



# TRAFFIC SIGN MAINTENANCE POLICY

---

## **Purpose and Goal**

The purpose of this policy is to establish uniformity and consistency in the application, installation, and maintenance of traffic signs on city right-of-way.

This policy recognizes that the Minnesota Manual on Uniform Traffic Control Devices (*MN MUTCD*) as the standard for all traffic control devices on all public roads in Minnesota, and, therefore, all traffic control devices on the City of Anoka's roadway system must conform to its standards and specifications as identified in Minnesota Statute Chapter 169.

This policy officially recognizes the rule in the *MN MUTCD* that establishes minimum retro-reflectivity levels for traffic signs and describes how the City of Anoka will achieve compliance.

The goal of this policy is to improve public safety on the City's streets and roads and prioritize the City's limited resources for maintenance and to replace signs. It is in the interest of the City of Anoka and the public to prevent the excessive use of traffic signs on the city roadway system. A conservative use of traffic signs reduces maintenance costs and improves the effectiveness of the remaining signs. Limiting the excessive use of traffic signs achieves the following:

- Fulfills demonstrated needs
- Improves public safety
- Champions a command of attention
- Reduces clutter that impedes the conveyance of a clear and simple meaning
- Fosters respect by road users, and reduces conflicts that may restrict time for a proper response that cumulatively improves traffic safety for all users

## **Introduction**

There are six different types of roadway signs, they include:

- Regulatory Signs
- Warning Signs
- Directional/Guide Signs
- Special Purpose or Miscellaneous Signs
- Construction Signs
- Not Permitted Signs

Regulatory signing is defined as a sign that gives notice to road users of traffic law or regulations.

Warning signing is defined as a sign that gives notice to road users of a situation that might not be readily apparent.

Directional/guide signing is defined as a sign that shows route designations, destinations, directions, distances, services, points of interest, or other geographical recreational, or cultural information.

Special purpose or miscellaneous sign is defined as a sign not required by the city for general traffic purposes to provide for a safe and efficient movement of people and goods.

Construction sign is defined as a sign in a construction zone to give road users and pedestrians a safe route through or around the construction zone.

Not permitted sign is defined as a sign that is prohibited by State Statute or City Ordinance.

**Policy**

All traffic signs on the City of Anoka’s roadway system must conform to the *MN MUTCD*. Traffic signs not explicitly required to be installed by the *MN MUTCD* should not be installed on the City of Anoka’s roadway system unless otherwise specified in this policy or authorized by the City Council.

**Policy Criteria**

**Installation of Signs:**

The City of Anoka will complete a sign inventory of all signs on the roadway system with in the right-of-way. Based on the inventory and level of funding available for sign maintenance, the City of Anoka will determine the amount of inventory that can be supported by the current funding structure.

The City of Anoka will maintain the determined amount of traffic signs to ensure safe and efficient operations. Based on the inventory and policy considerations, signs that are not consistent with policy, and signs that are not required or are determined by an engineering study to be unnecessary, may be removed. The following best practices will be implemented to assist in determining the need for all traffic signs:

- Signs that will be required to be installed are listed below. For low volume roads (less than 400 ADT), only the warning signs (minimum maintenance & railroad advance warning) listed below are required:

Regulatory	 	<ul style="list-style-type: none"> <li>■ Speed Limits <b>IF</b> a speed zone (other than a statutory limit) has been established.</li> <li>■ ONE-WAY &amp; DO NOT ENTER where applicable.</li> <li>■ The ALL-WAY STOP plaque at All-Way Stops.</li> <li>■ Prohibition signs where applicable</li> </ul>
Warning	 	<ul style="list-style-type: none"> <li>■ Rail Road Advance Warning and No Train Horn (if quiet zone established)</li> <li>■ Clearance <b>IF</b> clearance is less than 14'-6" (12" above the statutory minimum clearance height)</li> <li>■ Advance Traffic Control <b>IF</b> there is limited sight distance.</li> <li>■ Minimum Maintenance</li> </ul>
Guide	  	<ul style="list-style-type: none"> <li>■ Route Numbers on ALL numbered highways</li> <li>■ Junction Assembly</li> <li>■ Advance Route Turn Assembly</li> </ul>

- No warning (curve, pedestrian crossing, deer signs) or regulatory (speed limit, stop) signs on roads classified as local or residential unless specified in this policy or one of the following items is present:
  - Unusual or unique condition exists in the area
  - Indication of potential hazard
  - School campus
- Stop signs will automatically be installed on the less important road with a main road under the following conditions:
  - Total intersection traffic volumes are greater than 800 vehicles per day

- Intersect with a state or federal highway
- Intersect with a county or state aid road
- Unsignalized intersection in a signalized area
- Rail road crossing that are not equipped with an active traffic control system
- **NO** stops signs installed on low volume intersection (fewer than 800 vehicles per day) unless a minimum of two of the following items are met:
  - There is sight obstruction in the clear view triangle
  - Average speed at the 85<sup>th</sup> percentile is more than five (5) miles per hour over the speed limit
  - Five (5) or more crashes that involve the failure to yield right-of-way within a 3-year period or three (3) or more such crashes within a 2-year period.
  - Authorized by Public Services Director/City Engineer, Chief of Police or City Council
- Stop signs shall not be installed in an attempt to control speed or volume.
- Signs that require engineering judgment will undergo an engineering study, the results of which will be on file documenting reason for installation.
- Speed Limit signs will be installed at the entrance of the road and beyond major intersections when the speed zone is different than the statutory limit on local or residential road.
- No Parking signs will be installed at the entrance of the road and then spaced at a reasonable distance when there are parking restrictions on the local or residential road.
- No Outlet signs will be installed at the entrance of the road with street name signs onto one (1) post only when the end of the road is not visible from the intersection on local or residential road. A stand-alone, post-mounted sign will only be considered when approaching the last intersection without a turning movement.
- No Passing Zone signs shall be installed at all locations the roads are striped as *no passing* on a local or residential road.
- Crime Watch signs shall be only be allowed on low volume roads and one per direction, per block.
- Truck Route signs are not installed, the city does not comprehensively identify by a city-wide, truck routes with signs.
- Application of curve warning signs will be consistent with *MN MUTCD* requirements along roadways with ADT volumes greater than 1,000 vehicles per day with the following general guidelines for ADT volumes less than 1,000 vehicles per day:

<i>Radius</i>	<i>Horizontal Curve Signing</i>
Greater than 350 feet	No Sign
150 to 350 feet	Combination Curve Warning with Advisory Speed Sign
Less than 150 feet	Combination Curve Warning with Advisory Speed Sign + Chevrons (40 foot spacing)

- The installation of signs at roundabouts must be authorized by the City Engineer or City Council.
- Traffic signs will not be used as a reactive response to traffic crashes.
- Traffic signs will not be installed for traffic calming purposes.
- The application of warning signs will be based on system considerations; locations with similar characteristics will be proactively signed.
- When street name signs and stop signs are in the same quadrant (south-east), the signs will be combined onto one (1) post.
- Enhanced conspicuity for signs will be based on engineering judgement, including the removal or relocation of non-essential and illegal signs from the right-of-way.

**Removal of Signs:**

This policy is to consider removal of signs which are not required to comply with an applicable federal or state regulation or statute and which have been determined to be unnecessary for safety purposes.

Studies have found that various non-standard signs (e.g. Children at Play, Animal Crossing) are ineffective. Unauthorized or non-standard signs, defined as any sign not included in the *MN MUTCD*, will not be installed or reinstalled within the city, and may be removed at any time.

Extraordinary maintenance, such as a high amount of vandalism or theft may result in the removal of a sign.

#### **Request or Concern of a Sign:**

This policy may consider the installation of a sign which is requested by the public for safety purposes. The resident or business owner of the City of Anoka must address this request or concern with the Chief of Police, Public Service Director, and/or the Parking Advisory Board. All sign requests are subject to City Council approval.

### **Maintenance Method**

#### **Sign Inventory:**

The City of Anoka did a general inspection of all the street signs in 2009 and has updated this computerized inventory in 2011. The City of Anoka will update this inventory by dividing the city into four quadrants. Sign maintenance personnel will collect the installation date of the signs and then replace all signs outside of the expected sign life within the quadrant. Once the four quadrants are completed, the City of Anoka will continue to use the expected sign life for the retro-reflectivity requirements. The city expects to complete the sign inventory by 2020.

#### **Responsibility:**

Anoka will maintain all signs and street identification signs within the city, with the following exceptions:

- Signs on approaches to county highways originally installed by Anoka County.
- Stop signs at Minnesota Department of Transportation (MnDOT) controlled intersections and highway ramps with state/county highways.
- Specific signs installed by others.
- Signs along highways, within the right-of-way, unless specific agreement with MnDOT or Anoka County stipulates the city for the maintenance.
- Signs on approaches to city roads installed by private business and/or property owners.

#### **Retro-reflectivity Evaluation:**

This section applies to all regulatory, warning, and guide signs as set forth in the *MN MUTCD*.

Pursuant to Section 2A.08 of the *MN MUTCD*, the city excludes the following signs from the retroreflectivity maintenance guidelines:

- Parking, Stand, and Stopping signs (R7 & R8 series),
- Walking/Hitchhiking/Crossing signs (R9 series, R10-1 through R10-4b)
- Acknowledgement signs, including Memorial signs,
- All signs with blue or brown backgrounds, and
- Bikeway signs that are intended for exclusive use by bicyclists or pedestrians.

Substantial conformance with the *MN MUTCD* retro-reflectivity requirements (see Appendix A) will be achieved using a combination of management methods using the expected sign life and blanket replacement method. Conformance does not require or guarantee that every individual sign in the City of Anoka will meet or exceed the minimum retro-reflectivity levels at every point in time.

The City of Anoka adopts twelve (12) years for the life of signs by using 3M Diamond Grade 3 (DG<sup>3</sup>) reflective sheeting material (see appendix B). Applicable sign life may be revisited to determine appropriate length based

on the latest research and sign materials. Signs may be replaced prior to the expiration date due to damage, vandalism, stolen, knock downs, missing or other necessary reasons.

### **Sign Replacement:**

After the initial completion of replacing the signs, removal of unnecessary signs, and proper retro-reflectivity evaluation, the City of Anoka shall for the purpose of complying with the requirements of the *MN MUTCD*, maintain minimum retro-reflectivity standards as budgetary factors allow by replacing signs as they reach the end of the latter of their (a) expected life for the sheeting material used on the sign or (b) expected life as determined by an engineering study.

As each new sign is installed, the mounting should be checked for deterioration. Bent or excessively rusted posts should be replaced. All posts will comply with the *Manual for Assessing Safety Hardware* (AASHTO) for crashworthiness on roadways with speeds greater than 45 miles per-hour. The sign location and mounting height will be standardized and be installed according to *MN MUTCD* Sign Location and Mounting tables (see Appendix C).

For signs not recommended for installation by the Public Services or Chief of Police but approved by the City Council, the requesting party shall be responsible for cost and sign maintenance.

### **Public Concerns:**

When sign repair is needed, the city's goal is to respond after receiving notice of the repair with the following priorities:

- Stop sign: As soon as practical, no later than one (1) business day, a temporary story sign will be placed if required.
- Other regulatory signs: No later than three (3) business days.
- Warning signs: Within one (1) scheduled workday.
- Informational/guidance signs: As soon as scheduling/delivery permits.

Sign maintenance staff is not directly on-call after normal working hours. After-hours phone numbers for maintenance managers are available to the dispatchers so staff can be contacted in case of an emergency.

When the visibility of a sign is found to be impaired by other signs, trees, shrubs, etc. so that the effectiveness of the sign is significantly reduced, the City of Anoka will take action to bring the sign back to a functional level as soon as scheduling permits.

### **Modification and Deviation from Policy:**

The city reserves the right to modify this Traffic Sign Maintenance Policy at any time if deemed to be in the best interests of the city based on safety, social, political, and economic considerations.

The Public Services Director/City Engineer, or his/her designee, may authorize a deviation from the implementation of this policy in regard to a particular sign when deemed to be in the best interests of the city based on safety, social, political and economic considerations. Such deviation shall be documented including the reason for the deviation and other information supporting the deviation.

### **Policy History**

Initially Adopted: 05.18.2015

# APPENDIX A



# Maintaining Traffic Sign Retroreflectivity

*\*updated in 2013 to reflect current MUTCD compliance dates*

FHWA-SA-07-020 (Revised 2013)

This document is referenced in **Section 2A.08** of the *Manual on Uniform Traffic Control Devices* (MUTCD). Please be sure to review the methods discussed on pages two and three, along with the related procedures that make each method reliable and meaningful in its use to maintain signs above the minimum retroreflectivity levels. A full report on these methods can be found at [www.fhwa.dot.gov/retro](http://www.fhwa.dot.gov/retro).

## SCHEDULE

### Method:

Agencies have until **June 14, 2014** to implement and continue to use an assessment or management method that is designed to maintain regulatory and warning sign retroreflectivity at or above the minimum levels in Table 2A-3 of the 2009 MUTCD.

Although guide signs are included in the minimum retroreflectivity levels table, there is not a specified compliance date for guide signs (including street name signs) to be addressed by an agency's method. Guide signs are to be added to an agency's management or assessment method as resources allow.

### Sign Replacement:

Agencies need to replace any sign they identify as not meeting the established minimum retroreflectivity levels. Agencies' schedules for replacing signs are based on resources and relative priorities rather than specific compliance dates.

Traffic signs provide important information to road users. To be effective, traffic sign visibility must be maintained during daytime and nighttime conditions. In addition to Section 2A.08, the MUTCD addresses sign visibility in several other places, including Sections 1A.03, 1A.04, 1A.05, 2A.06, 2A.07, and 2A.22. These sections address factors such as uniformity, design, placement, operation, and maintenance.

The Standard in Section 2A.08 requires agencies to use a maintenance method that is designed to maintain traffic signs at or above minimum levels of retroreflectivity in Table 2A-3. Including Table 2A-3 in the MUTCD does not imply that an agency must measure the retroreflectivity of every sign. Rather, the MUTCD summarizes five methods that agencies can use to maintain traffic sign retroreflectivity at or above the minimum levels. These methods are listed in Section 2A.08 and are discussed on pages two and three of this document. The Standard promotes safety while providing sufficient flexibility for agencies to choose one or more maintenance methods that best match their specific conditions.

This Standard does NOT imply all signs need to be replaced. The intent is to identify and replace signs that no longer meet the needs of nighttime drivers.

The MUTCD language recognizes that there may be some individual signs that do not meet the minimum retroreflectivity levels at a particular point in time. Reasons for this include vandalism, weather, or damage due to a crash. As long as the agency is using one of the methods (with appropriate procedures) to maintain their signs, they are considered to be in compliance with this Standard.

The methods recommended in the MUTCD are broken into two categories: management methods and assessment methods. Assessment methods involve sending personnel out to examine and assess the retroreflective performance of signs. Some agencies may find this approach to be more labor intensive and turn to management methods as an alternative. Management methods may require less field work (or none at all in some cases) but may also result in replacing some signs that still have useful life left in terms of retroreflectivity. These recommended methods are discussed on pages two and three of this document and are described in detail in a full report entitled "Methods for Maintaining Traffic Sign Retroreflectivity," available at [www.fhwa.dot.gov/retro](http://www.fhwa.dot.gov/retro).

## ASSESSMENT METHODS

**Assessment methods** involve evaluating individual signs within an agency's jurisdiction. There are two basic assessment methods identified in the 2009 MUTCD: visual nighttime inspection and measured sign retroreflectivity.

### 1. VISUAL NIGHTTIME INSPECTION METHOD

In the visual nighttime inspection method, on-the-fly assessments of retroreflectivity are made by an inspector during nighttime conditions. The following are keys to successfully implementing the visual nighttime inspection method:

- A. Develop guidelines and procedures for inspectors to use in conducting the nighttime inspections and train inspectors in the use of these procedures.
- B. Conduct inspections at normal speed from the travel lane(s).
- C. Conduct inspections using low-beam headlights while minimizing interior vehicle lighting.
- D. Evaluate signs at typical viewing distances so that adequate time is available for an appropriate driving response.

One or more of the following procedures should be used to properly implement this method:

#### **Calibration Signs Procedure (for Visual Nighttime Inspection Method)**

Calibration signs have known retroreflectivity levels at or above minimum levels. These calibration signs are set up so the inspector views the calibration signs in a manner similar to nighttime field inspections. A trained inspector views calibration signs prior to conducting the nighttime inspection described in 1 A-D above. The inspector uses the visual appearance of the calibration signs to establish the evaluation threshold for that night's inspection.

During the nighttime drive-through inspection of in-service signs, if the inspector believes a sign appears to be less bright than the calibration signs viewed earlier, the in-service sign should be replaced. The following factors provide additional information on the use of this procedure:

- Calibration signs are needed for each color of sign in Table 2A-3 of the 2009 MUTCD.
- Calibration signs are viewed at typical viewing distances using the inspection vehicle.
- Calibration signs need to be properly stored between inspections so that their retroreflectivity does not deteriorate over time.

#### **Comparison Panels Procedure (for Visual Nighttime Inspection Method)**

Comparison panels are fabricated with retroreflectivity levels at or above the minimum levels. The trained inspector makes an initial nighttime visual inspection described in 1 A-D above to identify signs that are obviously above or below the minimum retroreflectivity values as well as those the inspector considers to be marginal.

Those signs designated as obviously below the minimum retroreflectivity values are scheduled for replacement.

For signs considered marginal, a supplementary nighttime inspection is conducted by attaching a comparison panel to the in-service sign. With a flashlight, the inspector views the in-service sign along with the comparison panel to determine whether the in-service sign appears brighter or less bright than the comparison panel. If the in-service sign appears less bright than the comparison panel, the in-service sign should be replaced.

#### **Consistent Parameters Procedure (for Visual Nighttime Inspection Method)**

For this procedure, nighttime inspections described in 1 A-D above are conducted by a trained inspector under similar factors that were used in the research to develop the minimum retroreflectivity levels. These traits include:

- Using an inspector who is at least 60 years old.
- Using a sport utility vehicle or pick-up truck from which to make the observations.
- Using a model year 2000 or newer vehicle.

The trained inspector makes a judgment call as to whether an in-service sign meets their nighttime driving needs. Those signs judged not to meet the visual driving needs should be replaced. Note, the three factors listed here are specific to this procedure and are not required for visual nighttime inspections using the calibration signs procedure or the comparison panels procedure.

### 2. MEASURED SIGN RETROREFLECTIVITY METHOD

In this method the retroreflectivity of a sign is measured with a handheld or mobile retroreflectometer and directly compared to the minimum level appropriate for that sign. ASTM E1709, Standard Test Method for Measurement of Retroreflective Signs Using a Portable Retroreflectometer, provides the standard method for measuring sign retroreflectivity with handheld instruments. If the measured sign retroreflectivity value is less than the appropriate level in Table 2A-3, the sign should be replaced.

## MANAGEMENT METHODS

**Management methods** provide an agency with the ability to maintain sign retroreflectivity without having to physically inspect each individual sign. While it is not required by the MUTCD, some agencies have chosen to determine the sheeting type and age or retroreflectivity levels of existing signs before using a management method. This is done by those agencies to prevent signs currently near or below minimum levels from being left in place several additional years. The 2009 MUTCD identifies three management methods:

### 1. EXPECTED SIGN LIFE METHOD

In this method, the agency monitors the age of individual signs and replaces them before they are expected to degrade below the minimum levels in Table 2A-3 of the 2009 MUTCD. The retroreflectivity life of a sign may vary by such factors as type of sheeting, geographic location, color, and direction the sign faces. This method depends on knowing the age and type of sheeting used for the signs. Agencies may choose to consider weathering deck results, measurements of field signs, sign sheeting warranties, or other criteria as the basis for the expected sign life. A common approach for identifying the age of individual signs uses a label on the sign to mark the year of fabrication or installation. Agencies can also use sign management systems to track the age of individual signs.

### 2. BLANKET REPLACEMENT METHOD

In this method, an agency manages signs in groups rather than as individual signs. An agency may choose to group signs by geographic area, roadway corridor, type of sheeting, or sign category (e.g., warning signs). The sign replacement interval is based on the expected sign life for the sign sheeting in the group with the shortest expected life. This method typically obligates an agency to replace all of the designated signs within a group, even if a sign was recently replaced due to issues such as vandalism or damage.

### 3. CONTROL SIGNS METHOD

In this method, agencies monitor the performance of a control sample of signs that represent a larger group of signs. Agencies track the retroreflectivity of the control signs to determine when replacement of the larger group is necessary based on the performance of the control signs.

- Agencies should develop a sampling plan to determine the appropriate number and type of control signs needed to represent the larger group of signs. Samples should represent the entire group, including such factors as sign sheeting type and color.
- Control signs may be actual signs in the field or signs in a maintenance yard (for convenience).
- Agencies should monitor the retroreflectivity of the control signs using an assessment method.

## OTHER METHODS

**Other assessment or management methods** that are developed based on engineering studies can be used as long as they are designed to maintain minimum levels in Table 2A-3 of the 2009 MUTCD, as stated in the MUTCD Standard statement in Section 2A.08.

# Excerpt from Part 2 of the 2009 MUTCD

## Section 2A.08 Maintaining Minimum Retroreflectivity

Support:

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

**Standard:**

02 **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 2A-3.**

Support:

03 Compliance with the Standard in Paragraph 2 is achieved by having a method in place and using the method to maintain the minimum levels established in Table 2A-3. Provided that an assessment or management method is being used, an agency or official having jurisdiction would be in compliance with the Standard in Paragraph 2 even if there are some individual signs that do not meet the minimum retroreflectivity levels at a particular point in time.

*Guidance:*

04 *Except for those signs specifically identified in Paragraph 6, 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*—Sign 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:

05 Additional information about these methods is contained in the 2007 Edition of FHWA's "Maintaining Traffic Sign Retroreflectivity" (see Section 1A.11).

Option:

06 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. Acknowledgment signs
- D. All signs with blue or brown backgrounds
- E. Bikeway signs that are intended for exclusive use by bicyclists or pedestrians

**Note:** The referenced document is actually this four-page brochure you are reading.

**Table 2A-3.  
Minimum Maintained  
Retroreflectivity  
Levels<sup>1</sup>**

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			Post-mounted
Black on Yellow or Black on Orange	Y*; O*	Y ≥ 50; O ≥ 50			2
	Y*; O*	Y ≥ 75; O ≥ 75			3
White on Red	W ≥ 35; R ≥ 7				4
Black on White	W ≥ 50				—

<sup>1</sup> The minimum maintained retroreflectivity levels shown in this table are in units of cd/lx/m<sup>2</sup> measured at an observation angle of 0.2° and an entrance angle of -4.0°.  
<sup>2</sup> For text and fine symbol signs measuring at least 48 inches and for all sizes of bold symbol signs  
<sup>3</sup> For text and fine symbol signs measuring less than 48 inches  
<sup>4</sup> Minimum sign contrast ratio ≥ 3:1 (white retroreflectivity ÷ red retroreflectivity)  
 \* This sheeting type shall not be used for this color for this application.

2009 MUTCD Section Number(s)	2009 MUTCD Section Title	Specific Provision	Compliance Date
2A.08	Maintaining Minimum Retroreflectivity	Implementation and continued use of an assessment or management method that is designed to maintain regulatory and warning sign retroreflectivity at or above the established minimum levels (see Paragraph 2)	<b>June 14, 2014</b> (date established in Revision 2 to 2009 MUTCD)*

\* Types of signs other than regulatory or warning are to be added to an agency's management or assessment method as resources allow.

# APPENDIX B



# Diamond Grade™

# DG<sup>3</sup> Reflective Sheeting Series 4000

Product Bulletin 4000

January 2012

## Description

3M™ Diamond Grade™ DG<sup>3</sup> Reflective Sheeting Series 4000 is a super-high efficiency, full cube retroreflective sheeting designed for the production of traffic control signs and delineators that are exposed vertically in service. DG<sup>3</sup> sheeting is designed to have the highest retroreflective characteristics at medium and short road distances as determined by the R<sub>A</sub> values at 0.5° and 1.0° observation angles in Table B. Performance at these observation angles represents the most common nighttime viewing geometries encountered by the driving public. During the daytime, Diamond Grade DG<sup>3</sup> fluorescent reflective sheeting provides higher visibility than ordinary (non-fluorescent) colored sheetings.

Applied to properly prepared sign substrates Diamond Grade DG<sup>3</sup> reflective sheeting provides long-term retroreflectivity and durability. Series 4000 sheeting is available in the following colors.

Color	Product Code
White	4090
Yellow	4091
Red	4092
Blue	4095
Green	4097
Brown	4099
Fluorescent Yellow - FY	4081
Fluorescent Yellow Green- FYG	4083
Fluorescent Orange - FO	4084

## Color Product Code

White - thermal transfer printable	4090TT
Yellow - thermal transfer printable	4091TT
Fluorescent Yellow - TT printable	4081TT
Fluorescent Yellow - Green - TT printable	4083TT

## Photometrics

### Daytime Color (x, y, Y)

The chromaticity coordinates and total luminance factor of the retroreflective sheeting conform to Table A.

### Color Test – Fluorescent Sheetings

Conformance to standard chromaticity (x, y) and luminance factor (Y %) requirements shall be determined by instrumental method in accordance with ASTM E 991 on sheeting applied to smooth aluminum test panels cut from Alloy 6061-T6 or 5052-H38. The values shall be determined on a HunterLab ColorFlex 45/0 spectrophotometer. Computations shall be done for CIE Illuminant D65 and the 2° standard observer.<sup>2</sup>

### Color Test – Ordinary Colored Sheeting

Conformance to standard chromaticity (x, y) and luminance factor (Y %) requirements shall be determined by instrumental method in accordance with ASTM E 1164 on sheeting applied to smooth aluminum test panels cut from Alloy 6061-T6 or 5052-H38. The values shall be determined on a HunterLab ColorFlex 45/0 spectrophotometer. Computations shall be done for CIE Illuminant D65 and the 2° standard observer.<sup>2</sup>

Table A - Daytime Color Specification Limits<sup>1</sup>

Color	x		y		x		y		Daytime Luminance Limit (Y%)	
	x	y	x	y	x	y	x	y	Min.	Max.
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329	27	
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472	15	45
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346	2.5	15
Blue	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216	1	10
Green	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771	3	12
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390	1	9
FY	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442	40	
FYG	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540	60	
FO	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355	20	

<sup>1</sup>The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 Colorimetric System.

<sup>2</sup>The instrumentally determined color values of retroreflective sheeting can vary significantly depending on the make and model of colorimetric spectrophotometer as well as the color and retroreflective optics of the sheeting (David M. Burns and Timothy J. Donahue, Measurement Issues in the Color Specification of Fluorescent Retroreflective Materials for High Visibility Traffic Signing and Personal Safety Applications, Proceedings of SPIE: Fourth Oxford Conference on Spectroscopy, 4826, pp. 39-49, 2003). For the purposes of this document, the HunterLab ColorFlex 45/0 spectrophotometer shall be the referee instrument.

### Coefficients of Retroreflection ( $R_A$ )

The values in Table B are minimum coefficients of retroreflection expressed in candelas per lux per square meter (cd/lux/m<sup>2</sup>).

### Test for Coefficients of Retroreflection

Conformance to coefficient of retroreflection requirements shall be determined by instrumental method in accordance with ASTM E-810 “Test Method for Coefficient of Retroreflection of Retroreflective Sheeting”, and per E-810 the values of 0° and 90° rotation are averaged to determine the  $R_A$  in Table B.

**Table B - Minimum Coefficient of Retroreflection  $R_A$  for new sheeting (cd/lux/m<sup>2</sup>)**

	Observation Angle <sup>4</sup>		
	0.2°	0.5°	1.0°
<b>-4° Entrance Angle<sup>3</sup></b>			
White	580	420	120
Yellow	435	315	90
Red	87	63	18
Green	58	42	12
Blue	26	19	5
Brown	17	13	4
Fluorescent Yellow	350	250	72
Fluorescent Yellow Green	460	340	96
Fluorescent Orange	175	125	36
<b>30° Entrance Angle<sup>3</sup></b>			
	0.2°	0.5°	1.0°
White	220	150	45
Yellow	165	110	34
Red	33	23	7
Green	22	15	5
Blue	10	7	2
Brown	7	5	1
Fluorescent Yellow	130	90	27
Fluorescent Yellow Green	180	120	36
Fluorescent Orange	66	45	14

<sup>3</sup> Entrance Angle – The angle from the illumination axis to the retroreflector axis. The retroreflector axis is an axis perpendicular to the retroreflective surface.

<sup>4</sup> Observation Angle – The angle between the illumination axis and the observation axis.

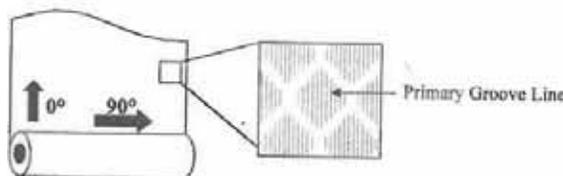
## Printed Colors and Overlay Films

For screenprinted or thermally transfer printed transparent color areas on white sheeting when processed according to 3M recommendations, the coefficients of retroreflection shall not be less than 70% of the value for the corresponding color in Table B. For white sheeting covered with 3M™ ElectroCut™ Film Series 1170 when processed according to 3M recommendations, the coefficients of retroreflection shall not be less than 100% of the value for the corresponding color in Table B. The color chromaticity and luminance shall conform to Table A on page 1.

## Entrance Angularity Performance in Regard to Orientation

Diamond Grade DG<sup>3</sup> Reflective Sheeting is designed to be an effective wide angle reflective sheeting regardless of its orientation on the substrate or ultimate orientation of the sign after installation. However, because the efficiency of light return from cube corner reflectors is not equal at all application orientations, especially with increasing entrance angles, it is possible to get the widest entrance angle light return when the sheeting is oriented in a particular manner. When high entrance angle (>50°) performance is required for given signs (e.g. Keep Right Symbols), it can be obtained easily by specifying the application orientation of the completed signs. In these situations the completed sign should have the sheeting positioned at the 0° orientation (downweb direction perpendicular to the road).

When the “primary groove line” (or, flat side of the diamond shape) is vertical in the completed sign, sheeting is said to be at a 0° orientation. When the “primary groove line” (or, flat side of the diamond shape) is horizontal in the completed sign, the sheeting is said to be at a 90° orientation. (Figure 1)



**Figure 1**

Unless the sign location and/or position calls for extra-wide entrance angularity performance, signs and applied copy (letters, arrows, borders and shields) can be fabricated and installed using the application orientation that most efficiently utilizes the reflective sheeting.

Note: For multi-panel signs it is recommended that all background panels be sheeted such that the sheeting direction is the same for all panels.

## Fabrication Lines

The manufacture of prismatic sheeting results in lines being present in the product. In Diamond Grade DG<sup>3</sup> sheeting these lines are slightly thicker than the seal pattern legs. Fabrication lines are noticeable in shop light but are not observable on the road either in daylight or at night under typical use conditions (Figure 2).

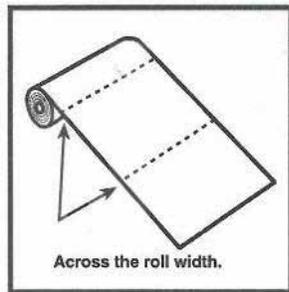


Figure 2 - Fabrication Lines

## Adhesive

Diamond Grade DG<sup>3</sup> sheeting has a pressure-sensitive adhesive that is recommended for application at temperatures of 65°F (18°C) or higher.

## Adhesive and Film Properties

### Standard Test Panels

Unless otherwise specified herein, sheeting shall be applied to test panels and conditioned in accordance with ASTM D4956 and test methods and conditions shall conform to ASTM D4956.

### Properties

The following properties shall conform to the requirements in ASTM D4956.

1. Adhesion
2. Outdoor weathering
  - retained coefficient of retroreflection
  - colorfastness
3. Shrinkage
4. Flexibility
5. Liner removal
6. Impact resistance
7. Night time color

In addition, DG<sup>3</sup> sheeting will conform to the following properties.

### 1. Gloss

Test Method – Test in accordance with ASTM D523 using a 60° glossmeter.

Requirement – Rating not less than 50.

### 2. Optical Stability

Test Method – Apply a 3-inch x 6-inch sample to a test panel. Measure  $R_A$  then place it in an oven at 71° C ± 3° C (160°F ± 5°F) for 24 hours followed by conditioning at standard conditions for two hours.

Remeasure  $R_A$ .

Requirement – The sheeting shall retain a minimum of 85% and a maximum of 115% of the original coefficient of retroreflection.

## Sign Fabrication Methods

### Application

Diamond Grade DG<sup>3</sup> sheeting incorporates a pressure sensitive adhesive and should be applied to the sign substrate at temperature of 65°F/18°C or higher by any of the following methods:

Mechanical squeeze roll applicator – refer to 3M Information Folder (IF) 1.4. Application to extrusions that are edge wrapped requires sufficient softening of the sheeting. This can be accomplished by directing additional heat to the “next to last” edge roller. This practice will increase productivity and minimize cracking.

Hand squeeze roll applicator – refer to 3M IF 1.6.

Application of Diamond Grade DG<sup>3</sup> sheeting for complete signs or backgrounds must be done with a roll laminator, either mechanical or hand driven.

### Hand Application

Hand application is recommended for legend and copy only. Refer to 3M Information Folder 1.5 for more details.

Hand applications will show some visual irregularities, which are objectionable to aesthetically critical customers. These are more noticeable on darker colors. To obtain a close-up uniform appearance, a roll laminator must be used.

All direct applied copy and border MUST be cut at all metal joints and squeegeed at the joints.

### Splices

Series 4000 sheeting must be butt spliced when more than one piece of sheeting is used on one piece of substrate. The sheeting pieces should not touch each other. This is to prevent buckling as the sheeting expands in extreme temperature and humidity exposure.

### Double Faced Signs

The sheeting on the bottom side of a double faced sign can be damaged if rolled through a squeeze roll applicator with an unprotected steel bottom roller. The use of a semi-soft flat sheet between the steel roller and the applied sign face will provide protection from damage. A material such as a rubber mat, tag board or cardboard is recommended.

## Substrates

For traffic sign use, substrates found to be most reliable and durable are properly prepared aluminum sheets and extrusions. **Users are urged to carefully evaluate all other substrates for adhesion and sign durability.** Other substrates that may be satisfactory for proper application of sheeting will have the following characteristics:

- Clean
- Smooth
- Flat
- Rigid
- Dimensionally stable
- Weather resistant
- Non-porous
- High surface energy (passes water break test)

Refer to Information Folder 1.7 for surface preparation recommendations. Substrates with low surface energy may require additional preparation such as flame treatment, mechanical abrasion or use of adhesion promoters prior to sheeting application. Guide sign extrusions may be edge wrapped. Flat panels or unwrapped extrusions are to be carefully trimmed so that sheeting from adjacent panels does not touch on assembled signs.

Diamond Grade DG<sup>3</sup> sheeting is designed primarily for applications to flat substrates. Any use that requires a radius of curvature of less than five inches should also be supported by rivets or bolts. Plastic substrates are not recommended where cold shock performance is required. **Sign failures caused by the substrate or improper surface preparation are not the responsibility of 3M.**

## Imaging

Diamond Grade DG<sup>3</sup> sheeting may be processed into traffic signs by any of the imaging methods described below. 3M assumes no responsibility for failure of sign face legends or backgrounds that have been processed with non-3M process colors or matched component imaging materials other than those listed below.

### Screen Processing

Diamond Grade DG<sup>3</sup> sheeting may be screen processed into traffic signs before or after mounting on a sign substrate, using 3M Process Colors Series 880I or Series 880N. Series 880I or 880N process colors can be screened at 60-100°F (16-38°C) at relative humidity of 20-50%. A PE 157 screen mesh with a fill pass is recommended. Refer to Information Folder 1.8 for details. No clear coating is required or recommended. Use of other process colors series is not recommended.

**Care should be taken to avoid flexing DG<sup>3</sup> sheeting before and especially after screening to eliminate the possibility of cracking from improper handling techniques.**

### Thermal Transfer Printing

Diamond Grade DG<sup>3</sup> TT sheeting may be imaged with 3M™ Thermal Transfer Ribbon Series TTR2300 in conjunction with the Matan SprinG3 or Matan Spot4 thermal transfer printers. For regulated traffic signs, Series TTR2300 Spot Traffic Colors are to be applied using these printers and must be covered with 3M™ ElectroCut™ Film 1170. Refer to Product Bulletin TTR2300 for more information.

### 3M™ ElectroCut™ Film

3M™ ElectroCut™ Film Series 1170 may be used to provide transparent colored background copy for traffic control signs on Diamond Grade DG<sup>3</sup> sheeting. Refer to Product Bulletin 1170 for fabrication procedures.

### Applied Cut-Out Copy

Diamond Grade DG<sup>3</sup> cut letters may be applied to a DG<sup>3</sup> sheeting background to create a sign legend. Such cut-out copy may be directly applied to the background sheeting, or may be applied in a demountable form. Direct applied copy must be cut at all panel seams and carefully trimmed back so that sheeting from adjacent panels does not touch on assembled signs. Refer to Information Folder 1.10 for more information.

Note: It is recommended to fabricate all but the largest signs using 1170 electronic cuttable overlay film instead of direct applied copy.

## Cutting

Diamond Grade DG<sup>3</sup> sheeting may be cut into letters and shapes of at least three inches in height and stroke widths of at least one half inch. Smaller sizes are not recommended. Sealing cut edges of DG<sup>3</sup> sheeting is not required.

### Plotter Cutting

Programmable knife cut (electronic cutting)

1. Flat bed plotters can either die cut or kiss cut and offer the most consistent and reliable performance.
2. Friction Fed plotter. Kiss cut only. Success has been achieved using plotters that have 600 grams of down force and a 60° cutting blade. Additional drive wheels may need to be added to improve tracking. An alternative procedure is to cut sheeting from the liner side. Blade force and knife depth must be set to score but not cut through the topfilm. Break apart individual copy or apply premask to retain spacing.

## Other Cutting Methods

Diamond Grade DG<sup>3</sup> sheeting may be hand cut or die cut one sheet at a time, and band sawed or guillotined in stacks. Cutting equipment such as guillotines and metal shears, which have pressure plates on the sheeting when cutting, may damage the optics. Padding the pressure plate and easing it down onto the sheets being cut will significantly reduce damage. Maximum stack height for cutting Series 4000 sheeting is 1½ inch or 50 sheets. Details on cutting can be found in Information Folder 1.10.

## Storage and Packaging

3M Diamond Grade DG<sup>3</sup> Sheeting should be stored in a cool, dry area, preferably at 65-75°F (18-24°C) and 30-50% relative humidity and should be applied within one year of purchase. Rolls should be stored horizontally in the shipping carton. Partially used rolls should be returned to the shipping carton or suspended horizontally from a rod or pipe through the core. Unprocessed sheets should be stored flat. Finished signs and applied blanks should be stored on edge.

Screen processed signs must be protected with SCW 568 slipsheet paper. Place the glossy side of the slipsheet against the sign face and pad the face with closed cell packaging foam. Double faced signs must have the glossy side of the slipsheet against each face of the sign.

Unmounted screened faces must be stored flat and interleaved with SCW 568 slipsheet, glossy side against the sign face.

Avoid banding, crating, or stacking signs. Package for shipment in accordance with commercially accepted standards to prevent movement and chafing. Store sign packages indoors on edges.

Panels or finished signs must remain dry during shipment and storage. If packaged signs become wet, unpack immediately and allow signs to dry. Refer to Information Folder 1.11 for instructions on packing for storage and shipment.

## Installation

Nylon washers are required when twist style fasteners are used to mount the sign.

## Cleaning

Signs that require cleaning should be flushed with water, then washed with a detergent solution and soft bristle brush or sponge. Avoid pressure that may damage the sign face. Flush with water following washing. Do not use solvents to clean signs. Refer to 3M Information Folder 1.10.

## Health and Safety Information

Read all health hazard, precautionary and first aid statements found in the Material Safety Data Sheet and/or product label of any materials prior to handling or use.

## General Performance Considerations

The durability of Diamond Grade DG<sup>3</sup> sheeting and finished signs using 3M Matched Component materials will depend upon substrate selection and preparation, compliance with recommended application procedures, geographic area, exposure conditions, and maintenance. Maximum durability of Diamond Grade DG<sup>3</sup> sheeting can be expected in applications subject to vertical exposure on stationary objects when processed and applied to properly prepared aluminum according to 3M recommendations provided in Information Folder 1.7. The user must determine the suitability of any nonmetallic sign backing for its intended use. **Sign failures caused by the substrate or improper surface preparation are not the responsibility of 3M.** Applications to unprimed, excessively rough or non-weather resistant surfaces or exposure to severe or unusual conditions can shorten the performance of such applications. Signs in mountainous areas that are covered by snow for prolonged periods may also have reduced durability. 3M process colors and ElectroCut™ Film, when used according to 3M recommendations, are generally expected to provide performance comparable to colored reflective sheeting. Custom colors, certain lighter colors, heavily toned colors or blends containing yellow or gold may have reduced durability. Atmospheric conditions in certain geographic areas may result in reduced durability.

Periodic sign inspection and regular sign replacement are strongly recommended in order for sign owners to establish their own effective service life expectation, beyond the warranty period.

## 3M Basic Product Warranty and Limited Remedy

3M™ Diamond Grade™ DG<sup>3</sup> Reflective Sheeting Series 4000 (“Product”) is warranted to be free of defects in materials and manufacture at the time of shipment and to meet the specifications stated in this Product Bulletin. If DG<sup>3</sup> Sheeting is proven not to have met the Basic Warranty on its shipment date, then a buyer’s exclusive remedy, and 3M’s sole obligation, at 3M’s option, will be refund or replacement of the sheeting.

## General Warranty Terms:

1. 3M makes the Additional Warranty (as defined below) as to any traffic control and guidance sign in the United States and Canada (“Sign”) made with 3M™ Diamond Grade™ DG<sup>3</sup> Reflective Sheeting Series 4000 (“Product”) and the Matched Component materials listed in Table E. Any Additional Warranty is contingent on all components involved in that Additional Warranty being stored, applied, installed, and used only as 3M recommends in its Product Bulletins and Other Product Information.

2. The Basic Warranty and any applicable Additional Warranty are collectively referred to as the “3M Warranty.” EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW, THE 3M WARRANTY IS MADE IN LIEU OF ALL OTHER WARRANTIES, RIGHTS OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND THOSE ARISING FROM A COURSE OF DEALING, CUSTOM OR USAGE OF TRADE. A BUYER IS RESPONSIBLE FOR DETERMINING IF A PRODUCT IS SUITABLE FOR ITS PARTICULAR PURPOSE AND APPLICATION METHODS.

3. A Sign’s failure to meet the 3M Warranty must be solely the result of the Product or the matched component materials’ design or manufacturing defects. 3M has no obligation under the 3M Warranty if a sign failure is caused by:

improper fabrication, handling, maintenance or installation; non-vertical applications where the Sign face is more than +/- 10% from vertical; use of any material or product not made by 3M or not included in Table E; use of application equipment not recommended by 3M; failure of sign substrate; loss of adhesion due to incompatible or improperly prepared substrate; exposure to chemicals, abrasion and other mechanical damage; snow burial or any other sign burial; collisions, vandalism or malicious mischief.

4. 3M reserves the right to determine the method of replacement, and any replacement Product will have the remainder of the original Product’s unexpired 3M Warranty. Claims made under this warranty will be honored only if

–The Sign was dated upon completion of fabrication (“Fabrication Date”) using a permanent method (sticker, permanent marker or crayon, metal stamp, etc.)

–3M is notified of a 3M Warranty claim during any applicable Warranty Period and the owner or fabricator provides the information reasonably required by 3M to verify if a 3M Warranty is applicable.

## Additional Warranty & Limited Remedy for Ordinary colored Product

1. The Additional Warranty for a Sign made with ordinary colored Product is that the Sign will: (a) **remain effective for its intended use when viewed from a moving vehicle under normal day and night driving conditions by a driver with normal vision**, and (b) after cleaning, will meet the **minimum values for coefficient of retroreflection stated in Table C** for Table C’s applicable Warranty Period measured from the Sign’s Fabrication Date.

**Table C – Minimum Percent Retained of Table B Initial R<sub>A</sub> for applicable Warranty Period for Ordinary Colors (white, yellow, red, green, blue and brown)**

Warranty Period	Minimum Percentage R <sub>A</sub> Retained
1-7 Years	80%
8-12 Years	70%

2. If any Sign made with Ordinary Product is proven not to have met the Additional Warranty, then a buyer’s **exclusive remedy**, and 3M’s sole obligation, at 3M’s option:

(a) if this occurs within seven years after the Fabrication Date, then 3M will, at its expense, restore the Sign’s surface to its **original effectiveness**; or

(b) if this occurs during the remainder of the Additional Warranty Period, then 3M will furnish only the necessary 3M sheeting Product and matched component materials quantity to restore the Sign’s surface to its original effectiveness.

## Additional Warranty & Limited Remedy for Fluorescent Product

1. The Additional Warranty for a Sign made with Fluorescent Product is that the Sign will: (a) **remain effective for its intended use when viewed from a moving vehicle under normal day and night driving conditions by a driver with normal vision**; (b) after cleaning, will **retain 70% of the minimum values for coefficient of retroreflection stated in Table B** for the applicable Warranty Period stated in Table D, measured from Fabrication Date; and (c) after cleaning, the fluorescent Product will **maintain daytime luminance equal to or greater than the minimums specified in Table A**.

**Table D – Warranty Period for Fluorescent Colors.**

Color	Warranty Period
Fluorescent Yellow	10/7 Years <sup>5</sup>
Fluorescent Yellow Green	10/7 Years <sup>5</sup>
Fluorescent Orange	3 Years

<sup>5</sup> Due to climatic conditions, Signs in Alabama, Arizona, Florida, Georgia, Hawaii, Louisiana, Mississippi, New Mexico, South Carolina and Texas have the 7-year Additional Warranty Period.

2. If a Sign made with Fluorescent Product is proven not to have met the Additional Warranty, then a buyer’s exclusive remedy, and 3M’s sole obligation, at 3M’s option:

- (a) for those Fluorescent Products with a 10-year Additional Warranty Period, 3M will, at its expense: (a) restore the Sign’s surface to its **original effectiveness** if this occurs within seven years after the Fabrication Date; or (b) furnish only the necessary 3M Fluorescent Product and matched component materials quantity to restore the Sign’s surface to its original effectiveness if this occurs during the remainder of the Warranty Period.
- (b) for those Fluorescent Products with a 7-year Additional Warranty Period, 3M will, at its expense: (a) restore the Sign’s surface to its **original effectiveness** if this occurs within five years after the Fabrication Date; or (b) furnish only the necessary 3M Fluorescent Product and matched component materials quantity to restore the Sign’s surface to its original effectiveness if this occurs during the remainder of the Warranty Period.
- (c) for those Fluorescent Products with a 3-year Additional Warranty Period, 3M will furnish only the necessary Fluorescent Product and matched component materials quantity to restore the Sign’s surface to its original effectiveness.

**Table E. Matched Component Materials.**

Matched Components	
Process Colors	Series 880I
Process Colors	Series 880N
Thermal Transfer Ribbons – Spot Traffic Colors only*	Series TTR2300
ElectroCut™ Film	Series 1170
Premium Protective Overlay Film	Series 1160
Slipsheet	SCW 568
Prespacing Tape	SCPS-2
Premasking Tape	SCPM-3
Transfer Tape	TPM-5

\* Must be covered with 3M™ ElectroCut™ Film 1170

Refer to 3M Information Folders and Product Bulletins for detailed information about recommended application procedures and equipment.

**Other Product Information**

**Always confirm that you have the most current version of the applicable Product Bulletin, Information Folder or Other Product Information.**

- IF 1.4 Instructions for Interstate Squeeze Roll Applicator
- IF 1.5 Hand Application Instructions
- IF 1.6 Hand Squeeze Roll Applicator
- IF 1.7 Sign Base Surface Preparation
- IF 1.8 Process Color Application Instructions
- IF 1.10 Cutting, Premasking, and Prespacing
- IF 1.11 Sign Maintenance Management
- PB 880I Process Color 880I
- PB 880N Process Color 880N
- PB 1170 ElectroCut™ Film
- PB TTR2300 Thermal Transfer Ribbons Series TTR2300
- PB 1160 Protective Overlay Film 1160

## Limitation of Liability

3M WILL NOT UNDER ANY CIRCUMSTANCES BE LIABLE TO A BUYER FOR DIRECT (other than the applicable Limited Remedy stated above), SPECIAL, INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES (INCLUDING, WITHOUT LIMITATION, LOSS OF PROFITS) IN ANY WAY RELATED TO A PRODUCT OR THIS PRODUCT BULLETIN, REGARDLESS OF THE LEGAL OR EQUITABLE THEORY ON WHICH SUCH DAMAGES ARE SOUGHT.

ASTM Test Methods are available from ASTM International, West Conshohoken, PA.

3M assumes no responsibility for any injury, loss or damage arising out of the use of a product that is not of our manufacture. Where reference is made in literature to a commercially available product, made by another manufacturer, it shall be the user's responsibility to ascertain the precautionary measures for its use outlined by the manufacturer.

### Important Notice

All statements, technical information and recommendations contained herein are based on tests we believe to be reliable, but the accuracy or completeness thereof is not guaranteed, and the following is made in lieu of all warranties, or conditions express or implied. Seller's and manufacturer's only obligation shall be to replace such quantity of the product proved to be defective. Neither seller nor manufacturer shall be liable for any injury, loss or damage, direct, special or consequential, arising out of the use of or the inability to use the product. Before using, user shall determine the suitability of the product for his/her intended use, and user assumes all risk and liability whatsoever in connection therewith. Statements or recommendations not contained herein shall have no force or effect unless in an agreement signed by officers of seller and manufacturer.

3M and Diamond Grade are trademarks of 3M. Used under license in Canada.



#### Traffic Safety Systems Division

3M Center, Building 0235-03-A-09  
St. Paul, MN 55144-1000  
1-800-553-1380  
[www.3M.com/tss](http://www.3M.com/tss)

#### 3M Canada Company

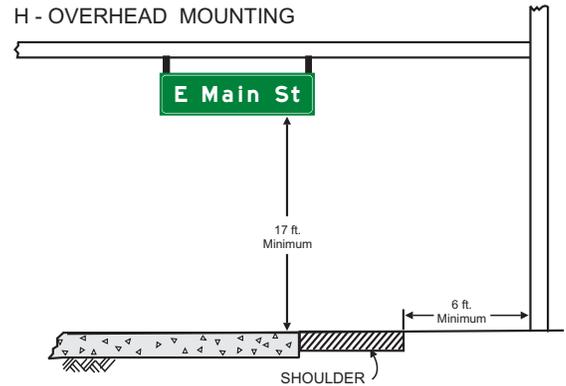
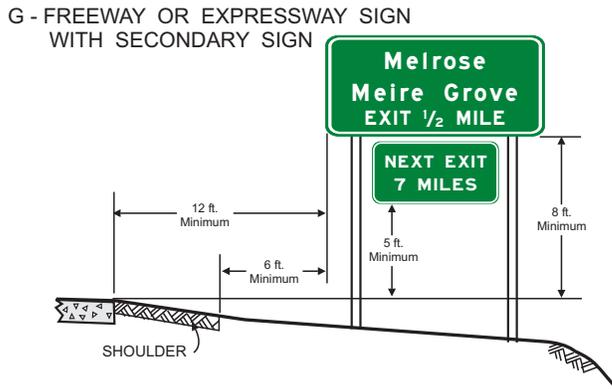
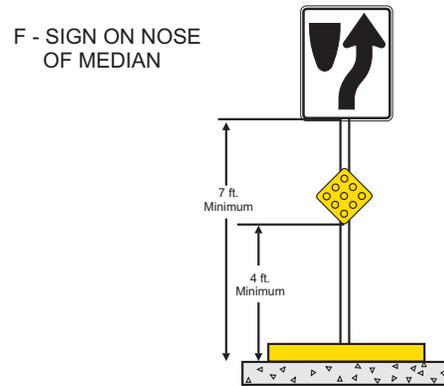
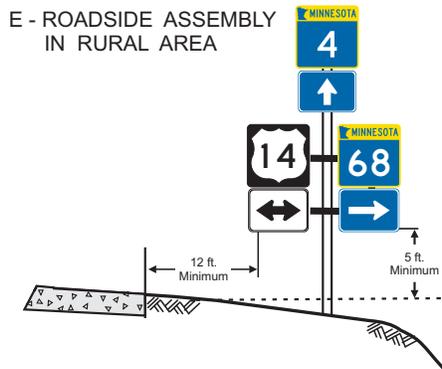
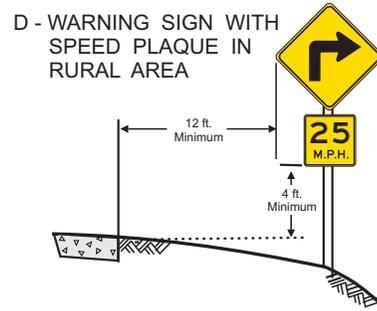
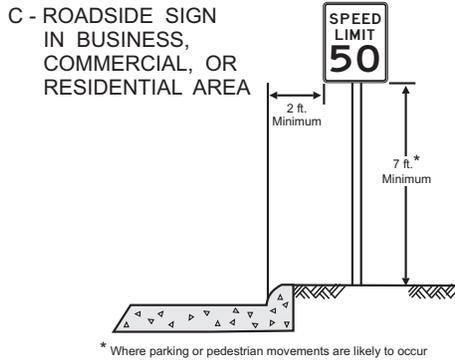
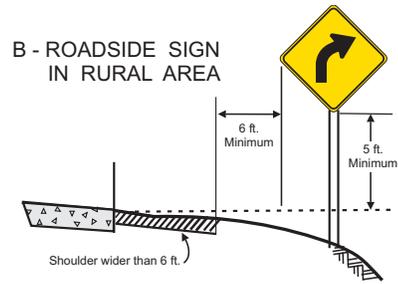
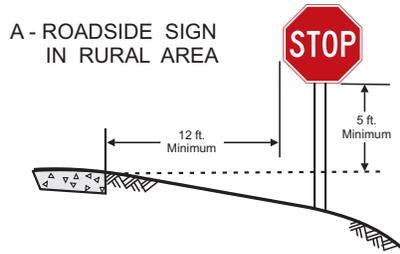
P.O. Box 5757  
London, Ontario N6A 4T1  
1-800-3MHELPS

#### 3M México, S.A. de C.V.

Av. Santa Fe No. 55  
Col. Santa Fe, Del. Alvaro Obregón  
México, D.F. 01210

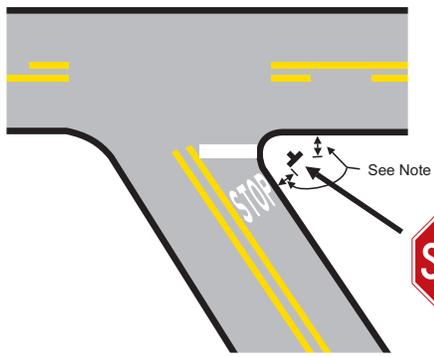
Please recycle.  
© 3M 2011. All rights reserved.  
Bolger 12010104  
Electronic Only

# APPENDIX C

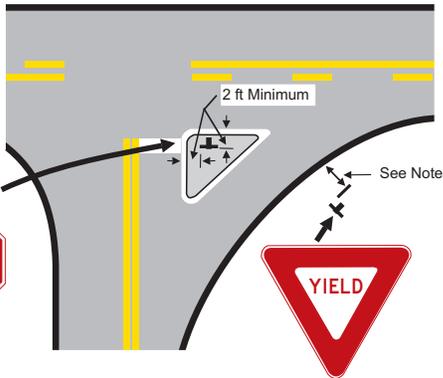


Note:  
See Section 2A.19 for reduced lateral offset distances that may be used in areas where lateral offsets are limited, and in business, commercial, or residential areas where sidewalk width is limited or where existing poles are close to the curb.

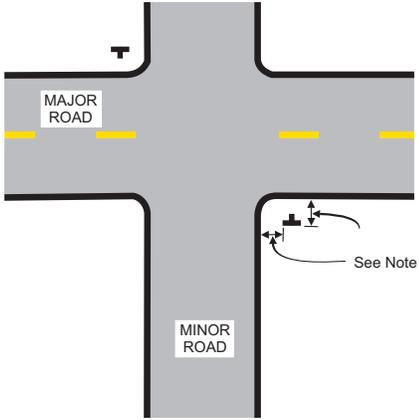
Figure 2A-2 Examples of Heights and Lateral Locations of Sign Installations



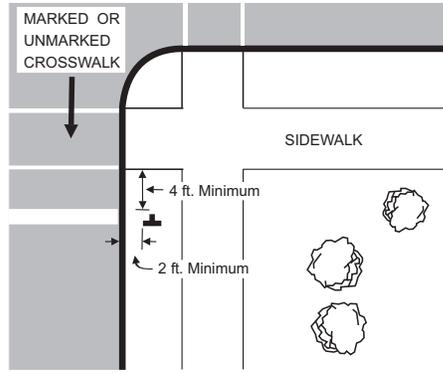
A - ACUTE ANGLE INTERSECTION



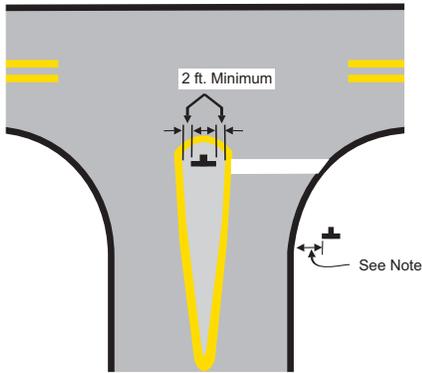
B - CHANNELIZED INTERSECTION



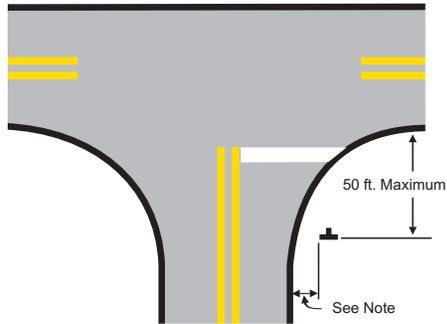
C - MINOR CROSSROAD



D - URBAN INTERSECTION



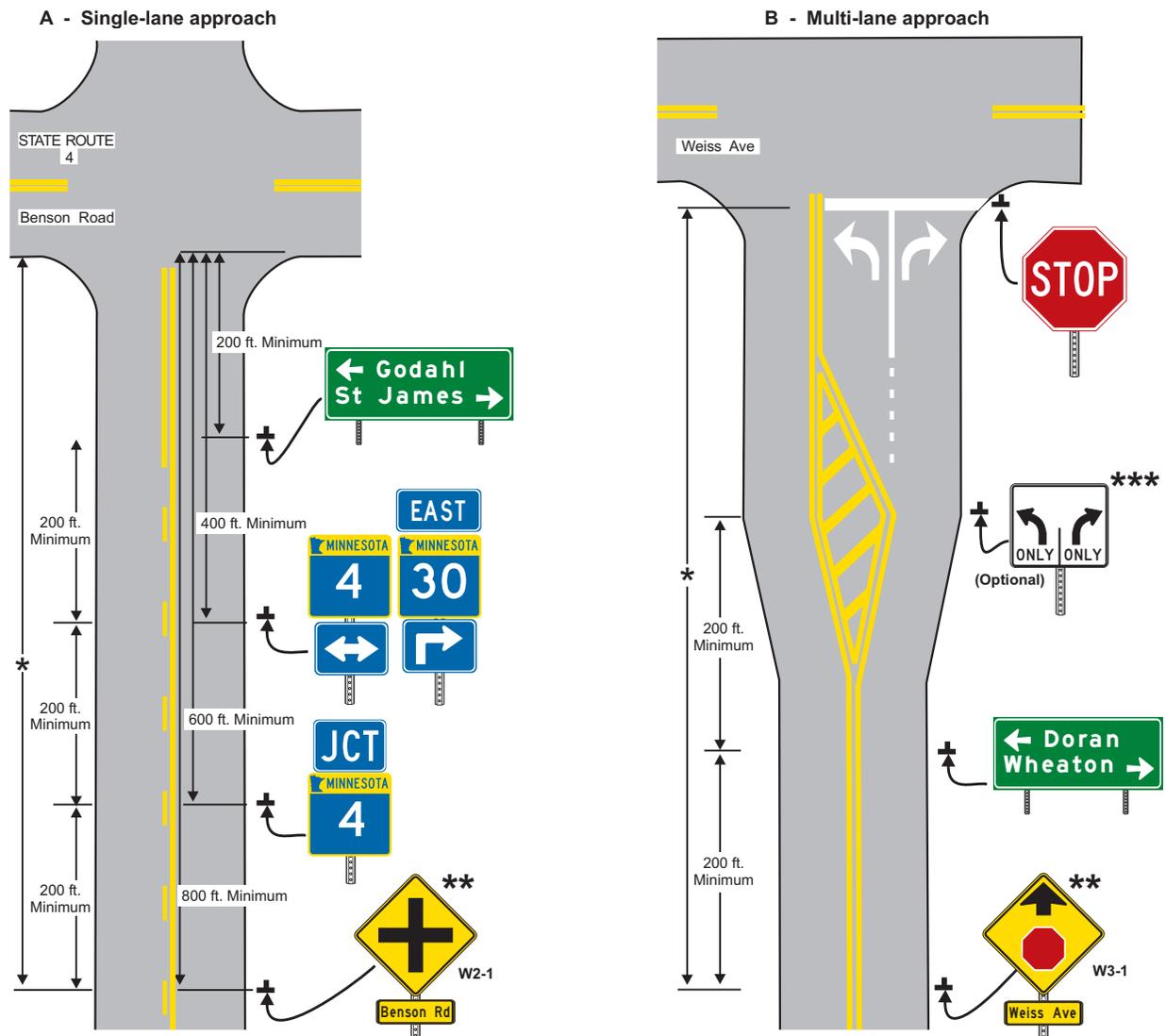
E - DIVISIONAL ISLAND



F - WIDE THROAT INTERSECTION

Note: Lateral offset is a minimum of 6 feet measured from the edge of the shoulder, or 12 feet measured from the edge of the traveled way. See Section 2A.19 for lower minimums that may be used in urban areas, or where lateral offset space is limited.

Figure 2A-3 Examples of Locations for Some Typical Signs at Intersections



Notes: See Chapter 2D for information on guide signs and Part 3 for information on pavement markings

\* See Table 2C-4 for the recommended minimum distance  
 \*\* See Section 2C.46 for the application of the W2-1 sign and Section 2C.36 for the application of the W3-1 signs  
 \*\*\* See Section 2B.22 for the application of Intersection Lane Control signs

**Figure 2A-4 Relative Locations of Regulatory, Warning, and Guide Signs on an Intersection Approach**

**SUPPORT:**

STOP signs are typically located within 6 to 12 feet of the edge of the traveled portion of intersecting roadways (see Figure 2A-2) in order to place vehicles stopped on the minor road in a location that optimizes sight lines to the major roadway. At wide throat intersections with large corner radii (over 40 feet), this optimum sign location would result in the STOP sign being placed in the paved part of the road. In

these cases, the 50 foot major road offset should be maintained because a larger offset would require drivers on the minor road to either stop twice or look for a longer gap. When corner radii exceeds 90 feet, it is not possible to comply with both the minor and major road offsets. Redesigning the intersection in order to provide a free right turn island would provide a protected location for the STOP sign consistent with the optimum major and minor road offsets.