation can be both implemented and effective at the local level. When improving an intersection consider some general strategies such as the following:

- Attempt to minimize intersection conflicts and crashes, and lessen the impacts of crashes when they do occur;
- Attempt to match a countermeasure to an identified safety problem;
- Evaluate implemented countermeasures to identify what works and what does not, for consideration at future locations; and
- Select countermeasures that are technically feasible and practical, and provide an advantageous benefit/cost ratio.

Photo Source: AASHTO Strategic Highway Safety Plan

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Low Cost Intersection Safety Improvements

Low Cost Countermeasures

Although large-scale intersection treatments can be used, there are also many effective low cost countermeasures that can be implemented. This fact sheet targets some of the common safety challenges at intersections, and places an emphasis on identifying low-cost improvements that could likely be implemented in a short timeframe (i.e., less than a year). Although several definitions exist for low cost improvements, such as the Federal Highway Administration's (FHWA) definition of less than $50,000, the information below is based upon treatments under $15,000. Lastly, focusing on low cost measures often allows for a proactive approach to traffic safety, and may eliminate, or at least defer, the need for a high-cost improvement.

Identified Safety Challenge	Potential Countermeasures
Driver confusion resulting from lane usage patterns	• Install lane use designation signage along side or above the intersection approach. • Add symbolic lane use markings. • Delineate paths through intersection for confusing vehicle movements (e.g., left turns).
Crashes involving left-turning vehicles	• At signalized locations add protected left-turn phase; however, this should be based upon a capacity analysis. • Consider existing lane usage patterns and reconfigure existing usage to dedicate an exclusive left-turn lane.
Sight distance issues	• Improve sight lines by clearing obstacles such as brush, unnecessary signs, etc. • Add advance warning signs alerting motorists of intersection ahead.
Traffic signal conspicuity	• Add backplates to traffic signal heads. • Consider use of LED signal indications. • Consider position of traffic signal heads with respect to driver sight lines (see MUTCD for guidance).
Driver navigation errors	• Install improved street direction and guidance signage to aid drivers.
STOP sign violations	• Upgrade STOP signs (e.g., size and retroreflectivity). • Add advance signage or pavement markings. • Consider flashing intersection control beacons.

Did you know?

According to a Kentucky Transportation Center Research Report warning signs in general are associated with a 25% reduction in crashes. The same report also indicates that all-way stop control reduces crashes by 55%

For more information contact:
MassHighway
Traffic Engineering
(617) 973-8484

Last Revised:
January 2008

Low Cost Intersection Safety Improvements

Identified Safety Challenge	Potential Countermeasures
Red light running crashes	• Revise signal timing for yellow and all-red intervals. • Add advance signal ahead signage when traffic signal sight distance is limited, and based upon conditions consider dynamic signage.
Accommodation of bicycles and pedestrians	• Mark intersection crosswalks. • Consider pedestrian signal phasing. • Restrict turns during pedestrian phase. • Potentially restripe roadway to provide a travel lane for bicycles at bicycle/traffic intersections. • Install bicycle detection at signalized locations.
Signs obstruct driver vision or increase driver workload	• Remove or relocate unnecessary signage either on the intersection approach or at the intersection itself that may obstruct other more important signs. Similarly, unnecessary signs or flashing lights may capture drivers attention causing drivers to miss critical information.
Transit stop issues	• Relocate transit stops from intersections. • Relocate transit stops from near side to far side.
Angle crashes at unsignalized intersections	• At intersections with no exiting control where right-of-way may not be obvious consider stop control. • Consider multiway stop control at intersections with nearly equivalent volumes and right-of-way issues.
Turning radius challenges	• Add “No Parking” restrictions near intersections to improve turning radii for heavy vehicles.

Resources

NCHRP 500 Series – Implementation of AASHTO Strategic Highway Safety Plan
This series of guidebooks provides recommendations and countermeasures aimed at targeting specific safety problems along roadways, and is found at http://safety.transportation.org/guides.aspx

Massachusetts Traffic Safety Toolbox Series
This series of fact sheets provides information on safety improvements that can be implemented at the local level. Information on problem areas, possible countermeasures, and implementation considerations is included in each fact sheet which can be found at www.mass.gov/mhd/safetytoolbox/

MASSACHUSETTS EXECUTIVE OFFICE OF TRANSPORTATION
MASSHIGHWAY
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University of Massachusetts Transportation Center

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January 2008

Low Cost Non-Intersection Safety Improvements

Low Cost Non-Intersection Safety Improvements

Background

In 2006, there were 430 fatalities in vehicular crashes in Massachusetts with over half of these fatalities occurring at non-intersection locations. As a result, targeting safety at these non-intersection locations has been the focus of safety-related projects at all levels; however, it is often at the local level where the most significant impacts are realized. This fact sheet provides insight regarding low cost safety fixes for non-intersection crash locations. Recognizing that resources are often limited, an emphasis is provided on the identification of strategies that will yield effective results which are easily implemented from both a time and cost perspective.

Research Has Shown…

Post mounted delineators and chevrons can reduce run-off road crashes by up to 58% and 31%, respectively. (*Source: Low Cost Local Road Safety Solutions by American Traffic Safety Services Association and National Association of County Engineers)*

Low Cost Safety Countermeasure Development

When attempting to improve safety at non-intersection locations consider some general strategies such as the following:

- Identify crash countermeasures that are likely to influence crashes based upon the dominant crash type.
- Select alternatives, assess the economic costs, and implement the appropriate countermeasure(s).
- Evaluate countermeasures to ensure no adverse consequences occur during and after implementation.

Countermeasure Considerations
Technically feasible – Is the countermeasure feasible for the particular location? Does it comply with existing guidelines and/or standards?
Advantageous Cost/Benefit – Does the benefit of the countermeasure outweigh the costs? Are there more cost-effective strategies to consider?
Affordable and Practical – Is the countermeasure practical considering the identified problem? Can it be funded?
Acceptable – Will the public accept the countermeasure politically and within the community? Will there be educational needs for the public?
Legal – Is the countermeasure legal to use? For example, speed limits are regularly revised without proper authorization, and STOP signs are used without meeting the appropriate MUTCD warrants.
Compatible with other roadway features – Does the countermeasure disrupt other safety features, which may result in unintended consequences?

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Low Cost Non-Intersection Safety Improvements

Although large-scale treatments can be used, there are also many effective low cost countermeasures that can be implemented. This fact sheet targets some of the common safety challenges at non-intersection locations, and places an emphasis on identifying low-cost improvements that could likely be implemented in a short timeframe (i.e., less than a year). Although several definitions exist for low cost improvements, such as the FHWA definition of less than $50,000, the information below is based upon treatments under $15,000.

Identified Safety Challenge	Potential Countermeasures
Horizontal curve issues	• Provide advance warning signage. • Add chevrons along the curve. • Add embedded pavement markings and enhanced curve delineation. • Add roadside reflectors to delineate curves. • Increase/add pavement markings to provide 6-inch centerlines and/or edgelines.
Sight distance issues	• Trim or clear trees or bushes obstructing various access points or existing signage. • Add warning signs advising of potential hazards.
Run-off-road crashes at known location	• Enhance delineation through improved pavement markers or roadside reflectors. • Provide adequate clear zone to minimize crash consequences. • Add guard rail to limit roadway departures.
Edge drop-off	• Add and maintain fill to prevent drop-off at roadside which limits vehicle ability to re-enter the roadway upon departure. • Identify drop-off cause (e.g., drainage) and improve.
Drainage-related issues	• Ensure adequate drainage . • Clear/clean catch basins with regularity.
Weather-related crashes	• Alter or increase winter weather treatment program. • Utilize warning signs to identify possible hazardous locations for motorists. • Employ changeable message signs to alert motorists of winter weather conditions.
Pedestrian crossings	• Adequately mark with advance signage and yield lines any non-intersection pedestrian crosswalks.

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MassHighway
Traffic Engineering
(617) 973-8484

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Low Cost Non-Intersection Safety Improvements

Identified Safety Challenge	Potential Countermeasures
Maintenance issues	• Clear brush which may inhibit roadway operations or obstruct existing roadway signage. • Sweep roadways and shoulders regularly. • Fill roadway cracks and potholes. • Replace worn pavement markings and faded signs.
Tree or utility pole crashes	• Relocate or remove existing trees or poles in problematic locations. • Add reflectors to trees or poles. • Add guard rail shielding existing trees or poles.
Speed-related crashes	• Ensure roadways are properly posted in accordance with existing speed regulations (check with MassHighway for existing regulations). • Consider traffic calming measures to reduce speeds. • Consider experimental optical speed measures. • Restripe to provide narrower lanes. • Ensure regular enforcement of appropriate speed limits.
Parking	• Restrict parking at selected locations including constrained cross-section, near intersections, and on the approaches to pedestrian crosswalks.
Passing issues	• Restrict and enforce passing when adequate passing sight distance is not provided.

Resources

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Last Revised:
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Pavement Markings: Other

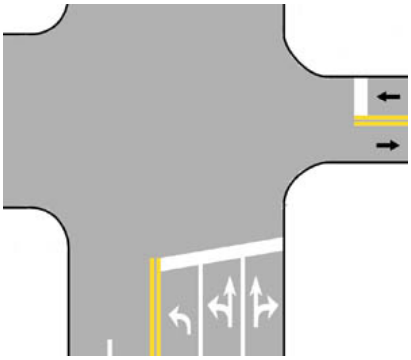
Pavement Markings: Other

Background

This fact sheet refers to non-centerline and non-edgeline pavement markings, such as stop lines, yield lines, crosswalks, symbols, and text messages. For details on centerline and edgeline pavement markings, please refer to the *Pavement Markings: Centerline and Edgeline* fact sheet in this toolbox series. Although signs typically line the sides of roadway, the roadway itself is another medium by which to convey important messages to the roadway user that may supplement other traffic control devices. Specifically, pavement markings are on-road markings that provide guidance and information to the user.

Roadways are designed to provide a safe and efficient environment for roadway users. Pavement markings allow for the road user to keep their eyes on the roadway and still be focused on the upcoming path ahead. Pavement markings can be effectively used to provide drivers with pertinent information along the roadway.

There are considerations municipalities must address when using pavement markings including factors such as size, color retroreflectivity, and wording. Specific information regarding this type of information can be found in Part 3 of the Manual on Uniform Traffic Control Devices (MUTCD) which provides standards and guidance on all traffic control devices used.



Source: MUTCD

For example, an intersection may contain many of these markings, such the symbolic pavement markings to provide drivers lane use designation regarding turning maneuvers. In addition, stop lines and crosswalks are also likely at an intersection providing separation between vehicles and pedestrians.

Pavement markings do however have limitations, especially in states like Massachusetts where snowfall is frequent during the winter months. Pavement markings are only visible to the driver if the roadway is clear of snow and debris. Similarly, high traffic volumes may also obscure a driver's ability to view pavement markings. In addition, heavy traffic volumes will increase the rate at which pavement markings wear. Another consideration is that all pavement marking materials are susceptible to wear and tear from snow plows. Maintenance is key to keeping pavement markings a useful tool for roadway users.

For more information contact:
MassHighway
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(617) 973-8484

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Pavement Markings: Other

Typical Pavement Markings

The following table includes descriptions of pavement markings found on roadways, including placement of these markings and their practical importance. Also provided are direct references to the relevant sections of the MUTCD where a more comprehensive description of the pavement markings can be found.

Types of Pavement Markings

Stop Line is a solid white line that extends across approach lanes to indicate the point at which a stop is required to be made on conjunction with STOP sign, a traffic control signal, or at an at-grade railroad crossings. A stop line is important because of its connection to the STOP sign. (MUTCD Section 3B.16 or MUTCD Section 8B.21)

Yield Line is a line of white triangle markings that extend across approach lanes to indicate a point at which a yield maneuver is required and a driver must exercise caution. Examples include an entrance to a traffic circle or roundabout as well as a non-intersection pedestrian crossing. (MUTCD Section 3B.16)

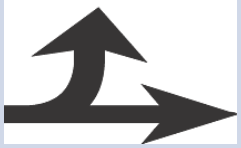
Sample Yield Line
(Source: MUTCD)

Pedestrian Crossings (Crosswalks) help alert motorists and pedestrians alike as to the location of designated crossing areas. Additional details on crosswalks, including installation tips, can be found in the *Crosswalks* fact sheet of this toolbox series. Information on crosswalks can also be found in MUTCD Section 3B.17.

Word Markings are used on roadways to guide or warn drivers of conditions ahead. Some example of word markings include "STOP AHEAD" or "SCHOOL XING", and a listing of allowable word messages is available in the MUTCD Section 3B.19.

Sample "ONLY" Marking
(Source: MUTCD)

Symbol Markings are used on roadways to convey either guidance or mandatory information to roadway users. Some examples of symbol markings include directional arrows or railroad crossing symbols, and more information can be found in MUTCD Section 3B.19 or MUTCD Section 8B.20 .



Sample Symbol Marking
(Source: MUTCD)

Important Reminder!

Municipalities do not have the authority to add pavement markings on state roadways. Rather, they must work cooperatively with MassHighway. If you are not sure if the roadway is a state roadway, contact MassHighway.

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Pavement Markings: Other

Implementing Pavement Markings

The MUTCD must be consulted for specifications on sizing and exact placement before adding pavement markings to roadways. Another useful reference is the **Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)** by the U.S. Access Board, which provides information on handicapped parking spaces and crosswalk design and construction, among other elements.

What material should be used? On roadways, if it's being done under a MassHighway contract, the material would be either thermoplastic or heat-fused retroreflective preformed thermoplastic. If your municipality is doing the work itself, using municipal workers or a contractor, the state of Massachusetts does not have a specific requirement as to what material to use. It is important to remember cost can vary significantly by material.

Reminder!
Although the materials used on the municipal roadways for pavement markings are up to your town, they still must be compliant in terms of color and retroreflectivity with the MUTCD.

Cost Estimates (MassHighway Price List)	
Pavement Arrows and Legends (retroreflective)	Painted - $1.56 per sq foot
	Surface Tape - $9.86 per sq foot
	Thermoplastic - $3.92 per sq foot
Crosswalk, Stop Lines, Yield Lines (retroreflective)	Painted - $0.60 per sq foot
	Thermoplastic - $1.53 per sq foot

Prices included are from the MassHighway Weighted Average Bid Prices as of January 2008. These prices reflect the relative cost differences between treatment options, and will generally be lower than what a municipality may expect to pay.

Retroreflective preformed thermoplastic is considerably lower in cost than surface tape but does cost more than paint. Paint however has the shortest functional life, sometimes needing to be replaced twice a year. For short stretches of roadway, surface tape may be advantageous as it can often be installed by a municipality.

Resources

The Manual on Uniform Traffic Control Devices (MUTCD)
Published by the FHWA, the MUTCD defines the standards used by transportation professionals nationwide to install and maintain traffic control devices on all streets and highways. The most recent version (2003) can be found at http://mutcd.fhwa.dot.gov/.

ADA Accessibility Guidelines for Buildings and Facilities (ADAAG)
This reference provides information regarding the design of facilities which incorporate features for transportation system users with mobility disabilities.

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Pavement Markings: Centerlines and Edgelines

Pavement Markings: Centerlines and Edgelines

Example of fading centerline and edgeline. (Photo Source: FHWA)

Did You Know?

A study by the American Traffic Safety Services Association and the National Association of County Engineers found that on two-lane rural roads with an ADT of at least 500 vehicles per day, edge lines yield $17 in safety benefits for every dollar invested.

Background

Providing pavement markings is an effective strategy to prevent vehicles from encroaching on the roadside. Run-off-the-road and cross-over-the-centerline crashes are among the most deadly crashes along U.S. roadways. Lane departure crashes account for nearly half of all fatal crashes in Massachusetts.

A Federal Highway Administration (FHWA) report of ranked countermeasures listed highly visible and well-maintained pavement markings, such as centerlines and edgelines, as the third-most effective low-cost safety improvement behind (1) the installation of edgeline rumble strips and (2) enhanced shoulder or in-lane delineation and markings for sharp curves. Such pavement markings can help prevent lane departure on roadways by guiding the roadway user. While the Manual on Uniform Traffic Control Devices (MUTCD) clearly details standards for installation of pavement markings, the primary challenge facing most communities is the maintenance of existing markings.

Please note that this fact sheet refers to centerline and edgeline pavement markings only. Additional details on all other types of pavement markings can be found in the *Pavement Markings: Other* fact sheet in this toolbox series.

Longitudinal Lines

Centerlines, edgelines, and lane lines are used to guide the road user and delineate travel lanes. These lines are even more critical when visibility is compromised by fog or heavy rain. Centerlines are intended to separate two opposing traffic streams, whereas edgelines are used to separate the travel lane from an adjacent shoulder. The MUTCD states that centerlines must be yellow and edgelines must be white. When used, lane line pavement markings delineating the separation of traffic lanes that have the same direction of travel shall be white. The MUTCD also provides information regarding the width of centerlines, lane lines, and edgelines.

Example of highly retroreflective pavement markings at night. (Source: FHWA)

A solid line discourages crossing and a double line prohibits crossing. A broken centerline, used to indicate a passing zone, indicates a permissive condition. The MUTCD suggests that the broken line should consist of 10-foot line segments and 30-foot gaps, or dimensions in a similar ratio of line segments to gaps as appropriate for traffic speeds and need for delineation.

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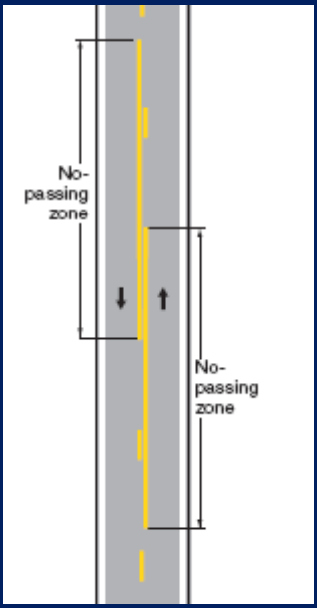
Pavement Markings: Centerlines and Edgelines



Typical two-lane, two-way marking with no passing zones. (Source: MUTCD)

Centerlines

Centerlines are required on all paved urban arterials and collectors that have a traveled way of 20 feet or more in width and an Average Daily Traffic (ADT) volume of 6,000 vehicles per day or greater. Centerline markings should also be placed on all paved two-way streets or undivided highways that have three or more lanes for travel.

A two-lane, two-direction roadway meeting the above criteria should have one of the following centerline combinations: a double yellow solid centerline where passing is prohibited in both directions, a single solid yellow and adjoining broken yellow line where passing in one direction is permitted, or a single broken yellow line. A highway with four or more lanes, with at least two lanes in each direction should have a double yellow solid centerline along the entire roadway.

Edgelines

Edgelines shall be placed on paved rural arterials with a traveled way of 20 feet or more and an ADT of 6,000 vehicles per day or greater. Edgelines may also be placed on any paved street or highway where an engineering study indicates a need and does not show that edgelines would decrease safety.

Installation Considerations

A problem facing many communities is the maintenance of worn centerlines and edgelines. There is a variety of new materials which are more durable, but cost more than older types, such as paint. A brief introduction to the differences between new non-paint-based materials and paint-based materials is included on the next page.

Line width, pattern, and color are all used to convey meaning to the road user. Another consideration may be the use of supplemental signage or markers, such as embedded or raised pavement markers, to emphasize a message.

Some other considerations when selecting materials and pavement marking type include: retroreflectivity in dry and wet conditions, durability, worker safety during application, total cost, ease of application, life expectancy, and supplier availability.

Solid double yellow centerline with embedded pavement markers.

For more information contact:
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(617) 973-8484

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Pavement Markings: Centerlines and Edgelines

Materials Comparison

	Thermoplastic	Solvent Based Paint	Epoxy	Grooved in Tape
Relative Cost $ (per installed linear foot)	.30 – .85	.03 – .15	.08 – .65	1.00 – 2.00
Life Expectancy (asphalt/concrete)	2 – 5 years	4 – 18 months	2 – 3 years	3 – 7 years
Life Expectancy (Portland cement)	1 – 3 years	2 – 7 months	1 – 2 years	3 – 7 years
Approximate Nighttime Visibility in feet (in dry conditions)	340	290	Data not available	320
Approximate Nighttime Visibility in feet (in wet conditions)	200	70		200

Source: *Wet Night Visibility of Pavement Markings: Executive Summary* by Gibbons, R., Hankey, J., and Pashaj, I. 2004.

Additional Considerations

The first step in installing pavement markings is determining the ADT and roadway classification (i.e., arterial, collector, or local). Contact the Executive Office of Transportation and Public Works (EOTPW) Planning Department for help in determining the roadway classification. Next, select appropriate pavement markings based upon the MUTCD. Finally, choose a marking material based upon information provided in this fact sheet as well as local considerations. Questions about pavement markings on state roads and bridges should be directed to MassHighway.

Resources

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Pavement Marking Materials

Additional information on pavement marking materials can be found online thought the Iowa State University Center for Transportation Research and Education at http://www.ctre.iastate.edu/reports/pavemark.pdf

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Retroreflectivity

Retroreflectivity

Background

According to the Federal Highway Administration (FHWA), while only 25 percent of travel occurs at night, more than half of traffic fatalities occur during nighttime hours. In Massachusetts, nearly half of all fatal crashes occur during the nighttime. Poor visibility may be a contributing factor in nighttime crashes. Headlights and roadway lighting help to illuminate the roadway, but are often not enough to meet the needs of nighttime drivers. For this reason, FHWA recommends the use of retroreflective traffic control devices so that at night a driver can see a sign or pavement marking sooner and can then take appropriate actions.

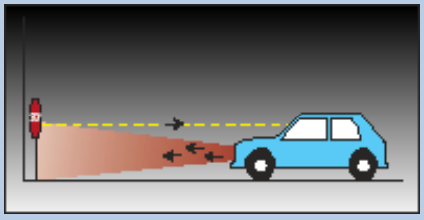
Did You Know?
The FHWA estimates that up to half of the 58 million traffic signs in the U.S. are beyond their useful lifespan (estimated at 10 years) from a retroreflectivity standpoint.

Retroreflective Signs and Pavement Markings

Retroreflective materials used on signs, pavement markings, and other traffic control devices can provide additional visual cues on wet pavements and in the nighttime driving environment helping to meet the needs of nighttime drivers. Retroreflective materials, which use small glass beads and microprismatic reflectors mixed into the paint, have the ability to reflect light and enable a vehicle operator to see traffic control devices more easily at night. The Manual on Uniform Traffic Control Devices (MUTCD) states that all signs and pavement markings shall be retroreflective or have adequate ambient lighting. Fortunately, most traffic signs and pavement markings use retroreflective technology.

Retroreflective paint can be useful and effective and can be used in nearly all instances to reflect a vehicle's headlights thus adding conspicuity. According to the MUTCD, pavement markings shall be installed with the proper retroreflective color as per Section 3A.04. Similarly, all regulatory, warning, and guide signs must use retroreflective or other illuminating materials displaying the same color during both night and day, unless specifically stated otherwise in the MUTCD Section 2A.11. Additionally, it is important to note that the installation procedure is critical in order to obtain the full benefit of retroreflective materials. For example, the height and lateral placement of a sign are critical components of the installation. Please see the MUTCD for additional information regarding the installation procedures of retroreflective signs.

As shown in the adjacent picture, the headlight from a vehicle shines on a retroreflective sign and the message on the sign bounces back to the driver.



Source: FHWA

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Retroreflectivity

Retroreflective STOP Sign *(Source: minimumreflectivity.org*

Measuring Retroreflectivity

As of January 2008, the FHWA has established guidelines for maintaining minimum retroreflectivity levels on traffic signs, which are available in the online version of the MUTCD in Section 2A.09. Signage that does not provide adequate retroreflectivity should be upgraded. In the field, retroreflectivity can be measured in two ways:

1. A precise measurement can be attained with a retroreflectometer. This device is pointed at a sign or pavement marking and measures the light from the object that has been scattered and reflected back to the meter. The actual units for this measure are candela per square meter per incident lux ($cd/lx/m^2$).
2. A more subjective, yet commonly used method, is to gauge retroreflectivity through a simple visual inspection at night.

Costs for Retroreflective Devices

When considering retroreflective devices, considerations in the overall cost include the type of traffic control device (e.g., paint, signs, etc.), the associated installation costs, as well as the level of retroreflective properties. It is also worth noting that costs may vary across manufacturers and with the quantity of an order. Based upon these variations in cost, it is recommended that several alternatives be considered when ordering retroreflective materials, including paint and signage. The following are some devices and the associated prices*:

- Retroreflective delineator—$22.75 per device
- Retroreflective warning signs—$18 per square foot
- Retroreflective location and guide signs—$20 per square foot
- Retroreflective street name signs —$100 per sign
- Retroreflective paint—$1.70 per square foot

*prices included are from the MassHighway Weighted Average Bid Prices as of January 2008. These prices reflect the relative costs for retroreflective materials, and will generally be lower than what a municipality may expect to pay.

Resources

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Last Revised:
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Road Safety Audits

Road Safety Audits

Background

The Federal Highway Administration defines a Road Safety Audit (RSA) as the formal safety examination of an existing or future road or intersection by an independent, multidisciplinary team. The purpose of an RSA is to identify potential safety issues and opportunities for safety improvements taking into account all roadway users. The overarching goal of an RSA is to improve safety along either an existing roadway or a new roadway in the planning, design, or construction stages. RSA's have been employed in other countries for some time, and are currently being fully embraced across the United States as a cost-effective opportunity to make significant safety improvements at any number of stages, ranging from project development and planning through existing operation. Furthermore, it is worth noting that RSA's have proven to be effective on projects of all shapes and sizes.

Did You Know?

In New York State, crash reductions occurred at over 300 high crash locations treated with low cost improvements following RSAs. Crash reductions ranged from 20% to 40%, depending on the type of improvement implemented.

Source: FHWA Office of Safety

Purpose of Road Safety Audits

Road safety audits identify potential safety problems for road users and ensure that measures to eliminate or reduce the problem are taken into consideration. The aim of an RSA is to answer the following questions:

- What elements of the road may present a safety concern: to what extent, to which road users, and under what circumstances?
- What opportunities exist to eliminate or alleviate identified safety concerns? Additionally, road safety audits can result in the increased application of safe design practices.

Considering the Benefits and Costs

Deciding what countermeasures to consider will often depend on how much you have to spend and what the anticipated benefits are. One important aspect of the decision should be the expected benefit-to-cost ratio. Ideally, any selected improvements have benefits that outweigh the associated costs. Fortunately, RSA's frequently result in the identification of countermeasures that are low cost, can be implemented in a short timeframe, and improve safety.

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(617) 973-8484

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Road Safety Audits

The Audit Team

The first step in the RSA process is the selection of the multidisciplinary team, usually consisting of two to five people. The value of an audit team is a result of the varied perspectives, experience, and expertise of the team members. The audit team must be independent and unbiased. In addition to good communication, audit team members should have qualifications and experience in one or more of the following areas: crash investigation, traffic engineering, road design, traffic enforcement, roadway maintenance, EMS, or human factors.

Road Safety Audit Process

Once the audit team has been identified, background information on the roadway is assembled and an initial meeting is held. At this preliminary meeting, project information and drawings are customarily reviewed. Other valuable information such as traffic volumes or crash data for existing roadways should also be considered. Additionally, multiple field reviews can be completed to garner sufficient information. For example, site visits may be made in both day and night to adequately assess roadway conditions. Following review of this information the actual audit is conducted, and an audit report is prepared. The audit report must record all identified issues, along with the level of risk and potential countermeasures for each issue. It is important to make sure that all recommended countermeasures are practical and will address identified safety issues. RSAs typically provide an opportunity for proactive safety measures, and it is important to consider all possible resources in the development of countermeasures. For suggestions on possible countermeasure please see the low cost safety fact sheets within this toolbox series. Any countermeasures that are implemented should be evaluated in order to examine their effectiveness, which may prove useful in identifying effective countermeasures that may be employed on other roadways.

Resources

Federal Highway Administration Office of Safety

The Office of Safety works to reduce both the number and severity of crashes along U.S. roadways. The Office of Safety supports the development, testing, and implementation of technologies and procedures to improve the physical safety of the Nation's roadway infrastructure, and can be found at http://safety.fhwa.dot.gov

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MassHighway
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(617) 973-8484

Last Revised:
January 2008

Sight Distance

Sight Distance

Background

According to the American Association of State Highway and Transportation Officials (AASHTO), the ability of a driver to see ahead on the roadway is of paramount importance for the safe and efficient operation of a vehicle. In general, sight distance refers to the driver's line of sight. Insufficient sight distance is a significant factor in roadway crashes and many other near collisions.

Sight distance can be categorized into various types: (1)*stopping sight distance (SSD)*, (2) *decision sight distance (DSD)*, (3) *passing sight distance (PSD), and (4) intersection sight distance (ISD)*. Each of these sight distances considers the reaction time of the driver and the subsequent time to complete the associated task (e.g., stopping, slowing, or maneuvering). Although summaries of these sight distance values are provided in this fact sheet, the actual formulas and figures used to determine these values should be obtained from AASHTO's *A Policy on Geometric Design of Highways and Streets* (AASHTO Green Book).

Did You Know?

The Federal Highway Administration reports that crash rates tend to increase as the available sight distance decreases.

Stopping Sight Distance

Stopping sight distance is calculated as the sum of (1) the distance a vehicle travels from the instant a driver sees an object necessitating a stop until the instant the brakes are applied, and (2) the distance required to actually stop the vehicle once the brakes are applied. In roadway design, the SSD is used to determine if drivers will have sufficient time to stop. Specifically, SSD is affected by both horizontal and vertical curves in a roadway's alignment.

Source : Iowa State University Center for Transportation Research and Education
- *Handbook of Simplified Practice for Traffic Studies*

It is important to understand the SSD available along roadways to determine if motorists are being afforded sufficient time to stop their vehicle. In the event that appropriate SSD is not available there are various countermeasures that can be considered. For example, one countermeasure that could improve conditions immediately is the trimming of brush that obstructs sight lines. Longer-term solutions may include geometric changes in horizontal and vertical curves.

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Decision Sight Distance

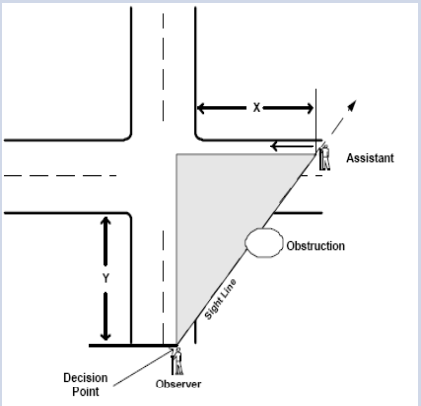
Decision sight distance (DSD) refers to the sight distance needed for a driver to (1) detect an unexpected or difficult-to-perceive condition in a roadway environment, (2) recognize the threat condition, (3) select an appropriate speed and path, and (4) initiate and complete the maneuver safely and efficiently. Some common examples of DSD on the roadway include the distance required to slow down for a turn, a merge, a lane drop, or an exit. It is important to consider DSD at locations where drivers may require additional time or distance due to complex driving situations. Because DSD is a greater distance than SSD, advance warning signs of an upcoming maneuver or required action may be warranted.

Passing Sight Distance

Passing sight distance (PSD) is the length of roadway needed to complete a normal passing maneuver PSD is the distance required to make a decision, react, pass, and rejoin the traffic stream. A calculation of PSD helps to determine if sufficient distance is available to allow for a passing zone to be installed or to determine if a current passing zone actually affords motorists sufficient distance and time to complete a passing maneuver.

Intersection Sight Distance

Intersection sight distance (ISD) refers to the line of sight between a driver on a roadway and a vehicle attempting to enter from a side street or driveway. This value is critical in determining where driveways or other access points should be located, or what traffic control devices are necessary, to ensure that adequate ISD is provided. ISD is easily measured in the field, and information on this procedure can be found in the AASHTO Green Book.



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PSD should be periodically re-evaluated to determine if adequate sight distance is provided per the AASHTO Green Book. Passing zones should be removed or adjusted when adequate PSD can not be provided

Countermeasures for Improving or Mitigating Sight Distance

A simple and relatively low cost and quick solution can be trimming trees, bushes, and plants within the right of way. Without disturbing private property or historic sites, one possible approach is to take annual visits around town and trim overhanging branches or trim bushes that affect the driver's line of sight. On private property, a respectful conversation with residents or property owners can often result in permission to trim on private property.

Utilizing traffic signs can also be an effective strategy. Signage can be added to alert drivers of an upcoming situation that is out of sight distance range. For example, adding a turn ahead or railroad grade crossing sign can help mitigate limitations in available sight distance. Also consider that some signs may inhibit sight distance so removing unnecessary signs that interfere with sight distance can also be effective.

Turn Ahead Warning Sign *(Source MUTCD)*

Another option that may help mitigate sight distance would be the establishment of an advisory speed. Although an advisory speed plaque does not guarantee that a driver will slow down, it may alert the driver that this section of roadway could be hazardous. Please note that these speeds are not enforceable, and advisory speed plaques should be mounted with the warning sign it is intended to supplement.

Sample Advisory Speed Plaque (W13-1) *(Source MUTCD)*

Altering the roadway or intersection itself may be a long-term, higher-cost countermeasure that may improve sight distance.

Resources

A Policy on Geometric Design of Highways and Streets

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Speed Limits & Speed Limit Setting

Speed Limits & Speed Limit Setting

Background

The National Highway Traffic Safety Administration (NHTSA) defines speeding as "travelling in excess of the posted speed limit" or "driving too fast for conditions." Nationally, speed-related crashes account for 30 percent of all fatal crashes, resulting in over 13,000 fatalities annually and a societal cost exceeding $40 billion. The numbers in Massachusetts are similar where 33 percent of the 442 fatalities in 2005 were speed-related. In Massachusetts, 58 percent of speed-related fatalities occurred on roadways with a posted speed limit of 35 mph or less, and 80 percent of speed-related fatalities occurred on a roadway with a posted speed limit of 45 mph or less. From an engineering standpoint *properly posted* speed limits represent the front lines of speed management. This fact sheet provides basic information regarding speed limits and guidance on proper speed limit setting and sign posting.

Did You Know?
According to NHTSA approximately 86% of 2003 speed-related fatalities occurred on non-interstate roadways

Speed Laws in Massachusetts

Within the Massachusetts General Laws (MGL) there are two sections that deal specifically with speed limits.

MGL Chapter 90, Section 18 allows for the posting of numerical limits on the typical speed limit sign. This law also indicates that this limit must be based on engineering study and needs approval via a Special Speed Regulation approved by the Registry of Motor Vehicles and MassHighway. Please note that all regulatory speed limit signs not posted under this procedure are in violation of the law and are not legally enforceable.*

Typical Speed Limit Sign (R2-1)

MGL Chapter 90, Section 17 applies to unposted roadways and specifically states that *it shall be prima facie evidence of a rate of speed greater than is reasonable and proper as aforesaid (1) if a motor vehicle is operated on a divided highway outside a thickly settled or business district at a rate of speed exceeding fifty miles per hour for a distance of a quarter of a mile, or (2) on any other way outside a thickly settled or business district at a rate of speed exceeding forty miles per hour for a distance of a quarter of a mile, or (3) inside a thickly settled or business district at a rate of speed exceeding thirty miles per hour for a distance of one-eighth of a mile, or (4) within a school zone which may be established by a city or town as provided in section two of chapter eighty-five at a rate of speed exceeding twenty miles per hour.*

* Please note there are special speed law provisions in the MGL for the Massachusetts Turnpike and Department of Conservation and Recreation (DCR) [formerly the Metropolitan District Commission (MDC)] Roads.

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Speed Limits & Speed Limit Setting

Setting Speed Limits

Municipalities should contact MassHighway to request speed limit posting on state-owned roadways. It is the responsibility of the municipality to follow the procedures for locally-owned roadways, which require approval by both MassHighway and the Registry of Motor Vehicles (RMV). When considering the establishment of speed limits there are two primary sources it is imperative you review which will provide specific guidance on speed zoning: (1) Procedures for Speed Zoning on State and Municipal Roads, and (2) The Manual on Uniform Traffic Control Devices (MUTCD Section 2B.13). The establishment of a speed limit is *required* to be based upon engineering study, and any resulting posting must be in increments of 5 mph. One major basis for the setting of speed limits is that most motorists are able to select a reasonable and safe speed. Using the 85th %ile speed as a baseline, the proposed speed limit may be adjusted based upon additional factors, including, road characteristics (e.g., shoulder condition, grade, alignment, and sight distance), the pace speed, roadside development and environment, parking practices and pedestrian activity, and reported crash experience.

Please Note

Research has shown that only changing a posted speed limit does not result in significant changes to the roadway speeds. In fact, this holds true for both increases and decreases to the posted limit.

Engineering Study

An engineering study from the municipality must contain both the collected data and analysis of this data. Data collection includes:

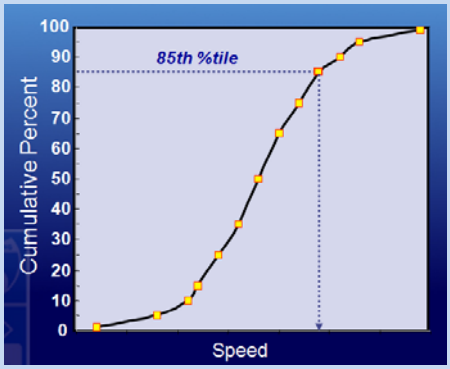
1. Preliminary study of conditions;
2. Speed calculations of curves (MassHighway responsibility);
3. Speed observations;
4. Studies of crash distributions; and
5. Trial runs over the location.

Speed observations are determined from a spot speed study and are representative of the motorists "opinion" regarding the speed limit. Speeds from 100 free flow vehicles (drivers choosing their own speed, i.e., not in queue) should be captured in each direction. Data analysis includes:

1. Safe speed range;
2. Selecting speed limits/lengths of zone;
3. Advisory speeds; and
4. Rechecks with trial runs.

What is the 85th %ile Speed?

This is the speed at which or below 85% of the vehicles are travelling . Speeds are typically assumed to be normally distributed which results in a probability distribution as shown below. Knowing this distribution allows for the targeting of egregious violators. Additionally, studies have shown that as vehicle speeds deviate from the mean the risk of a crash increases; using the 85th %ile method lessens variation of speeds within a traffic stream.



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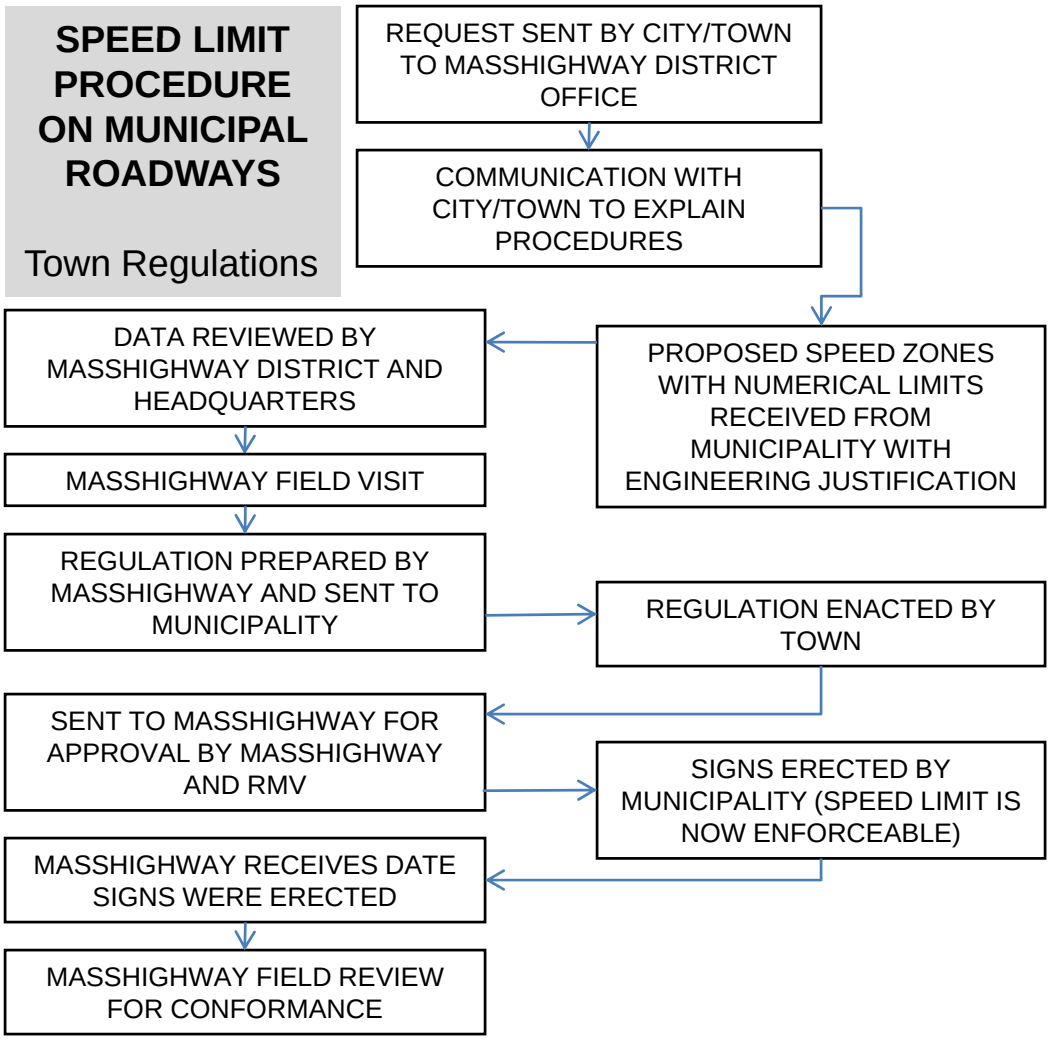
Speed Limits & Speed Limit Setting

Important Reminder!
Advisory speed signage should be used when engineering judgment indicates the need to advise road users of a recommended speed for a given condition (e.g., an exit, a ramp or a curve). Please note that advisory speed limits are not enforceable. Additional information on advisory speed limits is available in the MUTCD Sections 2C. 36 & 2C. 46.



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Procedures for Speed Zoning on State and Municipal Roads
These procedures provide specifications for speed zoning in Massachusetts and can be found at http://www.mhd.state.ma.us/downloads/manuals/speedZoning.pdf

The Manual on Uniform Traffic Control Devices (MUTCD)
Published by the FHWA, the MUTCD defines the standards used by transportation professionals nationwide to install and maintain traffic control devices on all streets and highways. The most recent version (2003) can be found at http://mutcd.fhwa.dot.gov/

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Stop Sign Installation

Stop Sign Installation

Did you know?

STOP sign compliance studies show that when all-way stop control was installed, but not warranted, an average of 30% of the motorists approaching the intersection do not come to a complete stop. *(Source: City of Fargo, ND – Stop Sign Facts)*

Background

STOP signs are traffic control devices that drivers come across regularly. The function of a STOP sign is to improve the safety and operation of intersections by defining who has the right-of-way. Since STOP signs have considerable control over traffic, they should be installed only where necessary. The Manual on Uniform Traffic Control Devices (MUTCD) provides guidelines for the installation of STOP signs. Unwarranted STOP signs may create problems either at the intersection or along the roadway itself by:

- Encouraging motorists to drive faster between intersections in order to save the time lost by stopping.
- Encouraging violation of traffic laws. For example, if STOP signs are installed at a location where the driver does not perceive a need for them, the rate of STOP sign violations tends to increase at that and other locations.
- Encouraging the use of alternate, often more local, routes by drivers trying to get around the STOP sign.
- Increasing the chance that drivers will disregard conflicting vehicle and pedestrian traffic, thus increasing the risk of collisions and injuries.

STOP Sign Regulations

In accordance with the MUTCD, a STOP sign shall be an octagon with white legends and border on a red background, and include only the word STOP. A "4-WAY" supplemental plaque or an "ALL WAY" plaque may be necessary when more than two directions are controlled by STOP signs. STOP signs shall be located on the right side of the roadway, however a secondary STOP sign can be installed on medians or on the left side of the road to supplement the sign on the right side if the road is very wide. The STOP sign shall be installed as close as practical to the intersection and should be visible to the driver as soon as possible. A STOP line or the word STOP on the pavement may be used along with a STOP sign. STOP signs and YIELD signs shall not be mounted on the same post. In addition, no sign should be mounted to the back of a STOP sign other than a DO NOT ENTER sign so the octagon shape of the STOP sign is always visible. Where two roads intersect at an angle, the sign should be placed out of view to the other roadway. A STOP sign in rural areas should be located 6 feet from the shoulder, or if there is no shoulder, 12 feet, and the height from the roadway to the bottom of the sign shall be a minimum of 5 feet. In urban areas, a lesser lateral clearance is permissible as necessary (i.e., 1 foot clearance from the curb is allowable), and the height shall be a minimum of 7 feet from the ground to the bottom of the sign.

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Stop Sign Installation

Technical Information

The Manual on Uniform Traffic Control Devices (MUTCD) provides technical information and guidelines for the usage of STOP signs. The sections below highlight some of the more critical guidelines from the MUTCD.

For two-way stop control, the MUTCD indicates that STOP signs should be used if engineering judgment justifies that one or more of the following exist:

A. Intersection of a less important road with a main road where application of the normal right-of-way rule would not be expected to provide reasonable compliance with the law;

B. Street entering a through highway or street;

C. Unsignalized intersection in a signalized area; and/or

D. High speeds, restricted view, or crash records indicate a need for control by the STOP sign.

A different application of the STOP sign is multiway control, which is limited to intersecting roads of relatively equal volume and characteristics. In accordance with the MUTCD, the following criteria should be considered in an engineering study for a multiway STOP sign installation.

A. A traffic signal is going to be installed and the intersection needs a temporary solution to control the traffic.

B. Within 12 months, at least five crashes have occurred at the intersection that could have been prevented by stop signs.

C. Minimum volumes:
   1. The vehicular volume entering the intersection from the major street approaches averages at least 300 vph for any 8 hours of the day.
   2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour .
   3. If the 85th %ile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70% of the above values.

D. Where no single criterion is satisfied, but where criteria B, C.1, and C.2 are all satisfied to 80% of the minimum values.

Additional criteria that may be considered in an engineering study related to installation of multiway stop control is available in MUTCD Section 2B.07.

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Stop Sign Installation

Once the decision has been made to install a stop sign, there are several critical elements to consider regarding the placement of the sign. Specifically, the MUTCD list three standards governing the placement of a STOP sign as follows:

- 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 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.

Did you know?
According to the San Jose DOT, stopping 5,000 vehicles per day generates 15 tons of additional pollutants per year.

Additional Considerations

Many traffic safety problems are complex and cannot be resolved by installing a STOP sign. For example, STOP signs should not be used to reduce speed or cut-through traffic. In fact, the improper use of STOP signs in these instances may have unintended and adverse impacts which may be opposite of the original intent. In addition, another consideration may be costs. Although the physical installation of a STOP sign is relatively inexpensive, other costs that need to be considered relate to its maintenance, and to extra fuel consumption, increased air and noise pollution and lost driver time. If a STOP sign is not necessary, other countermeasures may be considered. For example, trees and bushes can be trimmed or parking restrictions can be installed to increase visibility at the intersection. YIELD or warning signs, police enforcement, or traffic calming measures may also be effective strategies for consideration.

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Warning Signs

Warning Signs

Background

Warning signs provide important information that could lead to increased safety on roadways. Warning signs are used to call attention to conditions on or adjacent to a highway or street that may not be expected by or readily apparent to road users. Warning signs alert motorists to conditions that may call for some action on their part, such as a reduction in speed, and inform drivers of conditions that they are likely to encounter. Warning signs for which there is not an obvious, consistent need may cause motorists to ignore that type of sign even in locations where there is a consistent need for it. For this reason, overuse or misuse of warning signs is a significant concern.

Warning Sign Impact

A Minnesota Department of Transportation study reported that Traffic signing was found to reduce fatalities by 39% and non-fatal injuries by 15% with a benefit to cost ratio of 22.4.

Application and Design of Warning Signs

Typical Warning Sign (W4-2)

An effective warning sign must be visible, easily understood, and properly positioned. Signs should be highly visible both during the day and at night. All warning signs should be diamond shaped with a black legend and border on a yellow background unless specifically designated in the Manual on Uniform Traffic Control Devices (MUTCD). A fluorescent yellow-green background color with black legend and border may be used for conditions associated with pedestrians, bicyclists, playgrounds, and schools. Warning signs must be designed in accordance with the size, shapes, colors, and legends contained in the "Standard Highway Signs" book. See the Manual on Uniform Traffic Control Devices for more information on design specifications for warning signs. (MUTCD Chapter 2C)

Categories of Warning Signs

Category	Examples
Roadway Related: Alerts motorists to conditions involving changes in horizontal alignment, vertical alignment, cross section, and roadway surface condition.	Turn Curve Lane Drop
Traffic Related: Alerts motorists to conditions involving advance traffic control, traffic flow, change in speed, intersections, vehicular traffic, and non-vehicular traffic.	Stop Ahead Pedestrian Crossing
Supplemental Plaques: Includes distance, advisory speed, arrow, hill related, street name plaque, intersection, share the road, HOV, and traffic circle.	Advisory Speed Share the Road Traffic Circle

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Warning Signs

Placement of Warning Signs

Because warning signs are used for drivers who may be unfamiliar with a roadway and its conditions, placement of these signs is critical to achieving the intended effect. Specifically, warning signs intending to elicit a response from a driver must be located far enough in advance for the driver to have sufficient time to react. The total time needed to perceive and respond to a warning sign is called the PIEV time, or the sum of the times necessary for:

- **Perception** (seeing the problem);
- **Identification** (understanding);
- **Emotion** (decision making); and
- **Volition** (execution of decision).

Typical Warning Sign (W1-10) *(Source: MUTCD)*

Specific equations for calculating this time can be found in the AASHTO *A Policy on Geometric Design of Highways and Streets*. Warning signs must be placed in a location which provides adequate PIEV time, but should not be placed too far in advance of the condition, as this will cause many motorists to forget the warning due to other distractions. The minimum spacing between warning signs with different messages should be based on both the PIEV time and the time required to complete the intended maneuver. A key factor to consider when placing a warning sign is the posted speed (see MUTCD Table 2C-4). This is important to ensure that the signs will be spaced far enough apart for the required decisions to be made safely by the road user. Warning signs should be located on the right side of the roadway, such that they:

1. Are outside the clear zone unless placed on a breakaway or yielding support;
2. Optimize nighttime visibility;
3. Minimize the effects of mud splatter and debris;
4. Do not obscure each other; and
5. Are not hidden from view.

In certain circumstances, such as a curve to the right, signs may be placed on median islands or on the left side of the road. Signs in locations other than the right side of the road should be considered as supplementary to signs in the normal locations, except as indicated in MUTCD Section 2A-16.

Application of Warning Signs

Warning signs should only be used when justified by engineering judgment or studies. The use of warning signs should be coordinated with the design of the roadway in order to ensure that signs are located such that they give the road user adequate warning. Each sign should be used only for the specific purpose outlined in the MUTCD. Signs that are required by certain road conditions must be removed when those conditions cease to exist. See the MUTCD for more information. (MUTCD Chapter 2A)

Important Reminder

Use of warning signs should be kept to a minimum, as overuse tends to breed disrespect for all signs.

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Warning Signs

Excessive Use of Signs

The use of warning signs is determined by the physical conditions on or around the roadway and by field studies. All warning signs should fill a previously determined need, and should draw attention, as their purpose is defeated if they go unnoticed by road users. Signs should be located where hazards are not immediately evident to road users. Their use should be limited, as too many signs on a roadway can create visual clutter, which in turn can cause signs to get lost and lose effectiveness. An overabundance of signs is expensive and can cause confusion among motorists.

Consider an Example

Playground or children at play signs are meant to inform road users that they are entering a zone in which they are likely to consistently encounter children playing. If a playground sign is installed at a location in which children only occasionally play, road users will constantly see this sign with no apparent hazard, and eventually will begin to ignore the sign. This would defeat the purpose of installing the sign at locations in which it is actually necessary.

Typical Playground Sign (W15-1)

Sample Changeable Message Sign (CMS)

Changeable Message Signs

The use of changeable message signs is becoming more widespread. They are used to inform road users of variable situations, especially in areas with high volumes of traffic. When used to display a warning message, changeable message signs should use a black background with a white, yellow, orange, red, or fluorescent yellow-green legend as appropriate. Except for safety or transportation-related messages, changeable message signs should not be used to display information other than regulatory, warning, and guidance information related to traffic control.

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Work Zone Safety

Work Zone Safety

Knowing the Stats:
In the United States, 1,010 people were killed in 2006 in motor vehicle crashes that occurred in work zones. In Massachusetts, there were 11 fatalities in 2006 that occurred in work zones. It is the responsibility of any transportation agency to see that work zones are as safe as possible.
Date Source: Workzonesafety.org

Background

Construction and maintenance are ongoing activities aimed at keeping our roadways safe and efficient for roadway users; however, the very work zones that contain these construction and maintenance activities can create an unexpected condition along the roadway for motorists. Both the Federal Highway Administration (FHWA) and the Commonwealth of Massachusetts have established formal policies to help keep work zones safe for both drivers and workers, alike.

A work zone should be established at any location where construction or maintenance work is ongoing, which may include long-term or temporary work zones as well as moving work zones. The work zone should be set up such that traffic is separated from potential hazards, whether they be on the shoulder or in the center of the traffic lane. Work zones should last for the duration of time work is being performed. If necessary, a work zone should remain in place even when the worker are not present to separate traffic from roadway hazards.

Sample ROAD WORK AHEAD Warning Sign (*Source: MUTCD)*

Work Zone Safety

A fundamental safety element in a work zone is managing vehicle speeds. Some measures that help manage speeds are posting signs for a speed reduction by the work zone or providing advance signage alerting motorists of the potentially unexpected conditions ahead. Yet another method is to reduce lane width, abiding acceptable guidelines and standards, within the work zone itself. Although this may already occur as a result of construction, it may encourage drivers to find a safer, slower speed.

Construction of an adequate transition and termination zone before and after the designated work zone is another important consideration. This will smoothly move traffic into a path away from workers and equipment and safely back into the lane following the work zone, which can typically be done using signage. Dimensions for these geometric transitions can be found in the MUTCD (MUTCD Part 6). This signage should inform the driver of the geometry of any potential lane changes as well.

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Work Zone Safety

More Safety Tips

Work Zone Safety Tips

Education – Informing the public about upcoming or ongoing construction or maintenance can provide enhanced safety and operational benefits. Specifically, informing the public regarding a work zone may allow them to seek out alternate routes and be aware of the work zone.

Signage – Erecting temporary signs declaring the presence of a work zone ahead allows drivers added time to slow down or stop when the work zone is reached. Signs should be placed with adequate sight distance for drivers to react appropriately. Signs should follow MUTCD standards (MUTCD Chapter 6F). Any temporary signs should not impact existing signage. Another consideration is the physical condition and retroreflectivity of the sign.

Barriers – Limit access to the work zone. Allow for vehicular traffic to pass through the work zone, but delineate the zone with barriers to provide safety to the workers. This doesn't necessarily require the use of "Jersey Barriers"; something as simple as traffic cones, reflectorized plastic drum barrels, or Type III barricades.

Police Presence – Massachusetts requires a police presence within a work zone. A police officer helps direct traffic and increase work zone visibility.

Pedestrian, Bike, and Transit Accommodations – Pedestrian and bicyclist safety is as important as motor vehicle safety. Make accommodations for any work zone that shifts pedestrians or bicyclists out of their normal path. A temporary sidewalk or temporary bike lane is one possible solution. If the work zone obstructs a bus stop or roadside pull out, create temporary ones to accommodate users. (MUTCD Chapter 6D)

Pedestrian and Bicycle Detour Sign (M4-9aL)

Lighting – An additional safety measure is to provide additional lighting to the project site, which may allow drivers to better see obstructions and possible hazards at night.

Important Reminder!
All work zone signs and other traffic control devices shall comply with the MUTCD Part 6

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Work Zone Safety

Detour Sign (M4-9R)

In some instances it becomes necessary to set up a detour route to divert traffic from the work zone. A detour should be clearly marked with signage that conveys the new travel path to the driver. This includes signs warning of a detour, signs that direct the path of travel, and a sign that ends the detour. Detour signage must lead drivers back to their original path.

End Detour Sign (M4-8a)

Work Zone Signage Choices

Although the signs below do not necessarily represent the actual sequence of signage within a work zone, they do provide information about various signs that may prove useful regardless of the work zone location.

Give ample time and sight distance for drivers to realize that they are approaching a work zone. (Example Sign W21-1a)

If the roadway path has changed, give ample time and distance to drivers so they know what the roadway geometry will be in the upcoming work zone. (Example Sign W20-5R)

If the roadway changes path, show the change in geometry of the roadway so that the driver can prepare for any required maneuvers. (Example Sign W1-4R)

If the work zone creates potential roadway hazards, alert drivers of those hazards. This includes pavement changes, roadway dips, or bumps, as shown here. (Example Sign W8-1)

Just as at the end of a detour route, tell drivers where the work zone has ended and where they may proceed with their normal traffic flow. (Example Sign G20-2)

Resources

The Manual on Uniform Traffic Control Devices (MUTCD)
Published by the FHWA, the MUTCD defines the standards used by transportation professionals nationwide to install and maintain traffic control devices on all streets and highways. The most recent version (2003) can be found at http://mutcd.fhwa.dot.gov/

The National Work Zone Safety Information Clearinghouse
This web site is dedicated to providing comprehensive information to improve motorist, worker and pedestrian safety in roadway work zones. Available at www.workzonesafety.org

Standard Details & Drawings for the Development of Traffic Management Plans
Details and drawings developed by MassHighway for the purpose of standardizing the temporary Traffic Management Plans used to control traffic during road and bridge construction projects. These drawings should meet the majority of typical work zone setups, but shall also be used as examples for more customized applications. Available through MassHighway at www.mhd.state.ma.us

Massachusetts Executive Office of Transportation

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