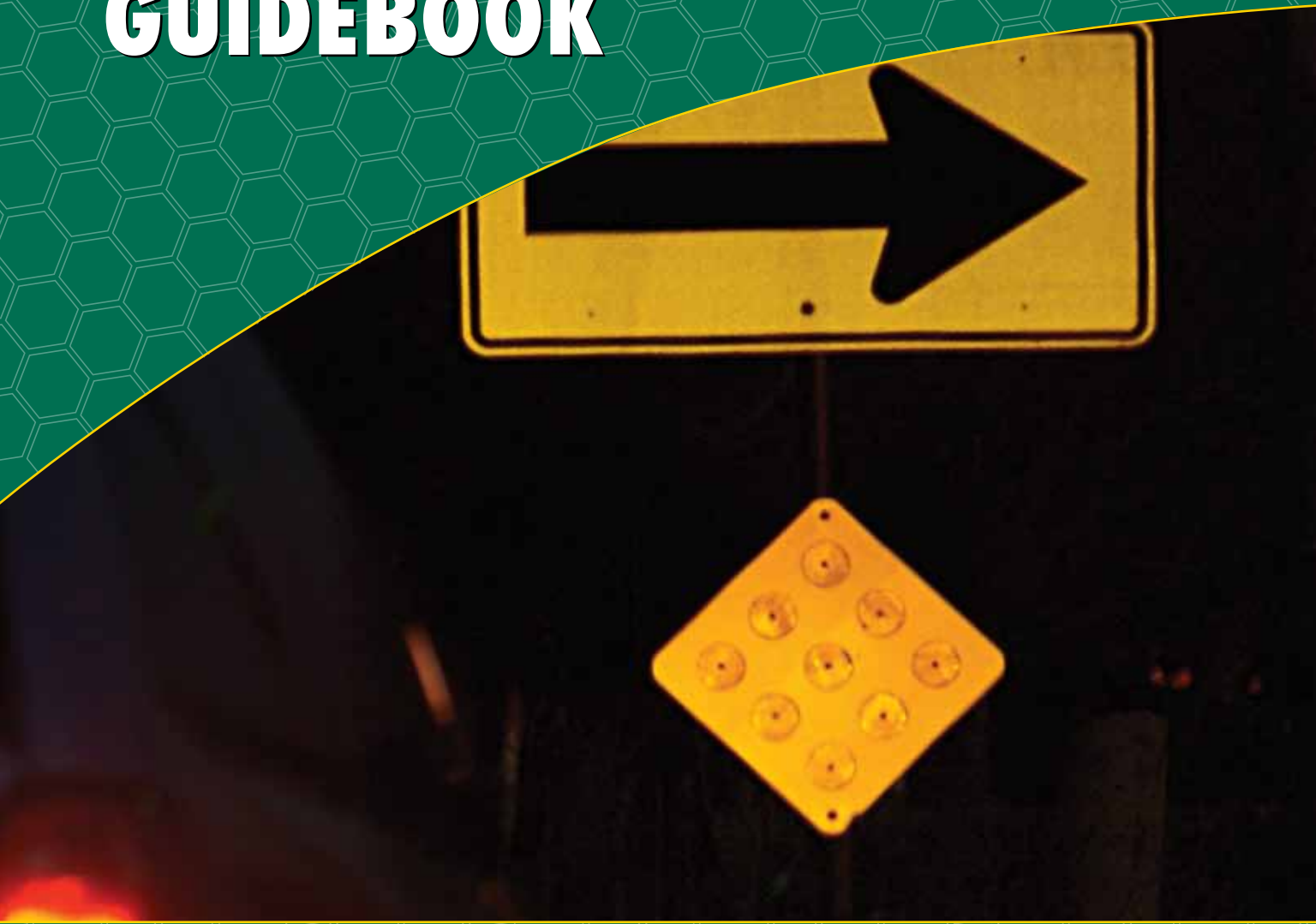
HOW TO MEET THE NEW NATIONAL STANDARD

SIGN RETROREFLECTIVITY GUIDEBOOK



FOR SMALL AGENCIES, FEDERAL LAND MANAGEMENT AGENCIES, AND TRIBAL GOVERNMENTS

U.S.Department of Transportation
Federal Highway Administration

FHWA-CFL/TD-09-005
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Foreword

The Federal Lands Highway (FLH) promotes development and deployment of applied research and technology applicable to solving transportation-related issues on Federal lands. The FLH provides technology delivery, innovative solutions, recommended best practices, and related information and knowledge sharing to Federal agencies, Tribal governments, and other offices within the Federal Highway Administration (FHWA).

This document was developed to assist small-sized agencies without traffic engineering staff in meeting the new Federal requirements for maintaining traffic sign retroreflectivity on roads open to public travel. By considering the needs and capabilities of small agencies, this document provides the necessary information needed to be in compliance with the new traffic sign retroreflectivity requirements.

Two products were produced. One is a stand-alone computer-based package (known as the Traffic Sign Retroreflectivity Toolkit) that includes the new retroreflectivity requirements as well as the necessary information needed to implement a program that will be in compliance with the new requirements. The second product is a hard copy of the computer-based package, without many of the features included in the computer-based package. These documents will help small agencies meet the new traffic sign retroreflectivity requirements while considering their limited resources.

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- Federal Highway Administration—Federal Lands Highway CTIP Council
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What Is Retroreflectivity?

"Retroreflectivity" refers to the property of a traffic sign to reflect light back to the driver. Retroreflective traffic signs are used to increase sign visibility at night. Maintaining traffic sign retroreflectivity is important since nighttime fatal crashes occur approximately three times as often as daytime fatal crashes.

Why Do I Need to Worry about It?

This toolkit will teach you about retroreflectivity and your responsibilities under new Federal Highway Administration (FHWA) requirements to maintain signs in your area. To promote safety and efficiency, FHWA maintains basic standards for traffic signs as found in the *Manual on Uniform Traffic Control Devices* (MUTCD). All agencies that maintain roadways open to public travel must comply with these new requirements.

Retroreflectivity degrades over time. Upgrading poorly maintained traffic signs may reduce traffic injuries and fatalities. Maintaining the retroreflectivity of your local traffic signs might save a neighbor's life—or your child's.

What Do I Need to Do?

Use this toolkit to learn about the new requirements and how to be in compliance. The MUTCD standards were recently updated, and bringing your local signs up to code is your responsibility. In fact, your job is the most important part of making the new standards successful—and your fellow citizens are depending on you.

The toolkit is intended for small cities, counties, townships, federal land management agencies, and tribal governments that don't have a traffic engineer on staff. In short, retroreflectivity maintenance procedures are explained in layman's terms.

1 INTRODUCTION

1

Introduction

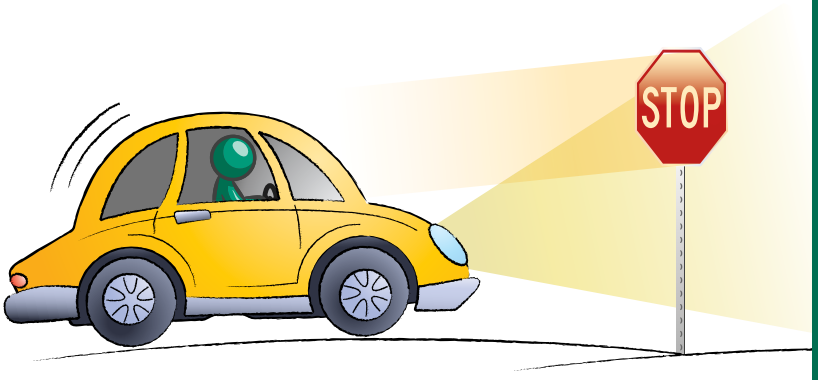
- Defines retroreflectivity and its importance to traffic safety
- Introduces the MUTCD
- Identifies new MUTCD retroreflectivity requirements for sign maintenance
- Outlines your agency's responsibilities under the new requirements
- Discusses how proper sign maintenance can help protect your agency legally

What Is Retroreflectivity?

"Retroreflectivity" describes how light is reflected from a surface and returned to its original source ("retro"-reflector). Traffic signs are made with retroreflective sheeting materials to increase their visibility at night. Maintaining traffic sign retroreflectivity is important to promoting nighttime traffic safety.

Traffic signs use technology with small glass beads or prismatic reflectors that reflect light from vehicle headlamps back to the vehicle and the driver's eyes, thus making the sign appear more bright and visible to the driver.

The figure below shows how retroreflectivity works to assist nighttime driving. There needs to be a light source (vehicle headlamps), a target (traffic sign), and a receptor (driver's eyes).

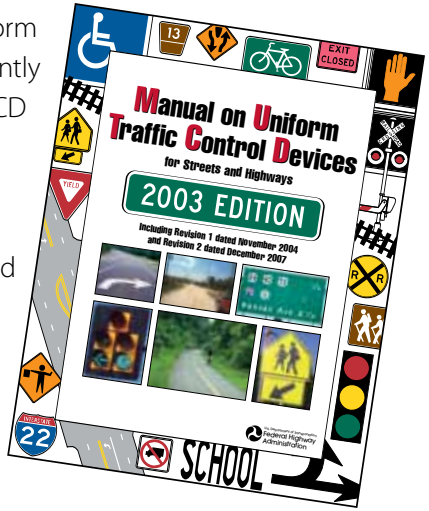


Recently adopted language in the MUTCD now requires all agencies that maintain roadways open to public travel to adopt a sign maintenance program designed to maintain traffic sign retroreflectivity at specific levels.

The *Manual on Uniform Traffic Control Devices*

The *Manual on Uniform Traffic Control Devices*, published by the U.S. Department of Transportation—Federal Highway Administration, sets forth basic principles of traffic signs: namely to promote safety and efficiency on our public roads. Traffic signs inform motorists of regulations, warn of potential hazards on or near the roadway, and help ensure that motorists reach their destinations as safely and efficiently as possible.

The MUTCD establishes uniform standards for traffic signs. Recently adopted language in the MUTCD now requires all agencies that maintain roadways open to public travel to adopt a sign maintenance program designed to maintain traffic sign retroreflectivity at or above specific levels.



Why Are Retroreflectivity Standards Important?

Highway statistics nationwide reveal that the nighttime fatal crash rate is approximately three times that of the daytime crash rate, measured in million miles traveled. Every public agency responsible for maintaining public highways and streets is required to use retroreflective materials on traffic control devices to facilitate driver safety. Moreover, improving nighttime visibility of traffic signs is ever more important as the older driver population increases.

What Are the New Requirements?

For years, the MUTCD has required signs to be either illuminated or made with retroreflective sheeting materials. (For specific language in the MUTCD, visit http://mutcd.fhwa.dot.gov/.)

Most signs in the United States fall in the latter category, but these materials have a limited life. They degrade over time. Until now, little information has existed to determine when signs should be replaced based on their retroreflectivity.

The 2003 MUTCD Edition, Revision 2, identifies minimum required retroreflectivity levels. If a sign falls below this minimum value, it needs to be replaced. Different types and

COMPLIANCE DATES

January 2012

By this date, all agencies will have to establish a sign maintenance program that can regularly address the new minimum sign retroreflectivity requirements.

January 2015

By this date, all agencies must comply with the new retroreflectivity requirements for most of their traffic signs they have installed, including all red or white "regulatory" signs (such as STOP signs and Speed Limit signs), yellow "warning" signs, and green/white "guide" signs.

January 2018

By this date, all agencies must comply with the new retroreflectivity requirements for overhead guide signs and all street name signs.

All agencies responsible for maintaining traffic signs in their area are required to comply with the new MUTCD requirements. These include the following agencies:

- State
- County
- City/township
- Federal land management
- Tribal Governments
- Private entities

quality of sheeting materials are available, and the effective life of a sign (that is, its retroreflectivity) will depend largely upon which material is chosen. To meet the requirements, all agencies must implement a traffic sign maintenance program by using one of the MUTCD's predetermined methods.

Failure to use one of the methods could result in lawsuits from drivers or their families who suffer injury or death attributable to substandard sign retroreflectivity maintenance.

Agencies will not need to measure retroreflectivity levels of all their signs, but they do need to implement a program that regularly evaluates and assesses the nighttime performance of their signs.

Responsibilities of Public Agencies

Public agencies—including State, county, and local/township agencies, as well as the Federal land management agencies (e.g., National Park Service, U.S. Forest Service, and U.S. Fish and Wildlife) and Tribal Governments that maintain roads open to public travel—have to comply with the minimum retroreflectivity requirements for their traffic signs. Public agencies should devote resources to retain the visibility and legibility of traffic signs, as well as ensuring that signs remain properly mounted and in good working condition.

Sign Management and Tort Liability

In addition to improving safety for drivers, FHWA believes that the selection of a reasonable method for maintaining sign retroreflectivity might serve to defend public agencies in tort liability claims and litigation. Public agencies that demonstrate a reasonable maintenance policy as outlined in the MUTCD should be better equipped to successfully defend against tort litigation involving claims of improper sign retroreflectivity.

Once an agency implements one of the methods described in this guidebook, it will be in compliance with the MUTCD requirements even if some individual signs do not meet the minimum retroreflectivity levels at a given point in time (within the restrictions of the compliance dates outlined earlier). For example, a sign might be covered with graffiti the week after the inspection. If that sign was compliant at the time of the inspection, the responsible agency would still be considered in compliance with MUTCD requirements. The minimum levels of retroreflectivity (see Appendix C on page 46) do not imply that an agency needs to measure the retroreflectivity of every sign in its jurisdiction. Instead, agencies must implement one of the methods designed to maintain the minimum retroreflectivity levels, using the criteria in Table 1 on page 47.

IN THE NEXT CHAPTER

The next chapter describes the toolkit on CD-ROM that is included with this guidebook. The CD-ROM is an interactive version of the guidebook that includes an electronic worksheet for budgeting retroreflectivity maintenance costs for signs in your area. It also contains electronic resources (such as sample documents, website links, and PowerPoint® presentations) for your use. If you have a computer, we strongly advise working with the CD-ROM from this point forward.

2 THE SIGN RETROREFLECTIVITY TOOLKIT ON CD-ROM

The Sign Retroreflectivity Toolkit on CD-ROM

What Is the Sign Retroreflectivity Toolkit on CD-ROM?

The Sign Retroreflectivity Toolkit on CD-ROM is an interactive version of this guidebook. If you have a computer that meets the minimum required specifications for running this program (see page 14), we recommend you use the CD-ROM rather than the paper guidebook. Not only does the CD-ROM have features not available in this guidebook, but it also describes other maintenance methods not presented in detail here.

The advantage of using the CD-ROM over the guidebook is that interactive features—such as the interactive budget estimation tool—can save you time and effort as you plan your maintenance activities. In addition, the CD-ROM contains letter and memo templates you can adapt to your needs.

2

- Describes the Sign Retroreflectivity Toolkit on CD-ROM
- Specifies system requirements for using the Toolkit on CD-ROM
- Provides an overview of the Toolkit on CD-ROM's sections
- Describes the Interactive Budget Estimation Tool
- Describes the alternative to the Toolkit on CD-ROM

WHAT DO I NEED TO BE ABLE TO USE THE CD-ROM?

All you need is a personal computer with a CD-ROM drive, speakers and a web browser. Your browser should be at least comparable with Internet Explorer version 6 (2001 or later). To use the interactive walkthrough, you'll need version 7 of the Flash Player or later. Support sites to acquire these applications follow:

Internet Explorer:
http://www.microsoft.com

Flash Player:
http://www.adobe.com/products/flashplayer/

Sections of the Toolkit on CD-ROM

The Toolkit on CD-ROM contains the following sections.

- **New Traffic Sign Maintenance Requirements**. This section provides the context for why retroreflectivity is important and details the purpose for the *Manual on Uniform Traffic Control Devices*. It also provides the precise language of the new MUTCD retroreflectivity requirements (see Appendix C on page 46).
- **Steps to Implementation**. This section includes a series of questions that will help you decide which maintenance method best fits your agency's needs and resources. While the guidebook includes detailed information on only one recommended maintenance method, the CD-ROM draws from four different maintenance methods to provide guidance best suited for your agency. Perhaps most importantly, you can use the Interactive Budget Estimation Tool from this section to determine the best maintenance method given your expertise and resources, as well as create and print a sample budget for maintenance.

- **Funding and Technical Resources**. Local, State, and Federal resources are listed here to help you plan your maintenance program.
- **Sample Forms and Letters**. This section provides sign inspection and other forms, as well as sample memos and letters, for you to use. Examples are provided as both Microsoft® Word and Adobe® PDF documents.
- **More Info**. Should you wish to learn more about retroreflectivity, this section provides more in-depth background material.

The Interactive Budget Estimation Tool

The heart of the Toolkit on CD-ROM is the Interactive Budget Estimation Tool. This application walks you through the process of choosing the best inspection method for your area. You answer a series of questions and, by doing so, fill out a sample budget that approximates the real costs associated with sign maintenance activities in your area.

Once you complete the interactive walkthrough, you can print your sample budget.

TRAINING MATERIAL

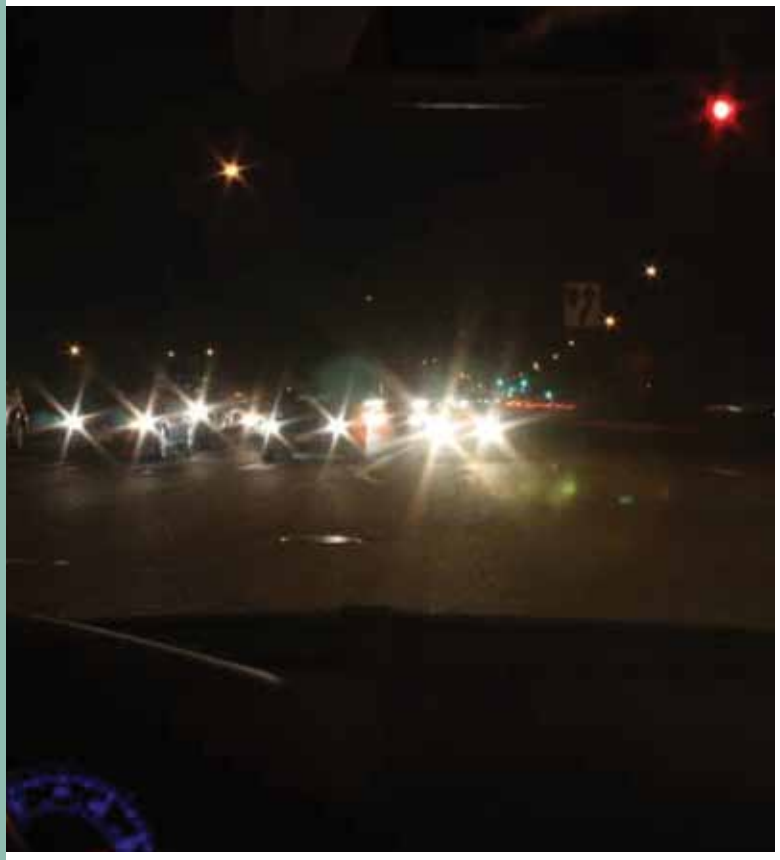
PowerPoint® slides for maintenance method training are provided for download at http://www.fhwa.dot.gov/retro.

IN THE NEXT CHAPTER

The next chapter explains in detail the Consistent Parameters Procedure of the Visual Inspection Method, which is the most practical maintenance method for the vast majority of small agencies.

If You Cannot Use the CD-ROM

If you do not have a computer or your computer doesn't match the required specifications, much of the content from the Toolkit on CD-ROM is replicated in this guidebook. This guidebook contains detailed information on one of the approved maintenance methods, specifically the Consistent Parameters Procedure of the Visual Inspection Method. Like the Interactive Budget Estimation Tool, Chapter 4 of this guidebook shows you how to create a preliminary budget for bringing the retroreflectivity level of your signs into compliance.



3 LOCAL MAINTENANCE

3

- Describes the Consistent Parameters Procedure for the Visual Inspection Method
- Lists the Consistent Parameter procedure requirements
- Suggests guidelines for establishing your inspection program

Local Maintenance

This guidebook presents in detail what may be the most practical inspection method for smaller agencies: the Consistent Parameters Procedure of the Visual Inspection Method. Other methods are described in Appendix B beginning on page 42. For more information on these alternative methods, please reference the accompanying Sign Retroreflectivity Toolkit on CD-ROM.

Description of the Visual Inspection Method—Consistent Parameters Procedure

As implied by its name, the Visual Inspection Method relies on a visual inspection of signs at night to assess their compliance with the MUTCD's retroreflectivity requirements. Of all the maintenance methods listed in the MUTCD, the Visual Inspection Method is probably the most practical for a small agency with limited resources because it requires practically no additional equipment and no sign inventories.

The Visual Inspection Method includes three different procedures. Your agency must select one of the three procedures. The most practical procedure for small agencies is the Consistent Parameters Procedure. The other two procedures included in the Visual Inspection Method are the Calibrated Signs Procedure and the Comparison Panel Procedure. Both of these procedures require special signs or panels that must be purchased or fabricated. The signs and panels also require special handling and storing. For these reasons,

CHECKLIST FOR ESTABLISHING AN INSPECTION PROCEDURE

- ☐ Consistency of testing conditions
- ☐ Vehicle speed
- ☐ Vehicle position
- ☐ Headlamp type
- ☐ Procedural safety issues
- ☐ Recordkeeping
- ☐ Replacement
- ☐ Frequency
- ☐ Compliance Dates

the Consistent Parameters Procedure of the Visual Inspection Method is probably the most practical way for small agencies to meet the MUTCD minimum sign retroreflectivity requirements.

Simply stated, inspectors using this procedure assess the visibility and retroreflectivity of traffic signs as they approach the signs on the roadway during nighttime conditions. If the signs are bright enough to be detected and read, then they are ok as is. If the signs are deemed marginal, they should be scheduled for replacement. If some signs are not bright enough, they should be replaced as soon as possible.

Consistent Parameter Procedure Requirements

The following conditions must be met to properly assess the retroreflectivity of signs using the Consistent Parameters Procedure option of the Visual Inspection Method:

- Inspections must be conducted at night.
- Inspectors must be 60 years or older.
- Inspectors must conduct inspections from a sports utility vehicle (SUV) or pickup truck, model year 2000 or later.
- Inspectors must go through training. Training courses are available at many Local Technology Assistance Program (LTAP) centers. http://www.ltapt2.org.

Guidelines for Establishing an Inspection Protocol

Your agency should develop specific guidelines for conducting nighttime inspections. The content of these guidelines is up to you and your agency. However, in general, the following considerations should be taken into account.

- **Consistency of testing conditions**. Conduct inspections during consistent nighttime conditions whenever possible (e.g., always conduct inspections on clear nights, when there is no rain or fog). Keep the interior light of the inspection vehicle off. Use a pen light for recording the results of the inspection. Use at least three ratings: adequate, marginal, and fail.

BY JANUARY 2012

All agencies must establish and implement a sign maintenance program addressing the minimum sign retroreflectivity requirements.

BY JANUARY 2015

All agencies must comply with the new retroreflectivity requirements for most of their traffic signs they have installed, including all red or white "regulatory" signs (such as STOP and Speed Limit signs), yellow "warning" signs, and green/white "guide" signs.

BY JANUARY 2018

All agencies must comply with the new retroreflectivity requirements for overhead guide signs and all street name signs.

IN THE NEXT CHAPTER

The next chapter explains in detail how to create a basic budget for maintaining signs in your area.

- **Speed of vehicle appropriate to the roadway**. Conduct inspections at normal roadway operating speeds. If you have to slow or stop the vehicle to read the sign, this usually means the sign should be replaced.
- **Vehicle position**. Signs should be inspected from the travel lane. Also, evaluate signs at a typical viewing distance (i.e., at a distance that provides the driver adequate time for an appropriate response).
- **Type of headlamp and alignment**. Use low-beam headlamps to conduct inspections. Take your inspection vehicle to your local mechanic to verify that the head lamps are aimed properly.
- **Safety issues related to conducting the inspections while in a moving vehicle**. If possible, designate a driver for the vehicle. This serves the dual purpose of focusing the inspector on sign evaluation, which promotes consistency and accuracy of results, as well as improving safety for all on the roadway.
- **Recordkeeping**. Use a standardized form for tracking inspection results and, if possible, keep these results in a file cabinet or computer database for ease of reference and comparison purposes later. Sample forms are provided in Appendix D (see page 48).
- **Replacement**. Any sign not legible to the inspector at a typical viewing distance and typical speed should be replaced as soon as possible. Signs rated as marginal should be scheduled for replacement.
- **Frequency**. There is no specific requirement for how often you should conduct the inspections. Generally, most agencies perform inspections on an annual basis.

Other considerations for sign retroreflectivity maintenance are provided in Appendix A on page 39.

4 BUDGETING

4

- Describes the budgeting process
- Presents a budgeting method based on knowing the total number of signs in your community
- Presents a budgeting method based on knowing the total number of centerline miles in your community
- Suggests the next step beyond budgeting

Budgeting

Chapter 2 recommends you use the Sign Retroreflectivity Toolkit on CD-ROM rather than this paper guidebook, especially for constructing a sample budget. The interactive features of that CD-ROM make constructing a sample budget easier. However, if you don't have access to a computer or your computer doesn't meet the specifications required to run the CD-ROM, we'll walk you through constructing a sample budget here.

Gathering Basic Information

Before you can implement a sign maintenance program for your area, the first step is to see how much it will cost to bring the retroreflectivity of your signs up to MUTCD standards. To that end, this chapter will help you gather the basic information you need to prepare a sample budget.

This guidebook presents two methods for estimating sign replacement costs. The first method requires you to know the total number of signs you have in your community. If you don't know this number, the second method can help you calculate costs if you know the total number of centerline miles of roadway in your community.

METHOD 1

Estimating Costs Based on Total Number of Signs

If you know the total number of signs in your community, estimate their replacement costs with the following formulas. In Step 1, you must estimate the number of each type of sign in your community. Step 2 helps you calculate the cost (by sign type) of updating the signs in your community.

To use this method, follow this procedure:

1. Pick the kind of community you represent (town, city, county, Federal land, or tribal government).
2. Plug in the total number of signs to determine how many of each sign type you have.
3. Plug in the total number of each sign type into Step 2 to calculate maintenance costs.
4. If you know the sign replacement cost for your area, use it rather than the default value of $150.

TOWNS

Step 1. Calculating the Number of Each Sign Type in Your Town

In all the calculations below, **T** = the total number of signs in your town. The percentage shown in the calculations (e.g., 75% in the case of regulatory signs) represents the estimated number of signs of that type in an average town. This percentage comes from previous research.

Regulatory Signs: **T** × 0.75 = _____ (**R**, or the estimated # of regulatory signs)

Warning Signs: **T** × 0.20 = _____ (**W**, or the estimated # of warning signs)

Guide Signs: **T** × 0.05 = _____ (**G**, or the estimated # of guide signs)

Step 2. Calculating Sign Replacement Costs (by Sign Type)

Using the total for each sign type estimated in Step 1, you can approximate the costs for updating the signs in your town. The percentage shown in the calculations below (e.g., 10% in the case of regulatory signs) is the estimated number of signs probably needing maintenance. The $150 estimated cost includes materials and labor. This percentage comes from previous research.

Regulatory Signs: **R** × 0.10 × $150 = _____

Warning Signs: **W** × 0.83 × $150 = _____

Guide Signs: **G** × 0.50 × $150 = _____

Sum of Total Sign Replacement Costs: _____

CITIES

Step 1. Calculating the Number of Each Sign Type in Your City

In all the calculations below, **T** = the total number of signs in your city. The percentage shown in the calculations (e.g., 80% in the case of regulatory signs) represents the estimated number of signs of that type in an average city. This percentage comes from previous research.

Regulatory Signs: $\mathbf{T} \times 0.80 =$ _____ (**R**, or the estimated # of regulatory signs)

Warning Signs: $\mathbf{T} \times 0.15 =$ _____ (**W**, or the estimated # of warning signs)

Guide Signs: $\mathbf{T} \times 0.05 =$ _____ (**G**, or the estimated # of guide signs)

Step 2. Calculating Sign Replacement Costs (by Sign Type)

Using the total for each sign type estimated in Step 1, you can approximate the costs for updating the signs in your city. The percentage shown in the calculations below (e.g., 10% in the case of regulatory signs) is the estimated number of signs probably needing maintenance. The $150 estimated cost includes materials and labor. This percentage comes from previous research.

Regulatory Signs: $\mathbf{R} \times 0.10 \times \$150 =$ _____

Warning Signs: $\mathbf{W} \times 0.66 \times \$150 =$ _____

Guide Signs: $\mathbf{G} \times 0.50 \times \$150 =$ _____

Sum of Total Sign Replacement Costs: _____

COUNTIES

Step 1. Calculating the Number of Each Sign Type in Your County

In all the calculations below, **T** = the total number of signs in your county. The percentage shown in the calculations (e.g., 65% in the case of regulatory signs) represents the estimated number of signs of that type in an average county. This percentage comes from previous research.

Regulatory Signs: $\mathbf{T} \times 0.65 =$ _____ (**R**, or the estimated # of regulatory signs)

Warning Signs: $\mathbf{T} \times 0.25 =$ _____ (**W**, or the estimated # of warning signs)

Guide Signs: $\mathbf{T} \times 0.10 =$ _____ (**G**, or the estimated # of guide signs)

Step 2. Calculating Sign Replacement Costs (by Sign Type)

Using the total for each sign type estimated in Step 1, you can approximate the costs for updating the signs in your county. The percentage shown in the calculations below (e.g., 10% in the case of regulatory signs) is the estimated number of signs probably needing maintenance. The $150 estimated cost includes materials and labor. This percentage comes from previous research.

Regulatory Signs: $\mathbf{R} \times 0.10 \times \$150 =$ _____

Warning Signs: $\mathbf{W} \times 0.42 \times \$150 =$ _____

Guide Signs: $\mathbf{G} \times 0.75 \times \$150 =$ _____

Sum of Total Sign Replacement Costs: _____

FEDERAL LANDS AND TRIBAL GOVERNMENTS

Step 1. Calculating the Number of Each Sign Type in Your Area

In all the calculations below, **T** = the total number of signs in your area. The percentage shown in the calculations (e.g., 60% in the case of regulatory signs) represents the estimated number of signs of that type in an average Federal land area. This percentage comes from previous research.

Regulatory Signs: **T** × 0.60 = _____ (**R**, or the estimated # of regulatory signs)

Warning Signs: **T** × 0.35 = _____ (**W**, or the estimated # of warning signs)

Guide Signs: **T** × 0.05 = _____ (**G**, or the estimated # of guide signs)

Step 2. Calculating Sign Replacement Costs (by Sign Type)

Using the total for each sign type estimated in Step 1, you can approximate the costs for updating the signs in your area. The percentage shown in the calculations below (e.g., 25% in the case of regulatory signs) is the estimated number of signs probably needing maintenance. The $150 estimated cost includes materials and labor. This percentage comes from previous research.

Regulatory Signs: **R** × 0.25 × $150 = _____

Warning Signs: **W** × 0.42 × $150 = _____

Guide Signs: **G** × 0.75 × $150 = _____

Sum of Total Sign Replacement Costs: _____

METHOD 2

Estimating Costs Based on Centerline Miles

If you know the total number of centerline miles in your community, estimate your sign replacement costs with the following formulas. First, you must estimate the number of each type of sign in your community in Step 1. Step 2 helps you calculate the cost (by sign type) of updating the signs in your community.

To use this method, follow this procedure:

1. Pick the kind of community you represent (town, city, county, Federal land, or tribal government).
2. Plug in the total number of centerline miles to determine how many of each sign type you have.
3. Plug in the total number of each sign type into Step 2 to calculate maintenance costs.
4. If you know the sign replacement cost for your area, use it rather than the default value of $150.

TOWNS

Step 1. Calculating the Number of Each Sign Type in Your Town

In all the calculations below,

- **C** = total number of centerline miles in your town,
- the number "24" represents the number of signs per centerline mile in an average town (based on previous research), and
- the percentage shown in the calculations (e.g., 75% in the case of regulatory signs) represents the estimated number of signs of that type in an average town (based on previous research).

Total Signs: $C \times 24 =$ _____ (**T**, or the estimated total # of signs)

Regulatory Signs: $C \times 0.75 \times 24 =$ _____ (**R**, or the estimated # of regulatory signs)

Warning Signs: $C \times 0.20 \times 24 =$ _____ (**W**, or the estimated # of warning signs)

Guide Signs: $C \times 0.05 \times 24 =$ _____ (**G**, or the estimated # of guide signs)

Step 2. Calculating Sign Replacement Costs (by Sign Type)

Using the total for each sign type estimated in Step 1, you can approximate the costs for updating the signs in your town. The percentage shown in the calculations below (e.g., 10% in the case of regulatory signs) is the estimated number of signs probably needing maintenance. The $150 estimated cost includes materials and labor. This percentage comes from previous research.

Regulatory Signs: $R \times 0.10 \times \$150 =$ _____

Warning Signs: $W \times 0.83 \times \$150 =$ _____

Guide Signs: $G \times 0.50 \times \$150 =$ _____

Sum of Total Sign Replacement Costs: _____

CITIES

Step 1. Calculating the Number of Each Sign Type in Your City

In all the calculations below,

- **C** = total number of centerline miles in your city,
- the number "28" represents the number of signs per centerline mile in an average city (based on previous research), and
- the percentage shown in the calculations (e.g., 80% in the case of regulatory signs) represents the estimated number of signs of that type in an average city (based on previous research).

Total Signs: $C \times 28 =$ _____ (**T**, or the estimated total # of signs)

Regulatory Signs: $C \times 0.80 \times 28 =$ _____ (**R**, or the estimated # of regulatory signs)

Warning Signs: $C \times 0.15 \times 28 =$ _____ (**W**, or the estimated # of warning signs)

Guide Signs: $C \times 0.05 \times 28 =$ _____ (**G**, or the estimated # of guide signs)

Step 2. Calculating Sign Replacement Costs (by Sign Type)

Using the total for each sign type estimated in Step 1, you can approximate the costs for updating the signs in your city. The percentage shown in the calculations below (e.g., 10% in the case of regulatory signs) is the estimated number of signs probably needing maintenance. The $150 estimated cost includes materials and labor. This percentage comes from previous research.

Regulatory Signs: $R \times 0.10 \times \$150 =$ _____

Warning Signs: $W \times 0.66 \times \$150 =$ _____

Guide Signs: $G \times 0.50 \times \$150 =$ _____

Sum of Total Sign Replacement Costs: _____

COUNTIES

Step 1. Calculating the Number of Each Sign Type in Your County

In all the calculations below,

- **C** = total number of centerline miles in your county,
- the number "4" represents the number of signs per centerline mile in an average county (based on previous research), and
- the percentage shown in the calculations (e.g., 65% in the case of regulatory signs) represents the estimated number of signs of that type in an average county (based on previous research).

Total Signs: $C \times 4 =$ _____ (**T**, or the estimated total # of signs)

Regulatory Signs: $C \times 0.65 \times 4 =$ _____ (**R**, or the estimated # of regulatory signs)

Warning Signs: $C \times 0.25 \times 4 =$ _____ (**W**, or the estimated # of warning signs)

Guide Signs: $C \times 0.10 \times 4 =$ _____ (**G**, or the estimated # of guide signs)

Step 2. Calculating Sign Replacement Costs (by Sign Type)

Using the total for each sign type estimated in Step 1, you can approximate the costs for updating the signs in your county. The percentage shown in the calculations below (e.g., 10% in the case of regulatory signs) is the estimated number of signs probably needing maintenance. The $150 estimated cost includes materials and labor. This percentage comes from previous research.

Regulatory Signs: $R \times 0.10 \times \$150 =$ _____

Warning Signs: $W \times 0.42 \times \$150 =$ _____

Guide Signs: $G \times 0.75 \times \$150 =$ _____

Sum of Total Sign Replacement Costs: _____

FEDERAL LANDS AND TRIBAL GOVERNMENTS

Step 1. Calculating the Number of Each Sign Type in Your Federal Land Area

In all the calculations below,

- **C** = total number of centerline miles in your area,
- the number "4" represents the number of signs per centerline mile in an average Federal land area (based on previous research), and
- the percentage shown in the calculations (e.g., 60% in the case of regulatory signs) represents the estimated number of signs of that type in an average Federal land area (based on previous research).

Total Signs: $C \times 4 =$ _____ (**T**, or the estimated total # of signs)

Regulatory Signs: $C \times 0.60 \times 4 =$ _____ (**R**, or the estimated # of regulatory signs)

Warning Signs: $C \times 0.35 \times 4 =$ _____ (**W**, or the estimated # of warning signs)

Guide Signs: $C \times 0.05 \times 4 =$ _____ (**G**, or the estimated # of guide signs)

Step 2. Calculating Sign Replacement Costs (by Sign Type)

Using the total for each sign type estimated in Step 1, you can approximate the costs for updating the signs in your area. The percentage shown in the calculations below (e.g., 25% in the case of regulatory signs) is the estimated number of signs probably needing maintenance. The $150 estimated cost includes materials and labor. This percentage comes from previous research.

Regulatory Signs: $R \times 0.25 \times \$150 =$ _____

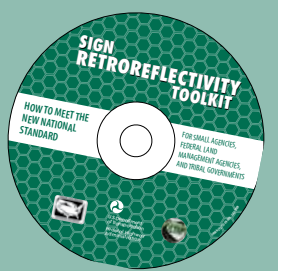
Warning Signs: $W \times 0.42 \times \$150 =$ _____

Guide Signs: $G \times 0.75 \times \$150 =$ _____

Sum of Total Sign Replacement Costs: _____

WHAT'S NEXT?

Now that you know the approximate costs for bringing sign retroreflectivity up to code in your community, you can begin to plan a maintenance schedule. You might consider taking the total sign replacement costs and dividing that by the number of years you want to spread out the costs. Remember the sign replacement deadlines provided on page 21. After you decide how much funding you will need per year, you can fill out a budget request to your management. See the budget request templates included as part of the Sign Retroreflectivity Toolkit on CD-ROM.



Summary

Now that you have gone through this Guidebook, you might want to use the following list of action items to help implement a sign retroreflectivity maintenance program.

1. Decide on a MUTCD Method and Procedure for evaluating your signs (Recommendation: Visual Nighttime Inspection—Consistent Parameters)
2. Before January 2012, document your agencies' adoption of an approved method and procedure by filing an internal memo that includes language such as: "In accordance with the Second Edition of the 2003 MUTCD—Section 2A.09, our agency adopts the Visual Nighttime Inspection Method and the Consistent Parameters Procedure as our technique for maintaining sign retroreflectivity levels. Our guidelines for inspection are attached (see pages 20 and 22 of this Guidebook). The _____ office is responsible for carrying out this method and procedure."
3. Request appropriate funding from your management for inspection and replacement of signs.
4. Begin inspecting your signs on an interval appropriate for your agency (usually once per year or once every two years).
5. By January 2015, have regulatory signs, warning signs, and ground mounted guide signs failing the sign inspections replaced.
6. By January 2018, have street name signs and overhead guide signs failing the sign inspections replaced.

APPENDICES

APPENDIX A

Other Considerations for Sign Retroreflectivity Maintenance

Defining Conformance with the MUTCD

Agencies can achieve substantial conformance with the MUTCD Section 2A.09 (see Appendix C on page 46) by simply having a method in place and using that method to maintain minimum sign retroreflectivity levels. Conformance does not require that every individual sign meet or exceed the minimum retroreflectivity levels at all times.

For example, once signs are rated as marginal or failing, it is expected that there will be a reasonable time period where those signs are in noncompliance until they are upgraded. Having a method in place to assess minimum retroreflectivity levels helps agencies prioritize how to spend limited resources on sign maintenance, ultimately contributing to improved safety for the motoring public.

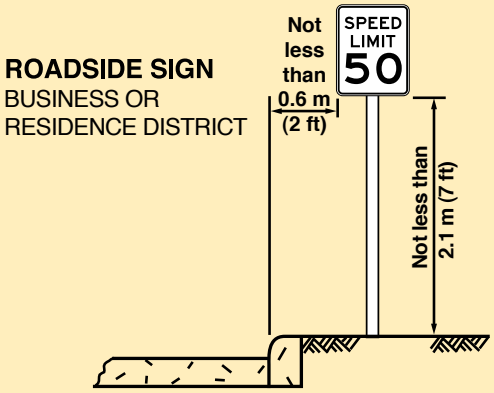
Furthermore, the more complete your agency's inspection records and the greater effort you have made to comply with the MUTCD, the better prepared you are to defend your maintenance practices against potential lawsuits.

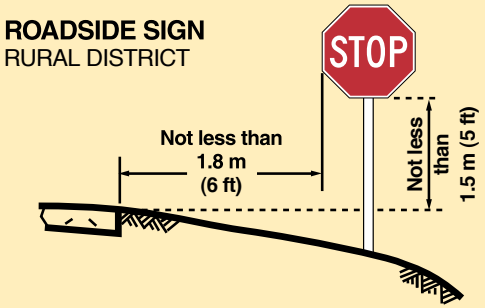
Signs do not last forever and should be periodically inspected.

Mounting Requirements

In general, traffic signs should be mounted on the right side of the road and not be obscured by such things as trees, parked vehicles, or other physical objects.

Mount signs need to meet the following requirements.





Crashworthiness Requirements

Section 2A-19 of the MUTCD states that "ground-mounted sign supports shall be breakaway, yielding, or shielded with a longitudinal barrier or crash cushion if within the clear zone." Rigid objects close to a roadway can be deadly when struck by a vehicle that strays off the pavement. Supports for road signs, frequently placed close to the roadway, are hazards if they do not break away upon impact.

"Breakaway signs" include supports that, when struck by a vehicle, separate from the base and are knocked ahead of or up and over the errant vehicle, as well as supports that "yield" or allow the vehicle to run over them. Note that compliance with this standard is required by January 2013 for all nonbreakaway sign supports within the clear zone of roads posted at 50 mph or greater.

Other Conditions to Consider

While research has shown that the Visual Inspection Method is a reasonable method for identifying signs that need replacement, the Visual Inspection Method is not 100 percent reliable.

There are conditions where signs might be rated as being satisfactory while temporarily falling below the minimum retroreflectivity levels. For example, dew and frost on signs have been shown to significantly reduce retroreflectivity.

When sign inventories are not available for use during visual inspections, it is possible to miss a small percentage of signs along a densely signed corridor, especially if a sign was knocked down or missing during the inspection. Or, signs might meet retroreflectivity minimums for a time, but due to factors such as manufacturing defects or inadvertent mishandling during installation, a certain percentage might fall below the minimum retroreflectivity levels sooner than expected.

CLEAR ZONE OF ROADS

A driver of a vehicle that leaves the roadway might be able to regain control of the vehicle and return to the roadway if **the open space adjacent to the roadway is clear, unobstructed, and relatively flat**. This area is known as the "clear zone." The width of the clear zone is a function of the speed of traffic, traffic volume, steepness of the side slopes, and curvature of the road. State highway agencies have accepted procedures for determining the required clear zones for roadways.

These photos show a breakaway sign in action. Breakaway signs make collisions with signs safe for the vehicle occupants.

APPENDIX B

Other Inspection Methods to Consider for Retroreflectivity Maintenance

MUTCD sign retroreflectivity maintenance methods other than the Consistent Parameters Procedure of the Visual Inspection Method are described on the following pages. Agencies can adapt these methods for maintaining sign retroreflectivity into their existing sign management processes.

Note that the Calibration Signs and Comparison Panels Procedures for the Visual Inspection Method both require the agency to have signs or panels for implementation. There are currently no turnkey operations offering these signs or panels. While they could be made by an agency's sign shop, it would require retroreflectivity measurements with equipment costing over $10,000 and not likely owned by small agencies.

The Expected Sign Life, Blanket Replacement, and Control Sign maintenance methods require some level of management in order to be implemented. The Retroreflectivity Measurement Method requires equipment purchases over $10,000.

For each of the last 25 years, approximately 50 percent of the fatal crashes have occurred at night despite the lower volumes of traffic at night.

The Visual Inspection Method—Alternative Procedures

The Consistent Parameters Procedure for this method has already been described in detail in Chapter 3 of this guidebook. Here are two alternative procedures for this method:

- **Calibration Signs Procedure**. In this procedure, an inspector views a "calibration sign" prior to conducting the nighttime inspection described above. Calibration signs have known retroreflectivity levels at or above minimum levels. These signs are set up where the inspector can view the calibration signs in a manner similar to nighttime field inspections. The inspector uses the visual appearance of the calibration sign to establish the evaluation threshold for that night's inspection activities. It is unlikely that small agencies will have the funds or equipment to make the calibration signs required for this procedure.

- **Comparison Panels Procedure**. Comparison panels are used to assess signs that have marginal retroreflectivity. The comparison panels are fabricated at retroreflectivity levels at or above the minimum levels. When the visual inspection identifies the retroreflectivity of a sign as marginal, a comparison panel is attached to the sign, and the sign/panel combination is viewed and compared by the inspector. It is unlikely that small agencies will have the funds or equipment to make the comparison panels required for this procedure.

Retroreflectivity Measurements

Retroreflectivity is measured using a retroreflectometer. Signs with retroreflectivity below the minimum levels should be replaced. The Retroreflectivity Measurement Method requires equipment purchases over $10,000.

Expected Sign Life

When signs are installed, the installation date is labeled or recorded so that the age of a sign is known. The age of the sign is compared to the expected sign life. The expected sign life is based on the experience of sign retroreflectivity degradation in a geographic area compared to the minimum levels. Signs older than the expected life should be replaced.

Blanket Replacement

All signs in an area/corridor or of a given type should be replaced at specified intervals. This eliminates the need to assess retroreflectivity or track the life of individual signs. The replacement interval is based on the expected sign life, compared to the minimum levels, for the shortest-life material used on the affected signs.

Control Signs

Replacement of signs in the field is based on the performance of a sample of control signs. The control signs might be a small sample located in a maintenance yard or a sample of signs in the field. The control signs are monitored to determine the end of their retroreflective life. All field signs represented by the control sample should be replaced before the retroreflectivity levels of the control sample reach the minimum levels.

APPENDIX C

The specific language for the new minimum requirements is as follows.

New MUTCD Minimum Retroreflectivity Maintenance Requirements

SUPPORT:

Retroreflectivity is one of several factors associated with maintaining nighttime sign visibility (see Section 2A.22).

STANDARD:

Public agencies or officials having jurisdiction shall use an assessment or management method that is designed to maintain sign retroreflectivity at or above the minimum levels in Table 1.

SUPPORT:

Compliance with the above Standard is achieved by having a method in place and using the method to maintain the minimum levels established in Table 1. Provided that an assessment or management method is being used, an agency or official having jurisdiction would be in compliance with the above Standard even if there are some individual signs that do not meet the minimum retroreflectivity levels at a particular point in time.

GUIDANCE:

Except for those signs specifically identified in the Option portion of this Section, one or more of the following assessment or management methods should be used to maintain sign retroreflectivity:

A. **Visual Nighttime Inspection** – The retroreflectivity of an existing sign is assessed by a trained sign inspector conducting a visual inspection from a moving vehicle during nighttime conditions. Signs that are visually identified by the inspector to have retroreflectivity below the minimum levels should be replaced.
B. **Measured Sign Retroreflectivity** – Retroreflectivity is measured using a retroreflectometer. Signs with retroreflectivity below the minimum levels should be replaced.
C. **Expected Sign Life** – When signs are installed, the installation date is labeled or recorded so that the age of a sign is known. The age of the sign is compared to the expected sign life. The expected sign life is based on the experience of sign retroreflectivity degradation in a geographic area compared to the minimum levels. Signs older than the expected life should be replaced.
D. **Blanket Replacement** – All signs in an area/corridor, or of a given type, should be replaced at specified intervals. This eliminates the need to assess retroreflectivity or track the life of individual signs. The replacement interval is based on the expected sign life, compared to the minimum levels, for the shortest-life material used on the affected signs.
E. **Control Signs** – Replacement of signs in the field is based on the performance of a sample of control signs. The control signs might be a small sample located in a maintenance yard or a sample of signs in the field. The control signs are monitored to determine the end of retroreflective life for the associated signs. All field signs represented by the control sample should be replaced before the retroreflectivity levels of the control sample reach the minimum levels.
F. **Other Methods** – Other methods developed based on engineering studies can be used.

SUPPORT:

Additional information about these methods is contained in the 2007 Edition of FHWA's "Maintaining Traffic Sign Retroreflectivity" (see Section 1A.11) at http://mutcd.fhwa.dot.gov/htm/2003r1r2/part2/part2a.htm.

OPTION:

Highway agencies may exclude the following signs from the retroreflectivity maintenance guidelines described in this Section:

A. Parking, Standing, and Stopping signs (R7 and R8 series)
B. Walking/Hitchhiking/Crossing signs (R9 series, R10-1 through R10-4b)
C. Adopt-A-Highway signs
D. All signs with blue or brown backgrounds
E. Bikeway signs that are intended for exclusive use by bicyclists or pedestrians

Table 1. Minimum Maintained Retroreflectivity Levels ①

Sign Color	Sheeting Type (ASTM D4956-04)				Additional Criteria
	Beaded Sheeting			Prismatic Sheeting	
	I	II	III	III, IV, VI, VII, VIII, IX, X	
White on Green	W*; G ≥ 7	W*; G ≥ 15	W*; G ≥ 25	W ≥ 250; G ≥ 25	Overhead
	W*; G ≥ 7	W ≥ 120; G ≥ 15			Ground mounted
Black on Yellow or Black on Orange	Y*; 0*	Y ≥ 50; 0 ≥ 50			②
	Y*; 0*	Y ≥ 75; 0 ≥ 75			③
White on Red	W ≥ 35; R ≥ 7				④
Black on White	W ≥ 50				

① The minimum Minimum Retroreflectivity levels shown in this table are in units of cd/lx/m^2 measured at an observation angle of 0.2° and an entrance angle of –4.0°.

② For text and fine symbol signs measuring at least 1,200 mm (48 inches) and for all sizes of bold symbol signs.

③ For text and fine symbol signs measuring less than 1,200 mm (48 inches).

④ Minimum sign contrast ratio ≥ 3:1 (white retroreflectivity ÷ red retroreflectivity).

* This sheeting type should not be used for this color for this application.

Bold Symbol Signs

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

Fine Symbol Signs—Symbol Signs Not Listed as Bold Symbol Signs

Special Cases

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

APPENDIX D

Sample Letters and Forms

Agency _____ Sheet _____ of _____

Traffic Sign Inspection Sheet

Date Surveyed _____

Zone _____ Roadway _____ Location/Direction _____

From _____ To _____

Milepoint	Direction	Sign Type	MUTCD Number	Sign Size	Sign Message	Retroreflectivity OK	Remove Sign	Replace Sign	Adjust Height	Steel Post	Wood Post	New Post	Level Post	Remarks
INSPECTOR														

✓ = okay

✗ = needs attention

Traffic Control Device Inspection Sheet

Agency _____ Road Identification _____ Direction _____

Beginning Point _____ Ending Point _____

Date _____ Inspector _____

Odometer Reading	Side of Road	Sign No.	Sign I.D.	Sign Type	Sign Inspection			
					Date	Action Taken	Date	Action Taken

Approved _____

Title _____

Page _____ of _____

Sample Funding Request Letter to State Department of Transportation (DOT)

Date

State DOT Contact
Title
Address
City, State, Zip Code

Dear (***State Contact Person***)

The (***Your Agency***) hereby requests further information on financial assistance that may be available from the (***Your State Department of Transportation***) regarding the State's Surface Transportation and Highway Safety programs. (***Your Agency***) is interested in continuing to improve safety on our local roads by reducing the severity and number of highway crashes.

New Federal rule making related to traffic sign retroreflectivity now published in the *Manual on Uniform Traffic Control Devices* (MUTCD) requires all government agencies to implement a traffic sign maintenance program and to begin meeting new minimum sign retroreflectivity requirements. (***Your Agency***) is interested in learning more about this program but, more importantly, applying for any funding opportunities that may be available for local agencies.

(***Your Agency***) anticipates needing an additional ($***XX,XXX***) in annual operating expenses to implement a sign management program and to begin the purchase and installation of new traffic signs. The requested improvements include the following:

1. (***Itemize***)
2.
3.

(***Your Agency***) will budget available necessary funds for a local share of any funding opportunities and can provide additional information related to this request.

Please let me know if you have any questions or need additional information.

Sincerely,

Mayor, County Executive, City Administrator, or Tribal Government Representative

Sample Funding Request Memo to Elected Officials

MEMORANDUM

TO: ***Board, Council, Commission***

FROM: ***City or County Administrator***

DATE:

SUBJECT: FY 20***XX*** Budget Service Level Increase

New Federal traffic sign standards require (***Your Agency***) to implement a traffic sign maintenance program and to begin meeting new minimum sign retroreflectivity requirements for many of our traffic signs. This will require (***Your Agency***) to:

1. establish a sign maintenance program by January 2012,
2. meet new minimum retroreflectivity requirements for most of our traffic signs by January 2015 (regulatory, warning, and guide signs), and
3. meet new minimum retroreflectivity requirements for our street name signs by January 2018.

To meet these new Federal requirements, the (***Your Agency***) will need an additional ($***XX,XXX***) in annual operating expenses to implement this sign maintenance program and to begin the purchase and installation of new traffic signs. The requested improvements include the following:

1. (***Itemize***)
2.
3.

There may be opportunities to apply for and receive State or Federal grant funds to help offset our anticipated increase in annual expenses, and our staff is investigating these opportunities.

Please let me know if you have any questions or need additional information.

APPENDIX E

Frequently Asked Questions

What is retroreflectivity?

"Retroreflectivity" describes how light is reflected from a surface and returned to its original source ("retro"-reflector). Traffic signs are covered by retroreflective sheeting materials to increase their visibility at night. Since nighttime crashes occur approximately three times as often as daytime crashes, maintaining traffic sign retroreflectivity is important to promoting traffic safety.

What makes the traffic signs visible at night?

Traffic signs use technology with small glass beads or prismatic reflectors that reflect light from vehicle headlamps back to the vehicle and the driver's eyes, thus making the sign appear more bright and visible to the driver. For retroreflectivity to work properly, there needs to be a light source (vehicle headlamps), a target (traffic sign), and a receptor (driver's eyes).

What is the MUTCD?

Published by the Federal Highway Administration, the *Manual on Uniform Traffic Control Devices* defines the standards used by road managers nationwide to install and maintain traffic control devices on all streets and highways. The MUTCD is available at http://mutcd.fhwa.dot.gov.

Can I use any type of sign sheeting as long as its retroreflectivity meets the minimum specified levels?

The new Table 1 (see page 47) indicates that any type of sheeting including the Type I (commonly called Engineering Grade), Type II (commonly called Super Engineering Grade), or Type III beaded (commonly called High Intensity Beaded) sheeting and the Type III, IV, VI, VII, VIII, IX, or X prismatic sheeting may be used on any sign with the following exceptions:

- Types I, II, and III beaded sheeting cannot be used for the white legends on overhead guide signs,
- Type I beaded sheeting cannot be used for the white legends on ground-mounted guide signs, and
- Type I beaded sheeting cannot be used for the yellow or orange backgrounds on warning and temporary traffic control signs.

Can I still use Type I Engineering Grade sign sheeting?

Type I Engineering Grade sign sheeting may still be used for white, green, and red backgrounds. Type I Engineering Grade sign sheeting also may still be used for the white legend on a sign with a red background. Thus, STOP signs and black-on-white regulatory signs may still be made from Type I Engineering Grade sign sheeting.

However, when agencies review their signing practices and choice of sign materials, consider the annualized costs of the signs using factors like expected sign life. Even though a particular type of sheeting might initially meet the minimum retroreflectivity levels when it is new, it might quickly degrade below minimum levels, thus losing its effectiveness at night and requiring replacement the next time its retroreflectivity is assessed. The use of higher-performance sheeting, although more expensive initially, might provide a better life-cycle cost for the agency.

NOTES

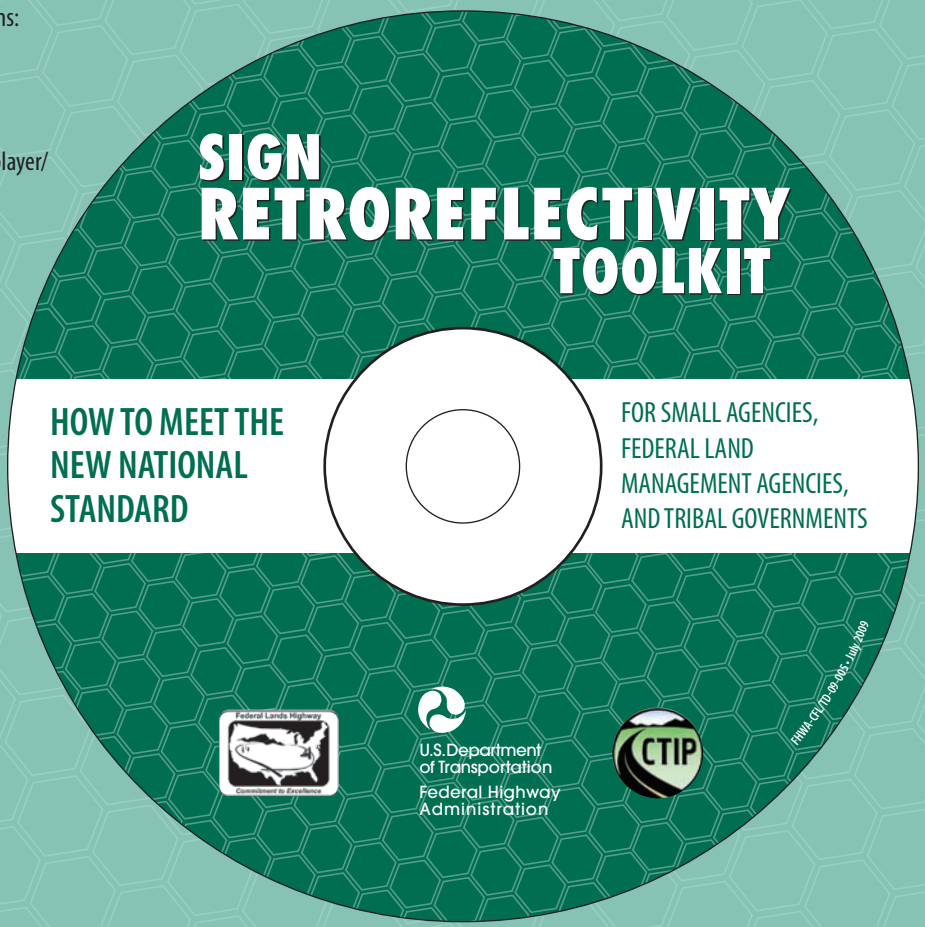
SYSTEM REQUIREMENTS

- Internet Explorer® version 6 (2001 or later) or comparable
- For the interactive walkthrough:
  Flash Player version 7 or later
- Support sites to acquire these applications:
  Internet Explorer:
  http://www.microsoft.com
  Flash Player:
  http://www.adobe.com/products/flashplayer/

INSTRUCTIONS

PC Users:
Use Windows Explorer to view the CD-ROM contents.
Double-click the file named "open".

Macintosh Users:
Double-click the CD-ROM icon.
Double-click the file named "open".



U.S. Department of Transportation
Federal Highway Administration

TTI.FHWA0901.0909.32M