

Idaho Department of Transportation requires any new sign on their controlled roads to be a type IX (minimum) retro reflectivity sheeting (with the exceptions of blue and brown signs which must meet minimum of a type IV). 3M Diamond Grade 4000 series is a type XI sheeting that exceeds minimum. Roads that are controlled by local our county entities must meet federal minimums of a type IV retroreflective sheeting. 3M High Intensity Prismatic 3000 series meets federal minimums.

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U.S. Department of Transportation Federal Highway Administration

and construction/work zone uses. product list. FHWA does not endorse or approve sign sheeting materials. Many other sheeting materials not listed here are available for delineation This document is intended to help identify sign sheeting materials for rigid signs and their common specification designations. It is not a qualified

Many sign sheeting materials have watermarks and/or patterns that are used to identify the material type and manufacturer. The watermarks shown in this guide have been enhanced. The watermarks will be less visible in practice and may not be present on smaller pieces of sheeting due to the spacing

			ntifying marks.	any patterns or ide	Iniform without	Grade sheeting is u	 2) Glass Bead Engineer
(4)	(4)	(4)	(3) (4) (9)	(4)	(3) (4) (9)	(2) (8)	NOTES:
N500	T-5500	ATSM HI	2800 3800	15000	T-2000	Several	Series
High Intensi	High Intensity	High Intensity	High Intensity	Super Engr Grade	Super Engr Grade	Engineer Grade	srand Name
Vippon Carbi	Avery N Dennison®	ATSM, Inc.	ЗМтм	Nippon Carbide	Avery Dennison®	Several companies	Manufacturer
A	A	A	A	(1)	(1)	(1)	ASHTO M268-13
Ξ	Ξ	III	III	II	=	-	STM D4956-13
Ξ	≡	Ξ	Ξ	=	=	_	STM D4956-04
				☆			xample of Sheeting Shown to scale)

3) Material no longer sold in the United States as of the date of this publication.

4) Section 2A.08 of the 2009 MUTCD (http://mutcd.fhwa.dot.gov) does not allow this sheeting type to be used for new legends on green signs.

ASTM D4956-04 is referenced in Table 2A-3 of the 2009 MUTCD

ASTM D4956-13 is the most current ASTM sign sheeting specification (the 2013 version is designated by "-13").

AASHTO M268-13 is the most current AASHTO specification (the 2013 version is designated by "-13").

Manufacturer Contact Information

Avery Dennison - http://www.reflectives.averydennison.com 3M - http://www.3M.com/roadwaysafety

ORAFOL Americas Inc. – http://www.orafolamericas.com Nippon Carbide - http://www.nikkalite.com ATSM, Inc. - http://www.atsminc.com

FHWA Publication Number: FHWA-SA-14-022. You may download and print the electronic version of this document, available at www.fhwa.dot.gov/retro

2014 Traffic Sign Retroreflective Sheeting Identification Guide

U.S. Department of Transportation Federal Highway Administration

This document is intended to help identify sign sheeting materials for rigid signs and their common specification designations. It is not a qualified product list. FHWA does not endorse or approve sign sheeting materials. Many other sheeting materials not listed here are available for delineation and construction/work zone uses. Many sign sheeting materials have watermarks and/or patterns that are used to identify the material type and manufacturer. The watermarks shown in this guide have been enhanced. The watermarks will be less visible in practice and may not be present on smaller pieces of sheeting due to the spacing.

	Retrore	flective S	heeting N	laterials l	Made wit	h Micro-F	Prisms		
Example of Sheeting (Shown to scale)	EGP					HIM			
D4956-04	(5)	(5)	III, IV	III, IV, X	(5)	(5)	(5) / X	(5)	
D4956-13			III, IV	III, IV	III, IV	III, IV	VIII	VIII	
M268-13	(6)	(6)	В	В	В	В	В	В	
Manufacturer	3M™	Avery Dennison®	Avery Dennison®	3M™	ORAFOL Americas Inc	Nippon Carbide	Nippon Carbide	3M™	
Brand Name	EGP	PEG	HIP	HIP	ORALITE® HIP	HIM	Crystal Grade	Reflective Sheeting	
Series	3430	T-2500	T-6500	3930	5900/5930	CRG 94000	CRG 92000	3940	
NOTES:	(8)	(8)							
Example of Sheeting (Shown to scale)									
D4956-04	VIII	VII, VIII, X	IX	IX	(5)	(5)	(5)	(5)	
D4956-13	VIII	VIII	IX	IX	IX	IX	XI	XI	
M268-13	В	(7)	В	В	В	В	D	D	
Manufacturer	Avery Dennison®	3M™	3M™	Avery Dennison®	Nippon Carbide	ORAFOL Americas Inc	3M™	Avery Dennison®	
Brand Name	MVP Prismatic	Diamond Grade™ LDP	Diamond Grade™ VIP	OmniView™	Crystal Grade	ORALITE®	Diamond Grade™ DG3	OmniCube™	
Series	T-7500	3970	3990	T-9500	95000	7900	4000	T-11500	
NOTES:		(9)			(9)				
5) Material w 6) Sheeting r	as either unav naterial does n	ailable in 2005 lot meet minim	(previous versi 100 Num AASHTO cl	on of this Guid	de) or unassigr teria.	ned in the 200	4 version of A	STM D4956.	

7) Material has been discontinued prior to AASHTO M268-10.

8) Section 2A.08 of the 2009 MUTCD (<u>http://mutcd.fhwa.dot.gov</u>) does not allow this sheeting type to be used for new yellow or orange signs, or new legends on green signs.

9) Material no longer sold in the United States as of the date of this publication.

Resources

Federal Highway Administration – http://www.fhwa.dot.gov/retro

Manual on Uniform Traffic Control Devices (MUTCD) – http://mutcd.fhwa.dot.gov

Texas A&M Transportation Institute – http://tti.tamu.edu/visibility

ASTM – http://www.astm.org

AASHTO – http://www.transportation.org

Sheeting Type (ASTM D4956-04)							
Sign Color	E	Beaded Sheetii	ng	Pr	ismatic Sheeting	Additional Criteria	
	I	II	III	III, I	V, VI, VII, VIII, IX, X	Unterna	
White on Groon	$W^*; G \ge 7$	W*; G ≥ 15	$W^*; G \ge 25$		$W \geq 250; G \geq 25$	Overhead	
White on Green	$W^*;G\geq 7$		W ≥ 120	0; G ≥ 1	5	Post-mounted	
Black on Yellow or	Y*; O*		$Y \ge 50$; O ≥ 50)	2	
Black on Orange	Y*; O*		Y ≥ 75	; O ≥ 75	5	3	
White on Red	White on Red W ≥ 35; R ≥ 7 4						
Black on White	Black on White W ≥ 50 -						
observation angle of 0.2° and an entrance angle of -4.0°. ² For text and fine symbol signs measuring at least 48 inches and for all sizes of bold symbol signs ³ For text and fine symbol signs measuring less than 48 inches ⁴ Minimum sign contrast ratio ≥ 3:1 (white retroreflectivity ÷ red retroreflectivity) * This sheeting type shall not be used for this color for this application.							
Bold Symbol Signs							
• W1-1,2 - Turn and Curve• W3-1 - Stop Ahead• W1-2 - Pedestrian Crossing• W1-3,4 - Reverse Turn and Curve• W3-2 - Yield Ahead• W1-2 - Large Animals• W1-5 - Winding Road• W3-1 - Merge• W1-5 - Farm Equipment• W1-6,7 - Large Arrow• W4-1 - Merge• W1-5 - Snowmobile Crossing• W1-8 - Chevron• W4-3 - Added Lane• W1-5 - Entering Roadway Merge• W1-15 - Z70 Degree Loop• W4-6 - Entering Roadway• W1-2 - Double Arrow• W2-2,3 - Side Road• W6-3 - Two-Way Traffic• W2-7,8 - Double Side Roads• W1-1,2,3,4,11,12 - Grade• W2-7,8 - Double Side Roads• W2-7,8 - Double Side Roads• W3-1 - Merge• W1-1,2,3,4,11,12 - Grade							
Fine S	ymbol Sig	ns (symbol sign	is not listed a	as bold	l symbol signs)		
		Special	Cases				
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 W13-1P,2,3,6,7 (Speed Advisory Plaques), use the largest sign dimension to determine the proper minimum retroreflectivity level							

Table 2A-3. Minimum Maintained Retroreflectivity Levels¹

- 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).

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



Transportation Safety Division

3M[™] Diamond Grade[™] DG³ Reflective Sheeting Series 4000

Product Bulletin 4000 May 2018

Replaces Product Bulletin 4000 Dated May 2017

1 Description

3M Diamond Grade DG³ Reflective Sheeting Series 4000 ("Sheeting") features the most efficient retroreflective prism design currently available from 3M for use on vertical traffic control signs and delineators to return light to drivers under a diverse set of nighttime viewing geometries encountered by the driving public. Series 4000, as manufactured by 3M, meets the stringent retroreflective requirements described in the ASTM D4956 standard for Type XI retroreflective Sheeting.

The Sheeting is available in the following colors.

Table 1. Product Codes by Color

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

2 Specifications

The Sheeting conforms to all current performance requirements of ASTM D4956 for Type XI retroreflective sheeting. Additionally, the Sheeting meets the following specifications.

2.1 Legibility

A traffic control and guidance sign ("Sign") made with the Sheeting used for both Sign background and cut-out copy will remain legible when viewed from a moving vehicle under normal day and night driving conditions by not excessively fading, discoloring, cracking, crazing, peeling, and blistering during the legibility periods in the locations as given in Table 2. Signs must be manufactured, installed, and maintained as recommended in the applicable 3M Information Folders listed in Section 16, and legibility must be assessed after Signs have been cleaned as described in <u>3M Information Folder 1.11</u>. Legibility Period is measured from the initial Sign fabrication date ("Fabrication Date"), and varies by Sign location as shown in Table 2.

Table 2. Sheeting Legibility Periods by Sheeting and Geographic Sign Location

Sheeting	Geographic Location of Sign	Legibility Period [from Fabrication Date]
4090, 4091, 4092, 4095, 4097, 4099	US & Canada	Up to 12 Years
4081, 4083	Alabama, Arizona, Florida, Georgia, Hawaii, Louisiana, Mississippi, New Mexico, South Carolina, and Texas	Up to 7 Years
	Canada and US other than the above States	Up to 10 Years
4084	US & Canada	Up to 3 Years

2.2 Gloss

The Sheeting has a rating of 50 or higher when tested in accordance with ASTM D523 using a 60° glossmeter.

2.3 Optical Stability

The Sheeting, applied to a 3-inch x 6-inch test panel, shall retain a minimum of 85% and a maximum of 115% of its initial coefficient of retroreflection when measured at a 0.2° observation and -4° entrance angle, after being placed in an oven at 71° C \pm 3° C (160° F \pm 5° F) for 24 hours followed by conditioning at standard room temperature for two hours.

2.4 Coefficient of Retroreflection (R_A)

Table 3 describes the durations and coefficients of retained retroreflection¹ for Signs fabricated with the Sheeting for use in the US and Canada. The values presented in Table 3 apply only to Sheeting that has been applied, processed, installed, maintained, and cleaned as recommended in the applicable 3M Information Folders listed in Section 16 of this product bulletin.

Table 3. Minimum Retained Coefficient of retrorenection (RA, [Cu/IX/III]) for Sheeting over this

Sheeting	Years from Fabrication Date	Minimum Retained Coefficient of Retroreflection [cd/lx/m ²]
	On Fabrication Date	ASTM D4956 Type XI
4090, 4091, 4092, 4095, 4097, 4099	Up to 7 Years	80% of ASTM D4956 Type XI
	8-12 Years	70% ASTM D4956 Type XI
4001 4002	On Fabrication Date	ASTM D4956 Type XI
4081, 4083	Up to 7 Years/10 Years ^a	70% of ASTM D4956 Type XI
4084	On Fabrication Date	ASTM D4956 Type XI
4004	Up to 3 Years	70% of ASTM D4956 Type XI

a. The retained coefficient of retroreflection applies for 7 years after Fabrication Date for the following states: Alabama, Arizona, Florida, Georgia, Hawaii, Louisiana, Mississippi, New Mexico, South Carolina, and Texas. For all other locations the retained coefficient of retroreflection is for 10 years.

1. Conformance to coefficient of retroreflection requirements shall be determined instrumentally in accordance with ASTM E810 "Test Method for Coefficient of Retroreflection of Retroreflective Sheeting," and per E810, values obtained at 0° and 90° rotations shall be averaged to determine the R_A values referenced in Table 3.

2

2.5 Entrance Angularity Performance and Orientation

3M Diamond Grade DG³ Series 4000 Reflective Sheeting has been designed to be an effective wide angle reflective Sheeting regardless of its orientation on the substrate or the 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, which is especially apparent at larger entrance angles, it is possible to get the widest entrance angle light return from a particular orientation. When high entrance angle (>50°) performance is required for a given Sign (e.g. "keep right" symbols), it can be obtained easily by properly orientating the Sheeting on the completed Sign. In such situations, the completed Sign should have the Sheeting positioned at the 0° orientation (downweb direction perpendicular to the road). When the flat side of the diamond (direction of diamond chain links) 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 on the completed Sign, the Sheeting is said to be at a 90° orientation. See Figure 1 for details.



Figure 1. Primary groove line.

Unless Sign location and/or position calls for extra-wide entrance angularity performance or a specific installation direction is required in a customer specification, 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.

3 System of Matched Components

The Sheeting is compatible with a wide range of 3M screen print and digital inks, translucent films, overlay films and other processing components. For a complete list of matched components for the Sheeting, please see the <u>3M</u> <u>MCS™ Warranty Bulletin</u>.

4 Physical Properties

4.1 Fabrication Lines

The Sheeting manufacturing process results in periodic fabrication lines in the product, as illustrated in Figure 2. Fabrication lines may be noticeable in shop light but do not impact Sign functionality on the road, either in daylight or at night, under typical use conditions.



Figure 2. Fabrication lines

4.2 Adhesive

Sheeting comes with a pressure-sensitive adhesive that is recommended for application at temperatures of 65° F (18° C) and higher.

5 Sign Fabrication Methods

5.1 Application

Diamond Grade DG³ Reflective Sheeting Series 4000DS should be applied to Sign substrates at temperature of 65°F/18°C and higher using any of the following methods:

Mechanical squeeze roll applicator - refer to <u>3M Information Folder 1.4</u> for details. Applications to extrusions that are edge wrapped require sufficient softening of Sheeting. This can be accomplished by directing additional heat to the "next to last" edge roller. This practice may increase productivity and minimize cracking.

Hand squeeze roll applicator - refer to <u>3M Information Folder 1.6</u> for details.

Application of Diamond Grade DG³ Reflective Sheeting Series 4000 for complete Signs or backgrounds must be done using a roll laminator, either mechanical or hand driven.

5.2 Hand Application

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

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

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

5.3 Splices

Diamond Grade DG³ Reflective Sheeting Series 4000 must be butt spliced when more than one piece of Sheeting is used on a single piece of substrate. Sheeting pieces should not touch one another. This is to prevent the buckling that can occur as Sheeting expands under extreme temperature and humidity conditions.

5.4 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.

6 Substrates

For traffic Sign use, the substrates found to be most reliable and durable are properly prepared aluminum sheets and extrusions. **Users are urged to carefully evaluate adhesion and Sign durability properties of all other**

substrates. Other substrates suitable for secure and durable applications of 3M Diamond Grade DG³ Reflective Sheeting Series 4000 have the following characteristics:

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

Refer to <u>3M Information Folder 1.7</u> for surface preparation recommendations. Substrates with low surface energies may require additional preparation steps, such as flame treatment, mechanical abrasion, or use of adhesion promoters prior to Sheeting application. Guide Sign extrusions may be edge wrapped. Flat panels and unwrapped extrusions must be carefully trimmed so that Sheeting sections on adjacent panels do not touch on assembled Signs.

Diamond Grade DG³ Reflective Sheeting Series 4000 is designed primarily for application to flat substrates. Any application to a substrate with 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 substrate failures or improper surface preparations are not the responsibility of 3M.**

7 Imaging

Diamond Grade DG³ prismatic Sheeting may be processed into traffic Signs using any of the imaging methods described below. 3M assumes no responsibility for the failures of Sign face legends or backgrounds that have been processed with non-3M process colors or with matched component imaging materials other than those listed below.

7.1 Digital Imaging

3M Diamond Grade[™] DG3 Reflective Sheeting Series 4000 is compatible with the HP Latex 360/365 printers in combination with HP 831/HP 871 Latex inks. This compatibility is backed with a 3M MCS[™] Warranty and 3M MCS Warranty for Traffic when the printing guidelines in <u>3M Information Folder 1.18</u> are followed and 3M ElectroCut[™] Film 1170C Clear is applied over the finished graphics. See the "Limited Warranty" section of this document for more information on the MCS Warranties.

7.2 Screen Processing

Series 4000 Sheeting may be screen processed into traffic Signs using 3M Process Colors Series 880I or Series 880N before or after mounting onto Sign substrates. Series 880I and 880N process colors can be screened at temperatures of 60-100°F (16-38°C) and at relative humidities of 20-50%. A P.E. 157 screen mesh with a fill pass is recommended. Refer to <u>3M Information Folder 1.8</u> for details. Clear coating is neither required nor recommended. Use of process colors series other than 880I or 880N is not recommended.

7.3 3M ElectroCut Film

3M ElectroCut Film Series 1170 may be used on Series 4000 Sheeting to provide transparent colored background copy for traffic control Signs. Refer to 3M Product Bulletin 1170 for fabrication procedures.

7.4 Applying Cut-Out Copy

Diamond Grade DG³ Prismatic Sheeting cut-out copy may be applied to sheeting backgrounds to create Sign legends. Such cut-out copy may be applied directly to the background sheeting or in a demountable form. Direct applied copy must be cut at all panel seams and carefully trimmed back so that the Sheeting sections of adjacent panels do not touch one another on assembled Signs. Refer to <u>3M Information Folder 1.10</u> for more information.

8 Cutting

Series 4000 Sheeting may be cut into letters and shapes with heights of at least 3 inches and stroke widths of at least ½ inch. Smaller sizes are not recommended. Sealing the cut edges of Series 4000 Sheeting is not required.

8.1 Plotter Cutting

Programmable knife cut (electronic cutting):

- 1 Flat bed plotters can be used to either die cut or kiss cut Series 4000 Sheeting and offer the most consistent and reliable performance.
- 2 Friction fed plotters can be used to kiss cut only. This is achieved using 600 grams of down force and a 60° cutting blade. Additional drive wheels may be needed to improve tracking. Alternatively, Series 4000 Sheeting can be cut from the liner side. To do so, the blade force and knife depth must be set to score, but not cut through, the topfilm. After scoring, break apart individual copy or apply premask to retain spacing.

8.2 Other Cutting Methods

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Series 4000 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 place 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 inches, or 50 sheets. Cutting procedure details can be found in <u>3M Information Folder 1.10</u>.

9 Processing, Storage, and Packaging

Diamond Grade DG³ Reflective Sheeting Series 4000 should be stored in a cool, dry area, preferably at 65-75°F (18-24°C) and 30-50% relative humidity, and applied within two years of date of manufacture. Rolls should be stored horizontally in their shipping cartons. Partially used rolls should be returned to their shipping cartons or suspended horizontally from rods or pipes through their cores. Unprocessed sheets should be stored flat. Finished Signs and applied blanks should be stored on edge.

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 and finished Signs must remain dry during shipment and storage. If packaged Signs become wet, unpack immediately and allow Signs to dry. Refer to <u>3M Information Folder 1.11</u> for instructions on packing for storage and shipment.

10 Installation

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

11 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 Sign faces. Flush with water following washing. Do not use solvents to clean Signs.

12 Durability

The durability of 3M Diamond Grade DG³ Reflective Sheeting Series 4000 will depend upon substrate selection and preparation, compliance with recommended application procedures, geographic area, exposure conditions, and maintenance. Maximum durability can be expected in applications subject to vertical exposure on stationary objects, when processed and applied to aluminum substrates prepared according to the recommendations provided in <u>3M Information Folder 1.7</u>. The user must determine the suitability of any nonmetallic Sign backing for its intended use. **Sign failures caused by substrate failures or improper surface preparations are not the responsibility of 3M**. Application to unprimed, excessively rough or non-weather resistant surfaces, or exposure to severe or unusual conditions can shorten the performance lifetime of Series 4000 Sheeting. Signs that are in mountainous areas and covered by snow for prolonged periods may also have reduced durabilities. Atmospheric conditions in certain geographic areas may result in reduced durability.

Periodic Sign inspection and regular Sign replacement are strongly recommended in order to help Sign owners establish their own effective service life expectations.

13 Health and Safety Information

Read all health hazard, precautionary, and first aid statements found in the Safety Data Sheets (SDS), Article Information Sheets, and product labels of any materials for important health, safety, and environmental information prior to handling or use. To obtain SDSs and Article Information Sheets for 3M products, go to 3M.com/SDS, contact 3M by mail, or for urgent requests call 1-800-364-3577.

14 Warranty Information

14.1 3M Warranty

3M warrants to the manufacturer of the Sign ("Sign Manufacturer") that the Sheeting will meet the specifications described in section 2 of this Product Bulletin ("3M Warranty").

14.2 3M MCS[™] Warranty and MCS Warranty for Traffic

For warranty on screen-printed or digitally printed Sheeting, or Sheeting imaged using translucent films, please refer to the <u>3M MCS™ Warranty Bulletin</u>.

14.3 3M Warranty Terms and Conditions

- The Sheeting must be stored, processed, applied, and maintained as described in this product bulletin and in accordance with all applicable, written 3M procedures provided in the applicable 3M Information Folders listed in Section 16.
- A failure to meet the 3M Warranty must be solely the result of design or manufacturing defect in the 3M Sheeting, and not a result of (a) outside causes, including improper fabrication, handling, packing, storing, shipping, maintenance, or installation; (b) non-vertical applications where the Sign is more than +/- 10° from vertical; (c) use of any material or product not recommended by 3M in this product bulletin, in the 3M Information Folders listed in Section 16, or in applicable 3M Technical Memorandums; (d) use of application equipment not recommended by 3M; (e) failure of Sign substrate; (f) loss of adhesion due to incompatible or improperly prepared substrate; (g) exposure to chemicals, abrasion, or other mechanical damage; (h) snow burial or any other Sign burial; (i) collisions, vandalism, or malicious mischief; or (j) an act of God.
- Claims made under this warranty will be honored only if (a) the Sign is dated with the Fabrication Date using a permanent method (sticker, marker, metal stamp, etc.), (b) 3M is notified in writing of the claim within thirty days of discovery, (c) 3M is provided with the information reasonably required to validate the claim, and (d) 3M is permitted to verify the cause of the failure.
- 3M is not responsible for any additional warranties that the Sign Manufacturer offers to its customers beyond the 3M Warranty.

14.4 Exclusive Limited Remedy

Valid claims under the 3M Warranty will receive either the Sign Restoration or Materials Replacement as detailed in Table 4.

Sheeting Type	Geographic Location of Sign	Limited Remedy Period [years from Fabrication Date]			
		Sign Restoration	Materials Replacement		
4090, 4091, 4092, 4095, 4097, 4099	US & Canada	Up to 7 Years	Years 8-12		
4081, 4083	Alabama, Arizona, Florida, Georgia, Hawaii, Louisiana, Mississippi, New Mexico, South Carolina, and Texas	Up to 5 Years	Years 6-7		
	Canada and US other than the above States	Up to 7 Years	Years 8-10		
4084	US & Canada		Years 0-3		

Table 4. Sheeting type, location, and type of limited remedy as a function of the age of Sign

Sign Restoration

During the Sign Restoration period as provided in Table 4, if Sheeting is proven to not meet the 3M Warranty, then the Sign Manufacturer's exclusive remedy, and 3M's sole obligation, at 3M's option, shall be that 3M, at its expense, will either refund the Sign Manufacturer's total original cost of the Sign, or refabricate the Sign, including (i) Sheeting and (ii) the aluminum Sign substrate (as needed). However, 3M will not provide other hardware or labor to install the replacement Sign. The Fabrication Date of the replacement Sign will be considered to be the original Fabrication Date of the Sign it replaces under the 3M Warranty.

Materials Replacement

During the Materials Replacement period as provided in Table 4, if Sheeting is proven to not meet the 3M Warranty, then the Sign Manufacturer's exclusive remedy, and 3M's sole obligation, at 3M's option, shall be that 3M, at its expense, will either refund the Sign Manufacturer's total original cost of the Sheeting, or provide the necessary Sheeting quantity to restore the Sign's surface. However, 3M will not provide the substrate or any labor to refabricate or reinstall the Sign.

14.5 Disclaimer

THE 3M WARRANTY IS MADE IN LIEU OF ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE, OR ANY IMPLIED WARRANTY ARISING OUT OF A COURSE OF DEALING OR OF PERFORMANCE, CUSTOM, OR USAGE OF TRADE.

14.6 Limitation of Liability

Except for the limited remedy stated above, and except where prohibited by law, 3M will not be liable for any loss or damage arising from the Signs or any 3M product, whether direct, indirect, special, incidental, or consequential damages (including but not limited to lost profits, business, or revenue in any way), regardless of the legal theory asserted including warranty, contract, negligence, or strict liability.

14.7 Additional Limitations

See the <u>3M Digitally-Imaged Sign Warranty Bulletin</u> for terms, additional limitations of your warranty, if any, and limitations of liability.

15 Other Product Information

Always confirm that you have the most current version of the applicable product bulletin, information folder, or other product information from 3M's Website at http://www.mmm.com/roadsafety.

16 Literature References

- <u>3M IF 1.4</u> Instructions for Interstate Squeeze Roll Applicator
- <u>3M IF 1.5</u> Hand Application Instructions
- <u>3M IF 1.6</u> Hand Squeeze Roll Applicator
- <u>3M IF 1.7</u> Sign Base Surface Preparation
- <u>3M IF 1.8</u> Process Colors Series 880 and 900 Instructions for Use
- <u>3M IF 1.10</u> Cutting, Premasking, and Prespacing
- <u>3M IF 1.11</u> Sign Maintenance Management
- <u>3M IF 1.18</u> Digital Imaging with HP Latex 360/365 Printers on 3M[™] Reflective Sheeting Series 4000 and 3930
- <u>3M IF 3.5</u> Digital Imaging with HP Latex 360/365/370/375 Printer on 3M[™] Reflective Sheeting Series 4000 and 3930 for Rigid Temporary Traffic Control Signing Applications
- <u>3M PB 1170</u> 3M[™] ElectroCut[™] Film Series 1170

3M Digitally-Imaged Sign Warranty Bulletin

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

For Information or Assistance Call: 1-800-553-1380 In Canada Call: 1-800-3M HELPS (1-800-364-3577)

Internet:

http://www.3M.com/roadsafety

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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.



Transportation Safety Division 3M Center, Building 0225-04-N-14 St. Paul, MN 55144-1000 USA

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Traffic Safety and Security Division

3M™ Digitally-Imaged Sign Warranty Bulletin

3M[™] MCS[™] Warranty for Traffic 3M[™] MCS[™] Warranty March 2016

General Warranty Information

Warranty Coverage Overview

The 3M[™] MCS[™] Warranty for Traffic and the 3M[™] MCS[™] Warranty are offered to the sign manufacturer ("**Manufacturer**") for a rigid traffic sign ("**Sign**"). The Manufacturer may extend these warranties to their customers. Additional warranties, if any, offered by the Manufacturer are separate and exclusive of the MCS Warranty for Traffic and MCS Warranty.

The warranty period for eligible graphics is as stated in the warranty matrices found online on the 3M TSSD MCS Warranty website, at the time that the film was purchased. The warranty period may be reduced and stipulations may apply for certain constructions and applications, as covered in this bulletin.

Warranty coverage is contingent upon using the matched component products and processing such products according to all applicable 3M guidelines as described in relevant product bulletins, information folders, and similar product literature. Failure to follow such descriptions and instructions will void all warranties and limited remedies.

Limitation of Liability

3M's liability under this warranty is limited to replacement as stated herein, and 3M assumes no liability for any incidental or consequential damages, such as lost profits, business or revenues in any way related to the product regardless of the legal theory on which the claim is based. EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW, THIS 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. This limitation of liability applies regardless of the legal or equitable theory under which such losses or damages are sought.

MCS[™] Warranty for Traffic

3M warrants ("**MCS Warranty for Traffic")** that, in the United States, a Sign containing only the standard traffic colors¹ and black ("**Traffic Colors**"), made with the purpose of conforming to the standard traffic colors¹ using the combinations of the 3M retroreflective sheeting ("**Sheeting**"), the digital printing ink ("**Ink**"), and the clear overlaminate ("**Overlaminate**") as given in a 3M MCS Warranty for Traffic Matrix for a digital printer ("**Printer**") will,

- remain legible when viewed from a moving vehicle under normal day and night driving conditions by resisting excessive fading, discoloring, cracking, crazing, peeling, and blistering ("Legibility Warranty"),
- after cleaning, retain a minimum percentage of coefficient of retroreflection (**"Retroreflection Retention** Warranty"),

for the number of years ("Warranty Period") as shown in the warranty matrix.

MCS[™] Warranty

3M also warrants ("**MCS Warranty**") that, in the United States, a Sign containing any color not made with the purpose of conforming to Traffic Colors² using the combinations of Sheeting, Ink, and Overlaminate as given in a 3M MCS Warranty Matrix for a Printer, will remain legible by resisting excessive fading, discoloring, cracking, crazing, peeling, and blistering, for the Warranty Period shown in the warranty matrix.

Limited Remedy

If a Sign is proven not to have met either the MCS Warranty for Traffic or MCS Warranty, then the owner's exclusive remedy, and 3M's sole obligation, at 3M's option shall be: (a) if this occurs during the Sign Restoration Period as given in the respective warranty matrix, 3M will, at its expense, restore the Sign's surface to its original effectiveness (this remedy shall include only the expense of making the new Sign face including the aluminum Sign substrate, but shall not include other hardware or labor to install the replacement Sign); or (b) if this occurs during the remainder of the Warranty Period as given in the respective warranty matrix, then 3M will furnish only the necessary Sheeting, Overlaminate, and Ink quantity to restore the Sign's surface to its original effectiveness.

Terms and Conditions

- The Warranty Period is measured from the Sign manufacturing date ("Fabrication Date"). Claims made under this warranty will be honored only if the Sign was dated on the Fabrication Date using a permanent method (sticker, permanent marker or crayon, metal stamp, etc.), records and retains of such production data traceable to the printed Sign is maintained, and 3M is notified of an MCS Warranty for Traffic/MCS Warranty ("MCS Warranties") claim during the applicable Warranty Period, and 3M is provided with the information reasonably required to validate the claim, and 3M is permitted to verify the cause of the failure.
- For the MCS Warranties to apply, 3M recommended settings and/or profiles must be used on the Printer applicable for the Sheeting. 3M may revise recommended settings based on internal or external test data, and may update the relevant information folder(s) reflecting any material changes in the recommended settings and/or profiles for the Printer. Failure to use the updated settings and/or profiles will void the MCS Warranties. However, such changes in recommended settings does not retroactively invalidate the MCS Warranties made prior to such notice.
- 3M recommended written processing guidelines are followed during the manufacturing of the Sign, the Sheeting and the Overlaminate are applied as recommended, to properly prepared substrates in accordance with 3M recommended procedures. It is the responsibility of the Manufacturer to ensure proper substrate preparation and that approved application procedures are followed, and to maintain production data including but not limited to the Printer profiles, that all 3M recommended procedures are applied, and such data is provided to 3M at 3M's request.

¹ For specific standard color information, please see the applicable 3M MCS Warranty for Traffic Matrix for the Printer.

² For specific color information, please see the applicable 3M MCS Warranty Matrix for the Printer.

- Except where prohibited by law, 3M will not be liable for any loss or damage arising from the 3M product, whether direct (other than the Limited Remedy stated above), indirect, special, incidental or consequential, regardless of the legal theory asserted.
- All components involved in the MCS Warranties must be stored, applied, installed, processed, and used only as 3M recommends in the relevant product bulletins and other product information such as information folders, and as noted herein.
- Printer has been maintained according to the Printer manufacturer's recommended maintenance schedule at the time of Fabrication Date, and reasonable maintenance records are provided to 3M at 3M's request.
- A Sign's failure to meet the MCS Warranties must be solely the result of the design or manufacturing defects
 of the Sheeting or the matched component materials listed in the respective product bulletin for the Sheeting.
 3M has no obligation under the MCS Warranties if failure is caused by, including but not limited to, the
 following: improper fabrication, handling, packaging, storing, shipping, maintenance or installation; nonvertical applications where the Sign is more than +/- 10% from vertical; use of any material or product not
 included in the respective warranty matrix; 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; or an act of God.
- 3M reserves the right to determine the method of replacement, and any replacement Sign will carry the MCS Warranty for Traffic or MCS Warranty only for the original Sign's unexpired Warranty Period.
- In case the standard warranty for Sheeting, outlined in the respective product bulletin for signage applications, is modified, 3M may change MCS Warranties in accordance with the changes in the standard warranty for Sheeting. Such modification does not retroactively invalidate the MCS Warranties for a Sign made prior to such modification.
- 3M makes no warranty or claims that a Sign covered under the 3M MCS Warranty will meet the color specifications given in any agency or customer specifications, or ASTM D4956.

For Information or Assistance Call: 1-800-553-1380 In Canada Call: 1-800-265-1840

Internet: www.3M.com/roadwaysafety

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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.



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Transportation Safety Division

3M[™] High Intensity Prismatic Reflective Sheeting Series 3930

Product Bulletin Series 3930 May 2018

Replaces Product Bulletin 3930 Dated January 2013

1 Description

High Intensity Prismatic Reflective Sheeting Series 3930 ("Sheeting") is a non-metalized microprismatic lens reflective sheeting designed for use in the production of durable reflective traffic control signs, work zone devices, and delineators that are exposed vertically in service ("Signs"). Applied to properly prepared Sign substrates, 3M Series 3930 prismatic Sheeting provides long-term reflectivity and durability.

Series 3930 Sheeting is available in the following colors.

Table 1. Product Codes by Color

Color	Product Code
White	3930
Yellow	3931
Red	3932
Orange	3934
Blue	3935
Green	3937
Brown	3939

2 Specifications

2.1 Daytime Color (x, y, Y)

The chromaticity coordinates and total luminance factors of the retroreflective Sheeting conform to the limits presented in Table 2.

Color		1	:	2	:	3		4	Reflectan	ce Limit (Y)
Color	x	У	x	У	x	У	x	У	Minimum	Maximum
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
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404	10	30
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

Table 2. Daytime Color Specification Limits^a

a. The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 Standard Colormetric System.

2.2 Color Test - Ordinary Colored Sheeting

Conformance to standard chromaticity (x, y) and luminance factor (Y%) requirements shall be determined instrumentally, in accordance with ASTM E1164, on Sheeting applied to smooth test panels cut from aluminum alloy 6061-T6 or 5052-H38. Chromaticity and luminance factor values shall be determined using a HunterLab ColorFlex 45/0 spectrophotometer.¹ Calculations shall be performed using CIE Illuminant D65 and the 2° standard observer.

2.3 Coefficient of Retroreflection (R_A)

The values shown in Table 3 are minimum coefficients of retroreflection, expressed in candelas per lux per square meter (cd/lux/m²).

Entroneo Anglo ^a	Sheeting Color	Observation Angle ^b		
Entrance Angle	Sheeting Oolor	0.2°	0.5°	
	White	560	200	
	Yellow	420	150	
	Red	84	30	
-4°	Orange	210	75	
	Blue	30	13	
	Green	56	21	
	Brown	18	7.5	
	White	280	100	
	Yellow	210	75	
	Red	42	15	
-30°	Orange	105	37	
	Blue	14	6	
	Green	28	10	
	Brown	8.5	3.5	

Table 3. Minimum Coefficient of Retroreflection R_A for New Sheeting (cd/lux/m²)

a. Entrance Angle – The angle from the illumination axis to the retroreflector axis. The retroreflector axis is an axis perpendicular to the retroreflective surface.

b. Observation Angle - The angle between the illumination axis and the observation axis.

^{1.} The instrumentally determined color values of retroreflective sheeting can vary significantly depending on the make and model of colorimetric spectrophotometer used, 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.

2.4 Test for Coefficient of Retroreflection

3

Conformance to coefficient of retroreflection requirements shall be determined instrumentally, in accordance with ASTM E-810 "Test Method for Coefficient of Retroreflection of Retroreflective Sheeting." Per ASTM E-810, the values presented in Table 3 are averages of R_A values obtained at 0° and 90° rotations.

2.5 Entrance Angularity Performance and Orientation

3M High Intensity Prismatic Reflective Sheeting Series 3930 has been designed to be an effective wide angle reflective sheeting regardless of its orientation on the substrate or the 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, which is especially apparent at larger entrance angles, it is possible to get the widest entrance angle light return from a particular orientation. When high entrance angle (>50°) performance is required for a given Sign (e.g. "keep right" symbols), it can be obtained easily by properly orientating the Sheeting on the completed Sign. In such situations, the completed Sign should have the Sheeting positioned at the 0° orientation (downweb direction perpendicular to the road). When the flat side of the diamond (direction of diamond chain links) 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 on the completed Sign, the Sheeting is said to be at a 90° orientation. See Figure 1 for details.



Figure 1. Primary groove lines used to define Sheeting orientation.

Unless Sign location and/or position calls for extra-wide entrance angularity performance or a specific installation direction is required in a customer specification, 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.

2.6 Printed Colors and Overlay Films

When processed according to 3M recommendations, the coefficient of retroreflection of a screen-printed transparent color on white Sheeting shall be not less than 70% of the R_A value of the corresponding colored Sheeting presented in Table 3. White Sheeting covered with 3M ElectroCut[™] Film Series 1170, when processed according to 3M recommendations, shall have a coefficient of retroreflection of not less than 100% of the value of the corresponding colored Sheeting, as presented in Table 3. The chromaticities and luminances of printed colors and overlay films shall conform to the specifications presented in Table 2.

3 Physical Properties

3.1 Fabrication Lines

4

The manufacture of prismatic Sheeting results in lines being present in the product, as shown in Figure 2. In prismatic 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.





3.2 Adhesive

Series 3930 Sheeting has a pressure-sensitive adhesive that is recommended for application at temperatures of 65°F (18°C) and higher.

4 Sign Fabrication Methods

4.1 Application

Series 3930 Sheeting should be applied to Sign substrates at temperatures of 65°F (18°C) and higher using any of the following methods:

Mechanical squeeze roll applicator – refer to <u>3M Information Folder 1.4</u>. Applications to extrusions that are edge wrapped require sufficient softening of the Sheeting. This can be accomplished by directing additional heat to the "next to last" edge roller. This practice may increase productivity and minimize cracking.

Hand squeeze roll applicator - refer to <u>3M Information Folder 1.6</u>.

Background or complete Sign applications of Series 3930 Sheeting must be performed with a roll laminator, either mechanical or hand driven.

4.2 Hand Application

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

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

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

4.3 Splices

Series 3930 Sheeting must be butt spliced when more than one piece of Sheeting is used on a single piece of substrate. Sheeting pieces should not touch one another. This is to prevent the buckling that can occur as Sheeting expands under extreme temperature and humidity conditions.

4.4 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.

5 Substrates

5

For traffic Sign use, the substrates that have been found to be most reliable and durable are properly prepared aluminum sheets and extrusions. Users are urged to carefully evaluate adhesion and Sign durability properties of all other substrates. Other substrates suitable for secure and durable applications of Series 3930 Sheeting have the following characteristics:

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

Refer to <u>3M Information Folder 1.7</u> for surface preparation recommendations. Substrates with low surface energies may require additional preparation steps, such as flame treatment, mechanical abrasion, or use of adhesion promoters prior to Sheeting application. Guide Sign extrusions may be edge wrapped. Flat panels and unwrapped extrusions must be carefully trimmed so that Sheeting sections on adjacent panels do not touch on assembled Signs.

High intensity prismatic Sheeting has been designed primarily for application to flat substrates. Any application to a substrate with 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 substrate failures or improper surface preparations are not the responsibility of 3M.

6 Imaging

High intensity prismatic Sheeting may be processed into traffic Signs using any of the imaging methods described below. 3M assumes no responsibility for the failures of Sign face legends or backgrounds that have been processed with non-3M process colors or with matched component imaging materials other than those listed below.

6.1 Digital Imaging

3M High Intensity Prismatic Reflective Sheeting Series 3930 is compatible with the HP Latex 360/365 printers in combination with HP 831/HP 871 Latex inks. This compatibility is backed with a 3M MCS[™] Warranty and 3M MCS Warranty for Traffic when the printing guidelines in <u>3M Information Folder 1.18</u> are followed and 3M ElectroCut[™] Film 1170C Clear is applied over the finished graphics. See the "Limited Warranty" section of this document for more information on the MCS Warranties.

6.2 Screen Processing

Series 3930 Sheeting may be screen processed into traffic Signs using 3M Process Colors Series 880I or Series 880N before or after being mounted onto a substrate. Series 880I and 880N process colors can be screened at temperatures of 60-100°F (16-38°C) and at relative humidities of 20-50%. A P.E. 157 screen mesh with a fill pass is recommended. Refer to <u>3M Information Folder 1.8</u> for details. Clear coating is neither required nor recommended. Use of process color series other than 880I or 880N is not recommended.

6.3 3M ElectroCut[™] Film

3M ElectroCut Film Series 1170 may be used on Series 3930 prismatic Sheeting to provide transparent colored background copy for traffic control Signs. Refer to <u>3M Product Bulletin 1170</u> for fabrication procedures.

6.4 Applied Cut-Out Copy

Series 3930 Sheeting cut-out copy may be applied to Sheeting backgrounds to create Sign legends. Such cut-out copy may be applied directly to the background Sheeting or in a demountable form. Direct applied copy must be cut at all panel seams and carefully trimmed back so that the Sheeting sections of adjacent panels do not touch one another on assembled Signs. Refer to <u>3M Information Folder 1.10</u> for more information.

7 Cutting

Series 3930 Sheeting may be cut into letters and shapes with heights of at least 3 inches and stroke widths of at least ½ inch. Smaller sizes are not recommended. Sealing the cut edges of Series 3930 Sheeting is not required.

7.1 Plotter Cutting

Programmable knife cut (electronic cutting):

- 1 Flat bed plotters can be used to either die cut or kiss cut Series 3930 Sheeting and offer the most consistent and reliable performances.
- 2 Friction fed plotters can be used to kiss cut only. This is achieved using 600 grams of down force and a 60° cutting blade. Additional drive wheels may be needed to improve tracking. Alternatively, Series 3930 Sheeting can be cut from the liner side. To do so, the blade force and knife depth must be set to score, but not cut through, the topfilm. After scoring, break apart individual copy or apply premask to retain spacing.

7.2 Other Cutting Methods

Series 3930 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 place 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 3930 Sheeting is 1½ inches, or 50 sheets. Cutting procedure details can be found in <u>3M Information Folder 1.10</u>.

8 Installation

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

9 Shelf-Life, Storage, and Packaging

Series 3930 Sheeting should be stored in a cool, dry area, preferably at 65-75°F (18-24°C) and 30-50% relative humidity, and applied within two years of date of manufacture. Rolls should be stored horizontally in their shipping cartons. Partially used rolls should be returned to their shipping cartons or suspended horizontally from rods or pipes through their cores. 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 a piece of slipsheeting against each face of the Sign.

Unmounted screened faces must be stored flat and interleaved with SCW 568 slipsheeting, 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 and finished Signs must remain dry during shipment and storage. If packaged Signs become wet, unpack immediately and allow Signs to dry. Refer to <u>3M Information Folder 1.11</u> for instructions on packing for storage and shipment.

10 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 Sign faces. Flush with water following washing. Do not use solvents to clean Signs.

11 Durability

The durabilities of Series 3930 Sheeting and finished Signs made using 3M Matched Component materials will depend upon substrate selection and preparation, compliance with recommended application procedures, geographic area, exposure conditions, and maintenance practices. Maximum durability of Series 3930 Sheeting can be expected in applications subject to vertical exposures on stationary objects, when processed and applied to aluminum substrates prepared according to the recommendations provided in <u>3M Information Folder 1.7</u>. The user must determine the suitability of any nonmetallic Sign backing for its intended use. **Sign failures caused by substrate failures or improper surface preparations are not the responsibility of 3M**. Application to unprimed, excessively rough or non-weather-resistant surfaces, or exposure to severe or unusual conditions can shorten the performance lifetime of Series 3930 Sheeting. 3M process colors and ElectroCut™ Film, when used according to 3M recommendations, are generally expected to produce Signs with performances comparable to those of their colored reflective Sheeting components. Custom colors, certain lighter colors, heavily toned colors, and blends containing yellow or gold may have reduced durabilities. Atmospheric conditions in certain geographic areas may result in reduced durability.

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

12 Health and Safety Information

Read all health hazard, precautionary, and first aid statements found in the Safety Data Sheets (SDS), Article Information Sheets, and products labels of any materials for important health, safety, and environmental information prior to handling or use. To obtain SDSs and Article Information Sheets for 3M products, go to 3M.com/SDS, contact 3M by mail, or for urgent requests call 1-800-364-3577.

13 Warranty Information

13.1 3M Basic Product Warranty and Limited Remedy

3M High Intensity Prismatic Reflective Sheeting Series 3930 ("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 Series 3930 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.

13.2 General Warranty Terms

- 3M makes the Additional Warranty (as defined below) as to any traffic control and guidance Sign in the United States and Canada made with 3M High Intensity Prismatic Reflective Sheeting Series 3930 and the Matched Component materials listed in Table 4, below. Any Additional Warranty is contingent on all components involved in the Additional Warranty being stored, applied, installed, and used only as 3M recommends in its Product Bulletins and Other Product Information.
- The Basic Warranty and any applicable Additional Warranty are collectively referred to as the "3M Warranty."
- 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 (a) outside causes including improper fabrication, handling, packing, storing, shipping, maintenance, or installation; (b) use of any material or product not recommended by 3M in this product bulletin, in the 3M information folders and product bulletins listed in Section 15, or in applicable 3M Technical Memorandums; (c) use of application equipment not recommended by 3M; (d) failure of Sign substrate; (e) loss of adhesion due to incompatible or improperly prepared substrate; (f) exposure to chemicals, abrasion, or other mechanical damage; (g) snow burial or any other Sign burial; (h) collisions, vandalism, or malicious mischief; or (i) an act of God.

- 3M reserves the right to determine method of replacement.
- Any replacement Product or Sign restoration will carry the unexpired warranty of the Product it replaces.
- Claims made under this warranty will be honored only if (a) the Sign was dated at the time of fabrication ("Fabrication Date") using a permanent method (sticker, marker, metal stamp, etc.), (b) 3M is notified in writing of the claim within thirty days of discovery, (c) 3M is provided with the information reasonably required to validate the claim, and (d) 3M is permitted to verify the cause of the failure.
- 3M is not responsible for any additional warranties that the Sign Manufacturer offers to its customers beyond the 3M Warranty.

Table 4. Matched Component Materials

Matched Components	
Process Colors	Series 880I Series 880N
ElectroCut™ Film	Series 1170
Premium Protective Overlay Film	Series 1160

13.3 Additional Warranty and Limited Remedy

The Additional Warranty for a Sign made with the 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 coefficient of retroreflection value stated in Table 5 for the applicable Warranty Period, as measured from the Sign's Fabrication Date.

Table 5. Minimum Percent of Initial R_A (See Table 3) Retained for Applicable Warranty Period for White, Yellow, Red, Green, Blue, and Brown Sheeting

Warranty Period	Minimum Percentage R _A Retained
1-7 Years	80%
8-10 Years	70%

- If any Sign made with the 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 is:
- If this occurs within seven years of the Fabrication Date, then 3M will, at its expense, restore the Sign's surface to its original effectiveness; or
- If this occurs during the remainder of the Additional Warranty Period, then 3M will furnish only the necessary Product and matched component materials quantities to restore the Sign's surface to its original effectiveness.

13.4 Additional Warranty & Limited Remedy for 3934 Orange Product

The Additional Warranty for a Sign made with 3934 orange Sheeting (Orange 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 the coefficient of retroreflection stated in Table 6 for three years, as measured from Fabrication Date; and (c) after cleaning, the Product will maintain daytime luminance equal to or greater than the minimum value specified in Table 2.

Table 6. Minimum Coefficient of Retroreflection for 3934 Orange Sheeting Product (cd/lux/m²) (0.2° observation angle and -4° entrance angle)

Warranty Period	Minimum R _A
3 Years	80

If any Sign made with the Orange 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, is that 3M will provide pro-rated replacement of the 3M materials.

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

13.5 Disclaimer

9

THE 3M WARRANTY IS MADE IN LIEU OF ALL OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE, OR ANY IMPLIED WARRANTY ARISING OUT OF A COURSE OF DEALING OR OF PERFORMANCE, CUSTOM, OR USAGE OF TRADE.

13.6 Limitation of Liability

Except for the limited remedy stated above, and except where prohibited by law, 3M will not be liable for any loss or damage arising from the Signs or any 3M product, whether direct, indirect, special, incidental, or consequential damages (including but not limited to lost profits, business, or revenue in any way), regardless of the legal theory asserted including warranty, contract, negligence, or strict liability.

14 Other Product Information

Always confirm that you have the most current version of the applicable product bulletin, information folder, or other product information from 3M's Website at <u>http://www.mmm.com/roadsafety</u>.

15 Literature References

Instructions for Interstate Squeeze Roll Applicator
Hand Application Instructions
Hand Squeeze Roll Applicator
Sign Base Surface Preparation
Process Colors Series 880 and 900 Instructions for Use
Cutting, Premasking, and Prespacing
Sign Maintenance Management
Digital Imaging with HP Latex 360/365 Printers on 3M™ Reflective Sheeting Series 4000 and 3930
Digital Imaging with HP Latex 360/365/370/375 Printer on 3M™ Reflective Sheeting Series 4000 and 3930 for Rigid Temporary Traffic Control Signing Applications
3M™ Process Color Series 880I
3M™ Process Color Series 880N
Premium Protective Overlay Film
3M™ ElectroCut™ Film Series 1170

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

For Information or Assistance Call: 1-800-553-1380 In Canada Call: 1-800-3M HELPS (1-800-364-3577)

Internet:

http://www.3M.com/roadsafety

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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.



Transportation Safety Division 3M Center, Building 0225-04-N-14 St. Paul, MN 55144-1000 USA

Phone 1-800-553-1380 Web <u>3M.com/roadsafety</u>

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Guidance:

Lettering on post-mounted Street Name signs should be composed of initial upper-case letters at least 6 inches in height and lower-case letters at least 4.5 inches in height.

On multi-lane streets with speed limits greater than 40 mph, the lettering on post-mounted Street Name signs should be composed of initial upper-case letters at least 8 inches in height and lower-case letters at least 6 inches in height.

Option:

- ⁰⁶ For local roads with speed limits of 25 mph or less, the lettering on post-mounted Street Name signs may be composed of initial upper-case letters at least 4 inches in height and lower-case letters at least 3 inches in height. *Guidance:*
- 17 If overhead Street Name signs are used, the lettering should be composed of initial upper-case letters at least 12 inches in height and lower-case letters at least 9 inches in height.

Support:

- ⁰⁸ The recommended minimum letter heights for Street Name signs are summarized in Table 2D-2. Option:
- ⁰⁹ Supplementary lettering to indicate the type of street (such as Street, Avenue, or Road) or the section of the city (such as NW) on the D3-1 and D3-1a signs may be in smaller lettering, composed of initial upper-case letters at least 3 inches in height and lower-case letters at least 2.25 inches in height. Conventional abbreviations (see Section 1A.15) may be used except for the street name itself.
- 10 A pictograph (see definition in Section 1A.13) may be used on a D3-1 sign.
- Standard:
- 11 Pictographs shall not be displayed on D3-1a or Advance Street Name (D3-2) signs (see Section 2D.44).
- 12 If a pictograph is used on a D3-1 sign, the height and width of the pictograph shall not exceed the upper-case letter height of the principal legend of the sign.

Guidance:

13 *The pictograph should be positioned to the left of the street name.*

Standard:

14 The Street Name sign shall be retroreflective or illuminated to show the same shape and similar color both day and night. The color of the legend (and border, if used) shall contrast with the background color of the sign.

Option:

15 The border may be omitted from a Street Name sign.

- 39. "Guidelines for Accessible Pedestrian Signals (NCHRP Web-Only Document 117B)," 2008 Edition (TRB)
- 40. "Highway Capacity Manual," 2000 Edition (TRB)
- 41. "Recommended Procedures for the Safety Performance Evaluation of Highway Features," (NCHRP Report 350), 1993 Edition (TRB)
- 42. "The Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)," July 1998 Edition (The U.S. Access Board)

Section 1A.12 Color Code

Support:

- The following color code establishes general meanings for 11 colors of a total of 13 colors that have been identified as being appropriate for use in conveying traffic control information. tolerance limits for each color are contained in 23 CFR Part 655, Appendix to Subpart F and are available at the Federal Highway Administration's MUTCD website at http://mutcd.fhwa.dot.gov or by writing to the FHWA, Office of Safety Research and Development (HRD-T-301), 6300 Georgetown Pike, McLean, VA 22101.
- ⁰² The two colors for which general meanings have not yet been assigned are being reserved for future applications that will be determined only by FHWA after consultation with the States, the engineering community, and the general public. The meanings described in this Section are of a general nature. More specific assignments of colors are given in the individual Parts of this Manual relating to each class of devices.

Standard:

- ⁰³ The general meaning of the 13 colors shall be as follows:
 - A. Black—regulation
 - B. Blue-road user services guidance, tourist information, and evacuation route
 - C. Brown-recreational and cultural interest area guidance
 - D. Coral-unassigned
 - E. Fluorescent Pink-incident management
 - F. Fluorescent Yellow-Green—pedestrian warning, bicycle warning, playground warning, school bus and school warning
 - G. Green-indicated movements permitted, direction guidance
 - H. Light Blue—unassigned
 - I. Orange-temporary traffic control
 - J. Purple—lanes restricted to use only by vehicles with registered electronic toll collection (ETC) accounts
 - K. Red-stop or prohibition
 - L. White-regulation
 - M. Yellow-warning

Section 1A.13 Definitions of Headings, Words, and Phrases in this Manual

Standard:

- ⁰¹ When used in this Manual, the text headings of Standard, Guidance, Option, and Support shall be defined as follows:
 - A. Standard—a statement of required, mandatory, or specifically prohibitive practice regarding a traffic control device. All Standard statements are labeled, and the text appears in bold type. The verb "shall" is typically used. The verbs "should" and "may" are not used in Standard statements. Standard statements are sometimes modified by Options. Standard statements shall not be modified or compromised based on engineering judgment or engineering study.
 - B. Guidance—a statement of recommended, but not mandatory, practice in typical situations, with deviations allowed if engineering judgment or engineering study indicates the deviation to be appropriate. All Guidance statements are labeled, and the text appears in unbold type. The verb "should" is typically used. The verbs "shall" and "may" are not used in Guidance statements. Guidance statements are sometimes modified by Options.
 - C. Option—a statement of practice that is a permissive condition and carries no requirement or recommendation. Option statements sometime contain allowable modifications to a Standard or Guidance statement. All Option statements are labeled, and the text appears in unbold type. The verb "may" is typically used. The verbs "shall" and "should" are not used in Option statements.
 - D. Support—an informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. Support statements are labeled, and the text appears in unbold type. The verbs "shall," "should," and "may" are not used in Support statements.

- ⁰² Unless otherwise defined in this Section, or in other Parts of this Manual, words or phrases shall have the meaning(s) as defined in the most recent editions of the "Uniform Vehicle Code," "AASHTO Transportation Glossary (Highway Definitions)," and other publications mentioned in Section 1A.11.
- ⁰³ The following words and phrases, when used in this Manual, shall have the following meanings:
 - 1. Accessible Pedestrian Signal—a device that communicates information about pedestrian signal timing in non-visual format such as audible tones, speech messages, and/or vibrating surfaces.
 - 2. Accessible Pedestrian Signal Detector—a device designated to assist the pedestrian who has visual or physical disabilities in activating the pedestrian phase.
 - 3. Active Grade Crossing Warning System—the flashing-light signals, with or without warning gates, together with the necessary control equipment used to inform road users of the approach or presence of rail traffic at grade crossings.
 - 4. Actuated Operation—a type of traffic control signal operation in which some or all signal phases are operated on the basis of actuation.
 - 5. Actuation—initiation of a change in or extension of a traffic signal phase through the operation of any type of detector.
 - 6. Advance Preemption—the notification of approaching rail traffic that is forwarded to the highway traffic signal controller unit or assembly by the railroad or light rail transit equipment in advance of the activation of the railroad or light rail transit warning devices.
 - 7. Advance Preemption Time—the period of time that is the difference between the required maximum highway traffic signal preemption time and the activation of the railroad or light rail transit warning devices.
 - 8. Advisory Speed—a recommended speed for all vehicles operating on a section of highway and based on the highway design, operating characteristics, and conditions.
 - 9. Alley—a street or highway intended to provide access to the rear or side of lots or buildings in urban areas and not intended for the purpose of through vehicular traffic.
 - 10. Altered Speed Zone—a speed limit, other than a statutory speed limit, that is based upon an engineering study.
 - 11. Approach—all lanes of traffic moving toward an intersection or a midblock location from one direction, including any adjacent parking lane(s).
 - 12. Arterial Highway (Street)—a general term denoting a highway primarily used by through traffic, usually on a continuous route or a highway designated as part of an arterial system.
 - 13. Attended Lane (Manual Lane)—a toll lane adjacent to a toll booth occupied by a human toll collector who makes change, issues receipts, and perform other toll-related functions. Attended lanes at toll plazas typically require vehicles to stop to pay the toll.
 - 14. Automatic Lane—see Exact Change Lane.
 - 15. Average Annual Daily Traffic (AADT)—the total volume of traffic passing a point or segment of a highway facility in both directions for one year divided by the number of days in the year. Normally, periodic daily traffic volumes are adjusted for hours of the day counted, days of the week, and seasons of the year to arrive at average annual daily traffic.
 - 16. Average Daily Traffic (ADT)—the average 24 hour volume, being the total volume during a stated period divided by the number of days in that period. Normally, this would be periodic daily traffic volumes over several days, not adjusted for days of the week or seasons of the year.
 - 17. Average Day—a day representing traffic volumes normally and repeatedly found at a location, typically a weekday when volumes are influenced by employment or a weekend day when volumes are influenced by entertainment or recreation.
 - 18. Backplate—see Signal Backplate.
 - **19.** Barrier-Separated Lane—a preferential lane or other special purpose lane that is separated from the adjacent general-purpose lane(s) by a physical barrier.
 - 20. Beacon-a highway traffic signal with one or more signal sections that operates in a flashing mode.
 - 21. Bicycle—a pedal-powered vehicle upon which the human operator sits.
 - 22. Bicycle Facilities—a general term denoting improvements and provisions that accommodate or encourage bicycling, including parking and storage facilities, and shared roadways not specifically defined for bicycle use.
 - 23. Bicycle Lane—a portion of a roadway that has been designated for preferential or exclusive use by bicyclists by pavement markings and, if used, signs.
 - 24. Bikeway—a generic term for any road, street, path, or way that in some manner is specifically designated for bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

- 25. Buffer-Separated Lane—a preferential lane or other special purpose lane that is separated from the adjacent general-purpose lane(s) by a pattern of standard longitudinal pavement markings that is wider than a normal or wide lane line marking. The buffer area might include rumble strips, textured pavement, or channelizing devices such as tubular markers or traversable curbs, but does not include a physical barrier.
- 26. Cantilevered Signal Structure—a structure, also referred to as a mast arm, that is rigidly attached to a vertical pole and is used to provide overhead support of highway traffic signal faces or grade crossing signal units.
- 27. Center Line Markings—the yellow pavement marking line(s) that delineates the separation of traffic lanes that have opposite directions of travel on a roadway. These markings need not be at the geometrical center of the pavement.
- 28. Changeable Message Sign—a sign that is capable of displaying more than one message (one of which might be a "blank" display), changeable manually, by remote control, or by automatic control. Electronic-display changeable message signs are referred to as Dynamic Message Signs in the National Intelligent Transportation Systems (ITS) Architecture and are referred to as Variable Message Signs in the National Electrical Manufacturers Association (NEMA) standards publication.
- 29. Channelizing Line Markings—a wide or double solid white line used to form islands where traffic in the same direction of travel is permitted on both sides of the island.
- **30.** Circular Intersection—an intersection that has an island, generally circular in design, located in the center of the intersection where traffic passes to the right of the island. Circular intersections include roundabouts, rotaries, and traffic circles.
- **31.** Circulatory Roadway—the roadway within a circular intersection on which traffic travels in a counterclockwise direction around an island in the center of the circular intersection.
- 32. Clear Storage Distance—when used in Part 8, the distance available for vehicle storage measured between 6 feet from the rail nearest the intersection to the intersection stop line or the normal stopping point on the highway. At skewed grade crossings and intersections, the 6-foot distance shall be measured perpendicular to the nearest rail either along the center line or edge line of the highway, as appropriate, to obtain the shorter distance. Where exit gates are used, the distance available for vehicle storage is measured from the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and is not perpendicular to the highway, the distance is measured either along the center line or edge line of the highway, as appropriate, to obtain the shorter distance.
- 33. Clear Zone—the total roadside border area, starting at the edge of the traveled way, that is available for an errant driver to stop or regain control of a vehicle. This area might consist of a shoulder, a recoverable slope, and/or a non-recoverable, traversable slope with a clear run-out area at its toe.
- 34. Collector Highway—a term denoting a highway that in rural areas connects small towns and local highways to arterial highways, and in urban areas provides land access and traffic circulation within residential, commercial, and business areas and connects local highways to the arterial highways.
- **35.** Concurrent Flow Preferential Lane—a preferential lane that is operated in the same direction as the adjacent mixed flow lanes, separated from the adjacent general-purpose freeway lanes by a standard lane stripe, painted buffer, or barrier.
- **36.** Conflict Monitor—a device used to detect and respond to improper or conflicting signal indications and improper operating voltages in a traffic controller assembly.
- 37. Constant Warning Time Detection—a means of detecting rail traffic that provides relatively uniform warning time for the approach of trains or light rail transit traffic that are not accelerating or decelerating after being detected.
- **38.** Contiguous Lane—a lane, preferential or otherwise, that is separated from the adjacent lane(s) only by a normal or wide lane line marking.
- **39.** Controller Assembly—a complete electrical device mounted in a cabinet for controlling the operation of a highway traffic signal.
- 40. Controller Unit—that part of a controller assembly that is devoted to the selection and timing of the display of signal indications.
- 41. Conventional Road—a street or highway other than a low-volume road (as defined in Section 5A.01), expressway, or freeway.
- 42. Counter-Flow Lane—a lane operating in a direction opposite to the normal flow of traffic designated for peak direction of travel during at least a portion of the day. Counter-flow lanes are usually separated from the off-peak direction lanes by tubular markers or other flexible channelizing devices, temporary lane separators, or movable or permanent barrier.

- 43. Crashworthy—a characteristic of a roadside appurtenance that has been successfully crash tested in accordance with a national standard such as the National Cooperative Highway Research Program Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features."
- 44. Crosswalk—(a) that part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line; (b) any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color.
- 45. Crosswalk Lines—white pavement marking lines that identify a crosswalk.
- 46. Cycle Length—the time required for one complete sequence of signal indications.
- 47. Dark Mode—the lack of all signal indications at a signalized location. (The dark mode is most commonly associated with power failures, ramp meters, hybrid beacons, beacons, and some movable bridge signals.)
- 48. Delineator—a retroreflective device mounted on the roadway surface or at the side of the roadway in a series to indicate the alignment of the roadway, especially at night or in adverse weather.
- **49.** Design Vehicle—the longest vehicle permitted by statute of the road authority (State or other) on that roadway.
- 50. Designated Bicycle Route—a system of bikeways designated by the jurisdiction having authority with appropriate directional and informational route signs, with or without specific bicycle route numbers.
- 51. Detectable—having a continuous edge within 6 inches of the surface so that pedestrians who have visual disabilities can sense its presence and receive usable guidance information.
- 52. Detector—a device used for determining the presence or passage of vehicles or pedestrians.
- 53. Downstream—a term that refers to a location that is encountered by traffic subsequent to an upstream location as it flows in an "upstream to downstream" direction. For example, "the downstream end of a lane line separating the turn lane from a through lane on the approach to an intersection" is the end of the lane line that is closest to the intersection.
- 54. Dropped Lane—a through lane that becomes a mandatory turn lane on a conventional roadway, or a through lane that becomes a mandatory exit lane on a freeway or expressway. The end of an acceleration lane and reductions in the number of through lanes that do not involve a mandatory turn or exit are not considered dropped lanes.
- 55. Dual-Arrow Signal Section—a type of signal section designed to include both a yellow arrow and a green arrow.
- 56. Dynamic Envelope—the clearance required for light rail transit traffic or a train and its cargo overhang due to any combination of loading, lateral motion, or suspension failure (see Figure 8B-8).
- 57. Dynamic Exit Gate Operating Mode—a mode of operation where the exit gate operation is based on the presence of vehicles within the minimum track clearance distance.
- 58. Edge Line Markings—white or yellow pavement marking lines that delineate the right or left edge(s) of a traveled way.
- **59.** Electronic Toll Collection (ETC)—a system for automated collection of tolls from moving or stopped vehicles through wireless technologies such as radio-frequency communication or optical scanning. ETC systems are classified as one of the following: (1) systems that require users to have registered toll accounts, with the use of equipment inside or on the exterior of vehicles, such as a transponder or barcode decal, that communicates with or is detected by roadside or overhead receiving equipment, or with the use of license plate optical scanning, to automatically deduct the toll from the registered user account, or (2) systems that do not require users to have registered toll accounts because vehicle license plates are optically scanned and invoices for the toll amount are sent through postal mail to the address of the vehicle owner.
- 60. Electronic Toll Collection (ETC) Account-Only Lane—a non-attended toll lane that is restricted to use only by vehicles with a registered toll payment account.
- 61. Emergency-Vehicle Hybrid Beacon—a special type of hybrid beacon used to warn and control traffic at an unsignalized location to assist authorized emergency vehicles in entering or crossing a street or highway.
- 62. Emergency-Vehicle Traffic Control Signal—a special traffic control signal that assigns the right-of-way to an authorized emergency vehicle.
- 63. End-of-Roadway Marker—a device used to warn and alert road users of the end of a roadway in other than temporary traffic control zones.

- 64. Engineering Judgment—the evaluation of available pertinent information, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. Engineering judgment shall be exercised by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. Documentation of engineering judgment is not required.
- 65. Engineering Study—the comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. An engineering study shall be performed by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. An engineering study shall be documented.
- 66. Entrance Gate—an automatic gate that can be lowered across the lanes approaching a grade crossing to block road users from entering the grade crossing.
- 67. Exact Change Lane (Automatic Lane)—a non-attended toll lane that has a receptacle into which road users deposit coins totaling the exact amount of the toll. Exact Change lanes at toll plazas typically require vehicles to stop to pay the toll.
- 68. Exit Gate—an automatic gate that can be lowered across the lanes departing a grade crossing to block road users from entering the grade crossing by driving in the opposing traffic lanes.
- 69. Exit Gate Clearance Time—for Four-Quadrant Gate systems at grade crossings, the amount of time provided to delay the descent of the exit gate arm(s) after entrance gate arm(s) begin to descend.
- 70. Exit Gate Operating Mode—for Four-Quadrant Gate systems at grade crossings, the mode of control used to govern the operation of the exit gate arms.
- 71. Expressway—a divided highway with partial control of access.
- 72. Flagger—a person who actively controls the flow of vehicular traffic into and/or through a temporary traffic control zone using hand-signaling devices or an Automated Flagger Assistance Device (AFAD).
- 73. Flasher—a device used to turn highway traffic signal indications on and off at a repetitive rate of approximately once per second.
- 74. Flashing—an operation in which a light source, such as a traffic signal indication, is turned on and off repetitively.
- 75. Flashing-Light Signals—a warning device consisting of two red signal indications arranged horizontally that are activated to flash alternately when rail traffic is approaching or present at a grade crossing.
- 76. Flashing Mode—a mode of operation in which at least one traffic signal indication in each vehicular signal face of a highway traffic signal is turned on and off repetitively.
- 77. Freeway—a divided highway with full control of access.
- 78. Full-Actuated Operation—a type of traffic control signal operation in which all signal phases function on the basis of actuation.
- 79. Gate—an automatically-operated or manually-operated traffic control device that is used to physically obstruct road users such that they are discouraged from proceeding past a particular point on a roadway or pathway, or such that they are discouraged from entering a particular grade crossing, ramp, lane, roadway, or facility.
- 80. Grade Crossing—the general area where a highway and a railroad and/or light rail transit route cross at the same level, within which are included the tracks, highway, and traffic control devices for traffic traversing that area.
- 81. Guide Sign—a sign that shows route designations, destinations, directions, distances, services, points of interest, or other geographical, recreational, or cultural information.
- 82. High-Occupancy Vehicle (HOV)—a motor vehicle carrying at least two or more persons, including carpools, vanpools, and buses.
- 83. Highway—a general term for denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.
- 84. Highway-Light Rail Transit Grade Crossing—the general area where a highway and a light rail transit route cross at the same level, within which are included the light rail transit tracks, highway, and traffic control devices for traffic traversing that area.
- 85. Highway-Rail Grade Crossing—the general area where a highway and a railroad cross at the same level, within which are included the railroad tracks, highway, and traffic control devices for highway traffic traversing that area.

- 86. Highway Traffic Signal—a power-operated traffic control device by which traffic is warned or directed to take some specific action. These devices do not include power-operated signs, steadily-illuminated pavement markers, warning lights (see Section 6F.83), or steady burning electric lamps.
- 87. HOV Lane—any preferential lane designated for exclusive use by high-occupancy vehicles for all or part of a day—including a designated lane on a freeway, other highway, street, or independent roadway on a separate right-of-way.
- 88. Hybrid Beacon—a special type of beacon that is intentionally placed in a dark mode (no indications displayed) between periods of operation and, when operated, displays both steady and flashing traffic control signal indications.
- 89. Inherently Low Emission Vehicle (ILEV)—any kind of vehicle that, because of inherent properties of the fuel system design, will not have significant evaporative emissions, even if its evaporative emission control system has failed.
- 90. In-Roadway Lights—a special type of highway traffic signal installed in the roadway surface to warn road users that they are approaching a condition on or adjacent to the roadway that might not be readily apparent and might require the road users to slow down and/or come to a stop.
- 91. Interchange—a system of interconnecting roadways providing for traffic movement between two or more highways that do not intersect at grade.
- 92. Interconnection—when used in Part 8, the electrical connection between the railroad or light rail transit active warning system and the highway traffic signal controller assembly for the purpose of preemption.
- 93. Intermediate Interchange—an interchange with an urban or rural route that is not a major or minor interchange as defined in this Section.
- 94. Intersection—intersection is defined as follows:
 - (a) The area embraced within the prolongation or connection of the lateral curb lines, or if none, the lateral boundary lines of the roadways of two highways that join one another at, or approximately at, right angles, or the area within which vehicles traveling on different highways that join at any other angle might come into conflict.
 - (b) The junction of an alley or driveway with a roadway or highway shall not constitute an intersection, unless the roadway or highway at said junction is controlled by a traffic control device.
 - (c) If a highway includes two roadways that are 30 feet or more apart (see definition of Median), then every crossing of each roadway of such divided highway by an intersecting highway shall be a separate intersection.
 - (d) If both intersecting highways include two roadways that are 30 feet or more apart, then every crossing of any two roadways of such highways shall be a separate intersection.
 - (e) At a location controlled by a traffic control signal, regardless of the distance between the separate intersections as defined in (c) and (d) above:
 - (1) If a stop line, yield line, or crosswalk has not been designated on the roadway (within the median) between the separate intersections, the two intersections and the roadway (median) between them shall be considered as one intersection;
 - (2) Where a stop line, yield line, or crosswalk is designated on the roadway on the intersection approach, the area within the crosswalk and/or beyond the designated stop line or yield line shall be part of the intersection; and
 - (3) Where a crosswalk is designated on a roadway on the departure from the intersection, the intersection shall include the area extending to the far side of such crosswalk.
- 95. Intersection Control Beacon—a beacon used only at an intersection to control two or more directions of travel.
- 96. Interval—the part of a signal cycle during which signal indications do not change.
- 97. Interval Sequence—the order of appearance of signal indications during successive intervals of a signal cycle.
- **98.** Island—a defined area between traffic lanes for control of vehicular movements, for toll collection, or for pedestrian refuge. It includes all end protection and approach treatments. Within an intersection area, a median or an outer separation is considered to be an island.
- 99. Lane Drop—see Dropped Lane.
- 100. Lane Line Markings—white pavement marking lines that delineate the separation of traffic lanes that have the same direction of travel on a roadway.
- 101. Lane-Use Control Signal—a signal face displaying indications to permit or prohibit the use of specific lanes of a roadway or to indicate the impending prohibition of such use.

- 102. Legend-see Sign Legend.
- 103. Lens—see Signal Lens.
- 104. Light Rail Transit Traffic (Light Rail Transit Equipment)—every device in, upon, or by which any person or property can be transported on light rail transit tracks, including single-unit light rail transit cars (such at streetcars and trolleys) and assemblies of multiple light rail transit cars coupled together.
- 105. Locomotive Horn—an air horn, steam whistle, or similar audible warning device (see 49 CFR Part 229.129) mounted on a locomotive or control cab car. The terms "locomotive horn," "train whistle," "locomotive whistle," and "train horn" are used interchangeably in the railroad industry.
- 106. Logo—a distinctive emblem or trademark that identifies a commercial business and/or the product or service offered by the business.
- 107. Longitudinal Markings—pavement markings that are generally placed parallel and adjacent to the flow of traffic such as lane lines, center lines, edge lines, channelizing lines, and others.
- 108. Louver—see Signal Louver.
- 109. Major Interchange—an interchange with another freeway or expressway, or an interchange with a high-volume multi-lane highway, principal urban arterial, or major rural route where the interchanging traffic is heavy or includes many road users unfamiliar with the area.
- 110. Major Street-the street normally carrying the higher volume of vehicular traffic.
- 111. Malfunction Management Unit-same as Conflict Monitor.
- 112. Managed Lane—a highway lane or set of lanes, or a highway facility, for which variable operational strategies such as direction of travel, tolling, pricing, and/or vehicle type or occupancy requirements are implemented and managed in real-time in response to changing conditions. Managed lanes are typically buffer- or barrier-separated lanes parallel to the general-purpose lanes of a highway in which access is restricted to designated locations. There are also some highways on which all lanes are managed.
- 113. Manual Lane-see Attended Lane.
- 114. Maximum Highway Traffic Signal Preemption Time—the maximum amount of time needed following initiation of the preemption sequence for the highway traffic signals to complete the timing of the right-of-way transfer time, queue clearance time, and separation time.
- 115. Median—the area between two roadways of a divided highway measured from edge of traveled way to edge of traveled way. The median excludes turn lanes. The median width might be different between intersections, interchanges, and at opposite approaches of the same intersection.
- 116. Minimum Track Clearance Distance—for standard two-quadrant warning devices, the minimum track clearance distance is the length along a highway at one or more railroad or light rail transit tracks, measured from the highway stop line, warning device, or 12 feet perpendicular to the track center line, to 6 feet beyond the track(s) measured perpendicular to the far rail, along the center line or edge line of the highway, as appropriate, to obtain the longer distance. For Four-Quadrant Gate systems, the minimum track clearance distance is the length along a highway at one or more railroad or light rail transit tracks, measured either from the highway stop line or entrance warning device, to the point where the rear of the vehicle would be clear of the exit gate arm. In cases where the exit gate arm is parallel to the track(s) and is not perpendicular to the highway, the distance is measured either along the center line or edge line of the highway, as appropriate, to obtain the longer distance.
- 117. Minimum Warning Time—when used in Part 8, the least amount of time active warning devices shall operate prior to the arrival of rail traffic at a grade crossing.
- 118. Minor Interchange—an interchange where traffic is local and very light, such as interchanges with land service access roads. Where the sum of the exit volumes is estimated to be lower than 100 vehicles per day in the design year, the interchange is classified as local.
- **119.** Minor Street—the street normally carrying the lower volume of vehicular traffic.
- 120. Movable Bridge Resistance Gate—a type of traffic gate, which is located downstream of the movable bridge warning gate, that provides a physical deterrent to vehicle and/or pedestrian traffic when placed in the appropriate position.
- 121. Movable Bridge Signal—a highway traffic signal installed at a movable bridge to notify traffic to stop during periods when the roadway is closed to allow the bridge to open.
- 122. Movable Bridge Warning Gate—a type of traffic gate designed to warn, but not primarily to block, vehicle and/or pedestrian traffic when placed in the appropriate position.
- 123. Multi-Lane—more than one lane moving in the same direction. A multi-lane street, highway, or roadway has a basic cross-section comprised of two or more through lanes in one or both directions. A multi-lane approach has two or more lanes moving toward the intersection, including turning lanes.

- 124. Neutral Area—the paved area between the channelizing lines separating an entrance or exit ramp or a channelized turn lane or channelized entering lane from the adjacent through lane(s).
- 125. Object Marker-a device used to mark obstructions within or adjacent to the roadway.
- 126. Occupancy Requirement—any restriction that regulates the use of a facility or one or more lanes of a facility for any period of the day based on a specified number of persons in a vehicle.
- 127. Occupant—a person driving or riding in a car, truck, bus, or other vehicle.
- 128. Open-Road ETC Lane—a non-attended lane that is designed to allow toll payments to be electronically collected from vehicles traveling at normal highway speeds. Open-Road ETC lanes are typically physically separated from the toll plaza, often following the alignment of the mainline lanes, with toll plaza lanes for cash toll payments being on a different alignment after diverging from the mainline lanes or a subset thereof.
- 129. Open-Road Tolling—a system designed to allow electronic toll collection (ETC) from vehicles traveling at normal highway speeds. Open-Road Tolling might be used on toll roads or toll facilities in conjunction with toll plazas. Open-Road Tolling is also typically used on managed lanes and on toll facilities that only accept payment by ETC.
- 130. Open-Road Tolling Point—the location along an Open-Road ETC lane at which roadside or overhead detection and receiving equipment are placed and vehicles are electronically assessed a toll.
- 131. Opposing Traffic—vehicles that are traveling in the opposite direction. At an intersection, vehicles entering from an approach that is approximately straight ahead would be considered to be opposing traffic, but vehicles entering from approaches on the left or right would not be considered to be opposing traffic.
- 132. Overhead Sign—a sign that is placed such that a portion or the entirety of the sign or its support is directly above the roadway or shoulder such that vehicles travel below it. Typical installations include signs placed on cantilever arms that extend over the roadway or shoulder, on sign support structures that span the entire width of the pavement, on mast arms or span wires that also support traffic control signals, and on highway bridges that cross over the roadway.
- 133. Parking Area—a parking lot or parking garage that is separated from a roadway. Parallel or angle parking spaces along a roadway are not considered a parking area.
- 134. Passive Grade Crossing—a grade crossing where none of the automatic traffic control devices associated with an Active Grade Crossing Warning System are present and at which the traffic control devices consist entirely of signs and/or markings.
- 135. Pathway—a general term denoting a public way for purposes of travel by authorized users outside the traveled way and physically separated from the roadway by an open space or barrier and either within the highway right-of-way or within an independent alignment. Pathways include shared-use paths, but do not include sidewalks.
- 136. Pathway Grade Crossing—the general area where a pathway and railroad or light rail transit tracks cross at the same level, within which are included the tracks, pathway, and traffic control devices for pathway traffic traversing that area.
- 137. Paved—a bituminous surface treatment, mixed bituminous concrete, or Portland cement concrete roadway surface that has both a structural (weight bearing) and a sealing purpose for the roadway.
- 138. Pedestrian-a person on foot, in a wheelchair, on skates, or on a skateboard.
- 139. Pedestrian Change Interval—an interval during which the flashing UPRAISED HAND (symbolizing DONT WALK) signal indication is displayed.
- 140. Pedestrian Clearance Time—the time provided for a pedestrian crossing in a crosswalk, after leaving the curb or shoulder, to travel to the far side of the traveled way or to a median.
- 141. Pedestrian Facilities—a general term denoting improvements and provisions made to accommodate or encourage walking.
- 142. Pedestrian Hybrid Beacon— a special type of hybrid beacon used to warn and control traffic at an unsignalized location to assist pedestrians in crossing a street or highway at a marked crosswalk.
- 143. Pedestrian Signal Head—a signal head, which contains the symbols WALKING PERSON (symbolizing WALK) and UPRAISED HAND (symbolizing DONT WALK), that is installed to direct pedestrian traffic at a traffic control signal.
- 144. Permissive Mode—a mode of traffic control signal operation in which left or right turns are permitted to be made after yielding to pedestrians, if any, and/or opposing traffic, if any. When a CIRCULAR GREEN signal indication is displayed, both left and right turns are permitted unless otherwise prohibited by another traffic control device. When a flashing YELLOW ARROW or flashing RED ARROW signal indication is displayed, the turn indicated by the arrow is permitted.

- 145. Physical Gore—a longitudinal point where a physical barrier or the lack of a paved surface inhibits road users from crossing from a ramp or channelized turn lane or channelized entering lane to the adjacent through lane(s) or vice versa.
- 146. Pictograph—a pictorial representation used to identify a governmental jurisdiction, an area of jurisdiction, a governmental agency, a military base or branch of service, a governmental-approved university or college, a toll payment system, or a government-approved institution.
- 147. Plaque—a traffic control device intended to communicate specific information to road users through a word, symbol, or arrow legend that is placed immediately adjacent to a sign to supplement the message on the sign. The difference between a plaque and a sign is that a plaque cannot be used alone. The designation for a plaque includes a "P" suffix.
- 148. Platoon—a group of vehicles or pedestrians traveling together as a group, either voluntarily or involuntarily, because of traffic signal controls, geometrics, or other factors.
- 149. Portable Traffic Control Signal—a temporary traffic control signal that is designed so that it can be easily transported and reused at different locations.
- 150. Post-Mounted Sign—a sign that is placed to the side of the roadway such that no portion of the sign or its support is directly above the roadway or shoulder.
- 151. Posted Speed Limit—a speed limit determined by law or regulation and displayed on Speed Limit signs.
- **152.** Preemption—the transfer of normal operation of a traffic control signal to a special control mode of operation.
- **153.** Preferential Lane—a highway lane reserved for the exclusive use of one or more specific types of vehicles or vehicles with at least a specific number of occupants.
- 154. Pre-Signal—traffic control signal faces that control traffic approaching a grade crossing in conjunction with the traffic control signal faces that control traffic approaching a highway-highway intersection beyond the tracks. Supplemental near-side traffic control signal faces for the highway-highway intersection are not considered pre-signals. Pre-signals are typically used where the clear storage distance is insufficient to store one or more design vehicles.
- **155.** Pretimed Operation—a type of traffic control signal operation in which none of the signal phases function on the basis of actuation.
- 156. Primary Signal Face—one of the required or recommended minimum number of signal faces for a given approach or separate turning movement, but not including near-side signal faces required as a result of the far-side signal faces exceeding the maximum distance from the stop line.
- 157. Principal Legend—place names, street names, and route numbers placed on guide signs.
- 158. Priority Control-a means by which the assignment of right-of-way is obtained or modified.
- 159. Private Road Open to Public Travel—private toll roads and roads (including any adjacent sidewalks that generally run parallel to the road) within shopping centers, airports, sports arenas, and other similar business and/or recreation facilities that are privately owned, but where the public is allowed to travel without access restrictions. Roads within private gated properties (except for gated toll roads) where access is restricted at all times, parking areas, driving aisles within parking areas, and private grade crossings shall not be included in this definition.
- 160. Protected Mode—a mode of traffic control signal operation in which left or right turns are permitted to be made when a left or right GREEN ARROW signal indication is displayed.
- 161. Public Road—any road, street, or similar facility under the jurisdiction of and maintained by a public agency and open to public travel.
- 162. Pushbutton—a button to activate a device or signal timing for pedestrians, bicyclists, or other road users.
- 163. Pushbutton Information Message—a recorded message that can be actuated by pressing a pushbutton when the walk interval is not timing and that provides the name of the street that the crosswalk associated with that particular pushbutton crosses and can also provide other information about the intersection signalization or geometry.
- 164. Pushbutton Locator Tone—a repeating sound that informs approaching pedestrians that a pushbutton exists to actuate pedestrian timing or receive additional information and that enables pedestrians who have visual disabilities to locate the pushbutton.
- 165. Queue Clearance Time—when used in Part 8, the time required for the design vehicle of maximum length stopped just inside the minimum track clearance distance to start up and move through and clear the entire minimum track clearance distance. If pre-signals are present, this time shall be long enough to allow the vehicle to move through the intersection, or to clear the tracks if there is sufficient clear storage distance. If a Four-Quadrant Gate system is present, this time shall be long enough to permit the exit gate arm to lower after the design vehicle is clear of the minimum track clearance distance.

- 166. Quiet Zone—a segment of a rail line, with one or a number of consecutive public highway-rail grade crossings at which locomotive horns are not routinely sounded per 49 CFR Part 222.
- 167. Rail Traffic—every device in, upon, or by which any person or property can be transported on rails or tracks and to which all other traffic must yield the right-of-way by law at grade crossings, including trains, one or more locomotives coupled (with or without cars), other railroad equipment, and light rail transit operating in exclusive or semi-exclusive alignments. Light rail transit operating in a mixed-use alignment, to which other traffic is not required to yield the right-of-way by law, is a vehicle and is not considered to be rail traffic.
- 168. Raised Pavement Marker—a device mounted on or in a road surface that has a height generally not exceeding approximately 1 inch above the road surface for a permanent marker, or not exceeding approximately 2 inches above the road surface for a temporary flexible marker, and that is intended to be used as a positioning guide and/or to supplement or substitute for pavement markings.
- **169.** Ramp Control Signal—a highway traffic signal installed to control the flow of traffic onto a freeway at an entrance ramp or at a freeway-to-freeway ramp connection.
- 170. Ramp Meter—see Ramp Control Signal.
- 171. Red Clearance Interval—an interval that follows a yellow change interval and precedes the next conflicting green interval.
- 172. Regulatory Sign-a sign that gives notice to road users of traffic laws or regulations.
- 173. Retroreflectivity—a property of a surface that allows a large portion of the light coming from a point source to be returned directly back to a point near its origin.
- 174. Right-of-Way [Assignment]—the permitting of vehicles and/or pedestrians to proceed in a lawful manner in preference to other vehicles or pedestrians by the display of a sign or signal indications.
- 175. Right-of-Way Transfer Time—when used in Part 8, the maximum amount of time needed for the worst case condition, prior to display of the track clearance green interval. This includes any railroad or light rail transit or highway traffic signal control equipment time to react to a preemption call, and any traffic control signal green, pedestrian walk and clearance, yellow change, and red clearance intervals for conflicting traffic.
- 176. Road—see Roadway.
- 177. Road User—a vehicle operator, bicyclist, or pedestrian, including persons with disabilities, within the highway or on a private road open to public travel.
- 178. Roadway—that portion of a highway improved, designed, or ordinarily used for vehicular travel and parking lanes, but exclusive of the sidewalk, berm, or shoulder even though such sidewalk, berm, or shoulder is used by persons riding bicycles or other human-powered vehicles. In the event a highway includes two or more separate roadways, the term roadway as used in this Manual shall refer to any such roadway separately, but not to all such roadways collectively.
- 179. Roadway Network-a geographical arrangement of intersecting roadways.
- 180. Roundabout—a circular intersection with yield control at entry, which permits a vehicle on the circulatory roadway to proceed, and with deflection of the approaching vehicle counter-clockwise around a central island.
- 181. Rumble Strip—a series of intermittent, narrow, transverse areas of rough-textured, slightly raised, or depressed road surface that extend across the travel lane to alert road users to unusual traffic conditions or are located along the shoulder, along the roadway center line, or within islands formed by pavement markings to alert road users that they are leaving the travel lanes.
- 182. Rural Highway—a type of roadway normally characterized by lower volumes, higher speeds, fewer turning conflicts, and less conflict with pedestrians.
- 183. Safe-Positioned—the positioning of emergency vehicles at an incident in a manner that attempts to protect both the responders performing their duties and road users traveling through the incident scene, while minimizing, to the extent practical, disruption of the adjacent traffic flow.
- 184. School—a public or private educational institution recognized by the State education authority for one or more grades K through 12 or as otherwise defined by the State.
- 185. School Zone—a designated roadway segment approaching, adjacent to, and beyond school buildings or grounds, or along which school related activities occur.
- 186. Semi-Actuated Operation—a type of traffic control signal operation in which at least one, but not all, signal phases function on the basis of actuation.
- 187. Separate Turn Signal Face—a signal face that exclusively controls a turn movement and that displays signal indications that are applicable only to the turn movement.
- 188. Separation Time—the component of maximum highway traffic signal preemption time during which the minimum track clearance distance is clear of vehicular traffic prior to the arrival of rail traffic.

- 189. Shared Roadway—a roadway that is officially designated and marked as a bicycle route, but which is open to motor vehicle travel and upon which no bicycle lane is designated.
- 190. Shared Turn Signal Face—a signal face, for controlling both a turn movement and the adjacent through movement, that always displays the same color of circular signal indication that the adjacent through signal face or faces display.
- 191. Shared-Use Path—a bikeway outside the traveled way and physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right-of-way or within an independent alignment. Shared-use paths are also used by pedestrians (including skaters, users of manual and motorized wheelchairs, and joggers) and other authorized motorized and non-motorized users.
- **192.** Sidewalk—that portion of a street between the curb line, or the lateral line of a roadway, and the adjacent property line or on easements of private property that is paved or improved and intended for use by pedestrians.
- 193. Sign—any traffic control device that is intended to communicate specific information to road users through a word, symbol, and/or arrow legend. Signs do not include highway traffic signals, pavement markings, delineators, or channelization devices.
- 194. Sign Assembly—a group of signs, located on the same support(s), that supplement one another in conveying information to road users.
- 195. Sign Illumination—either internal or external lighting that shows similar color by day or night. Street or highway lighting shall not be considered as meeting this definition.
- 196. Sign Legend—all word messages, logos, pictographs, and symbol and arrow designs that are intended to convey specific meanings. The border, if any, on a sign is not considered to be a part of the legend.
- **197.** Sign Panel—a separate panel or piece of material containing a word, symbol, and/or arrow legend that is affixed to the face of a sign.
- **198.** Signal Backplate—a thin strip of material that extends outward from and parallel to a signal face on all sides of a signal housing to provide a background for improved visibility of the signal indications.
- **199.** Signal Coordination—the establishment of timed relationships between adjacent traffic control signals.
- 200. Signal Face—an assembly of one or more signal sections that is provided for controlling one or more traffic movements on a single approach.
- 201. Signal Head—an assembly of one or more signal faces that is provided for controlling traffic movements on one or more approaches.
- 202. Signal Housing—that part of a signal section that protects the light source and other required components.
- 203. Signal Indication-the illumination of a signal lens or equivalent device.
- 204. Signal Lens—that part of the signal section that redirects the light coming directly from the light source and its reflector, if any.
- 205. Signal Louver—a device that can be mounted inside a signal visor to restrict visibility of a signal indication from the side or to limit the visibility of the signal indication to a certain lane or lanes, or to a certain distance from the stop line.
- 206. Signal Phase—the right-of-way, yellow change, and red clearance intervals in a cycle that are assigned to an independent traffic movement or combination of movements.
- 207. Signal Section—the assembly of a signal housing, signal lens, if any, and light source with necessary components to be used for displaying one signal indication.
- 208. Signal System-two or more traffic control signals operating in signal coordination.
- 209. Signal Timing—the amount of time allocated for the display of a signal indication.
- 210. Signal Visor—that part of a signal section that directs the signal indication specifically to approaching traffic and reduces the effect of direct external light entering the signal lens.
- 211. Signing—individual signs or a group of signs, not necessarily on the same support(s), that supplement one another in conveying information to road users.
- 212. Simultaneous Preemption—notification of approaching rail traffic is forwarded to the highway traffic signal controller unit or assembly and railroad or light rail transit active warning devices at the same time.
- 213. Special Purpose Road—a low-volume, low-speed road that serves recreational areas or resource development activities.



- 214. Speed—speed is defined based on the following classifications:
 - (a) Average Speed—the summation of the instantaneous or spot-measured speeds at a specific location of vehicles divided by the number of vehicles observed.
 - (b) Design Speed—a selected speed used to determine the various geometric design features of a roadway.
 - (c) 85th-Percentile Speed—the speed at or below which 85 percent of the motor vehicles travel.
 - (d) Operating Speed—a speed at which a typical vehicle or the overall traffic operates. Operating speed might be defined with speed values such as the average, pace, or 85th-percentile speeds.
 - (e) Pace—the 10 mph speed range representing the speeds of the largest percentage of vehicles in the traffic stream.
- **215.** Speed Limit—the maximum (or minimum) speed applicable to a section of highway as established by law or regulation.
- 216. Speed Limit Sign Beacon—a beacon used to supplement a SPEED LIMIT sign.
- 217. Speed Measurement Markings—a white transverse pavement marking placed on the roadway to assist the enforcement of speed regulations.
- 218. Speed Zone—a section of highway with a speed limit that is established by law or regulation, but which might be different from a legislatively specified statutory speed limit.
- 219. Splitter Island—a median island used to separate opposing directions of traffic entering and exiting a roundabout.
- 220. Station Crossing—a pathway grade crossing that is associated with a station platform.
- 221. Statutory Speed Limit—a speed limit established by legislative action that typically is applicable for a particular class of highways with specified design, functional, jurisdictional and/or location characteristics and that is not necessarily displayed on Speed Limit signs.
- 222. Steady (Steady Mode)—the continuous display of a signal indication for the duration of an interval, signal phase, or consecutive signal phases.
- 223. Stop Beacon—a beacon used to supplement a STOP sign, a DO NOT ENTER sign, or a WRONG WAY sign.
- 224. Stop Line—a solid white pavement marking line extending across approach lanes to indicate the point at which a stop is intended or required to be made.
- 225. Street—see Highway.
- 226. Supplemental Signal Face—a signal face that is not a primary signal face but which is provided for a given approach or separate turning movement to enhance visibility or conspicuity.
- 227. Symbol—the approved design of a pictorial representation of a specific traffic control message for signs, pavement markings, traffic control signals, or other traffic control devices, as shown in the MUTCD.
- 228. Temporary Traffic Control Signal—a traffic control signal that is installed for a limited time period.
- 229. Temporary Traffic Control Zone—an area of a highway where road user conditions are changed because of a work zone or incident by the use of temporary traffic control devices, flaggers, uniformed law enforcement officers, or other authorized personnel.
- 230. Theoretical Gore—a longitudinal point at the upstream end of a neutral area at an exit ramp or channelized turn lane where the channelizing lines that separate the ramp or channelized turn lane from the adjacent through lane(s) begin to diverge, or a longitudinal point at the downstream end of a neutral area at an entrance ramp or channelized entering lane where the channelizing lines that separate the ramp or channelized entering lane from the adjacent through lane(s) intersect each other.
- 231. Timed Exit Gate Operating Mode—a mode of operation where the exit gate descent at a grade crossing is based on a predetermined time interval.
- 232. Toll Booth—a shelter where a toll attendant is stationed to collect tolls or issue toll tickets. A toll booth is located adjacent to a toll lane and is typically set on a toll island.
- 233. Toll Island—a raised island on which a toll booth or other toll collection and related equipment are located.
- 234. Toll Lane—an individual lane located within a toll plaza in which a toll payment is collected or, for toll-ticket systems, a toll ticket is issued.
- 235. Toll Plaza—the location at which tolls are collected consisting of a grouping of toll booths, toll islands, toll lanes, and, typically, a canopy. Toll plazas might be located on highway mainlines or on interchange ramps. A mainline toll plaza is sometimes referred to as a barrier toll plaza because it interrupts the traffic flow.

- 236. Toll-Ticket System—a system in which the user of a toll road receives a ticket from a machine or toll booth attendant upon entering a toll system. The ticket denotes the user's point of entry and, upon exiting the toll system, the user surrenders the ticket and is charged a toll based on the distance traveled between the points of entry and exit.
- 237. Traffic—pedestrians, bicyclists, ridden or herded animals, vehicles, streetcars, and other conveyances either singularly or together while using for purposes of travel any highway or private road open to public travel.
- 238. Traffic Control Device—a sign, signal, marking, or other device used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, private road open to public travel, pedestrian facility, or shared-use path by authority of a public agency or official having jurisdiction, or, in the case of a private road open to public travel, by authority of the private owner or private official having jurisdiction.
- 239. Traffic Control Signal (Traffic Signal)—any highway traffic signal by which traffic is alternately directed to stop and permitted to proceed.
- 240. Train—one or more locomotives coupled, with or without cars, that operates on rails or tracks and to which all other traffic must yield the right-of-way by law at highway-rail grade crossings.
- 241. Transverse Markings—pavement markings that are generally placed perpendicular and across the flow of traffic such as shoulder markings; word, symbol, and arrow markings; stop lines; crosswalk lines; speed measurement markings; parking space markings; and others.
- 242. Traveled Way—the portion of the roadway for the movement of vehicles, exclusive of the shoulders, berms, sidewalks, and parking lanes.
- 243. Turn Bay—a lane for the exclusive use of turning vehicles that is formed on the approach to the location where the turn is to be made. In most cases where turn bays are provided, drivers who desire to turn must move out of a through lane into the newly formed turn bay in order to turn. A through lane that becomes a turn lane is considered to be a dropped lane rather than a turn bay.
- 244. Upstream—a term that refers to a location that is encountered by traffic prior to a downstream location as it flows in an "upstream to downstream" direction. For example, "the upstream end of a lane line separating the turn lane from a through lane on the approach to an intersection" is the end of the line that is furthest from the intersection.
- 245. Urban Street—a type of street normally characterized by relatively low speeds, wide ranges of traffic volumes, narrower lanes, frequent intersections and driveways, significant pedestrian traffic, and more businesses and houses.
- 246. Vehicle—every device in, upon, or by which any person or property can be transported or drawn upon a highway, except trains and light rail transit operating in exclusive or semi-exclusive alignments. Light rail transit equipment operating in a mixed-use alignment, to which other traffic is not required to yield the right-of-way by law, is a vehicle.
- 247. Vibrotactile Pedestrian Device—an accessible pedestrian signal feature that communicates, by touch, information about pedestrian timing using a vibrating surface.
- 248. Visibility-Limited Signal Face or Visibility-Limited Signal Section—a type of signal face or signal section designed (or shielded, hooded, or louvered) to restrict the visibility of a signal indication from the side, to a certain lane or lanes, or to a certain distance from the stop line.
- 249. Walk Interval—an interval during which the WALKING PERSON (symbolizing WALK) signal indication is displayed.
- 250. Warning Beacon—a beacon used only to supplement an appropriate warning or regulatory sign or marker.
- 251. Warning Light—a portable, powered, yellow, lens-directed, enclosed light that is used in a temporary traffic control zone in either a steady burn or a flashing mode.
- 252. Warning Sign—a sign that gives notice to road users of a situation that might not be readily apparent.
- 253. Warrant—a warrant describes a threshold condition based upon average or normal conditions that, if found to be satisfied as part of an engineering study, shall result in analysis of other traffic conditions or factors to determine whether a traffic control device or other improvement is justified. Warrants are not a substitute for engineering judgment. The fact that a warrant for a particular traffic control device is met is not conclusive justification for the installation of the device.
- 254. Wayside Equipment—the signals, switches, and/or control devices for railroad or light rail transit operations housed within one or more enclosures located along the railroad or light rail transit right-of-way and/or on railroad or light rail transit property.
- 255. Wayside Horn System—a stationary horn (or series of horns) located at a grade crossing that is used in conjunction with train-activated or light rail transit-activated warning systems to provide audible warning of approaching rail traffic to road users on the highway or pathway approaches to a grade crossing, either as a supplement or alternative to the sounding of a locomotive horn.

- 256. Worker—a person on foot whose duties place him or her within the right-of-way of a street, highway, or pathway, such as street, highway, or pathway construction and maintenance forces, survey crews, utility crews, responders to incidents within the street, highway, or pathway right-of-way, and law enforcement personnel when directing traffic, investigating crashes, and handling lane closures, obstructed roadways, and disasters within the right-of-way of a street, highway, or pathway.
- 257. Wrong-Way Arrow—a slender, elongated, white pavement marking arrow placed upstream from the ramp terminus to indicate the correct direction of traffic flow. Wrong-way arrows are intended primarily to warn wrong-way road users that they are going in the wrong direction.
- 258. Yellow Change Interval—the first interval following the green or flashing arrow interval during which the steady yellow signal indication is displayed.
- **259.** Yield Line—a row of solid white isosceles triangles pointing toward approaching vehicles extending across approach lanes to indicate the point at which the yield is intended or required to be made.

Section 1A.14 Meanings of Acronyms and Abbreviations in this Manual

Standard:

- 101 The following acronyms and abbreviations, when used in this Manual, shall have the following meanings:
 - 1. AADT—annual average daily traffic
 - 2. AASHTO-American Association of State Highway and Transportation Officials
 - 3. ADA—Americans with Disabilities Act
 - 4. ADAAG-Americans with Disabilities Accessibility Guidelines
 - 5. ADT-average daily traffic
 - 6. AFAD—Automated Flagger Assistance Device
 - 7. ANSI-American National Standards Institute
 - 8. CFR-Code of Federal Regulations
 - 9. CMS-changeable message sign
 - 10. dBA-A-weighted decibels
 - 11. EPA-Environmental Protection Agency
 - 12. ETC-electronic toll collection
 - **13.** EV—electric vehicle
 - 14. FHWA-Federal Highway Administration
 - 15. FRA-Federal Railroad Administration
 - 16. FTA-Federal Transit Administration
 - 17. HOT-high occupancy tolls
 - 18. HOTM-FHWA's Office of Transportation Management
 - 19. HOTO-FHWA's Office of Transportation Operations
 - 20. HOV-high-occupancy vehicle
 - 21. ILEV-inherently low emission vehicle
 - 22. ISEA—International Safety Equipment Association
 - 23. ITE-Institute of Transportation Engineers
 - 24. ITS—intelligent transportation systems
 - 25. LED—light emitting diode
 - 26. LP-liquid petroleum
 - 27. MPH or mph—miles per hour
 - 28. MUTCD-Manual on Uniform Traffic Control Devices
 - 29. NCHRP-National Cooperative Highway Research Program
 - **30.** ORT—open-road tolling
 - 31. PCMS-portable changeable message sign
 - 32. PRT-perception-response time
 - 33. RPM-raised pavement marker
 - 34. RRPM-raised retroreflective pavement marker
 - 35. RV-recreational vehicle
 - 36. TDD-telecommunication devices for the deaf
 - 37. TRB—Transportation Research Board
 - **38.** TTC—temporary traffic control
 - **39.** U.S.—United States
 - 40. U.S.C.—United States Code
 - 41. USDOT—United States Department of Transportation
 - 42. UVC—Uniform Vehicle Code
 - 43. VPH or vph-vehicles per hour

* https://apps.itd.idaho.gov/apps/manuals/Sign_Supplement.pdf

* https://apps.itd.idaho.gov/Apps/manuals/SpecBook/

SpecBook18.pdf

* https://apps.itd.idaho.gov/Apps/manuals/

SpecBook/2019_Supplementals.pdf

* https://mutcd.fhwa.dot.gov/pdfs/2009/mutcd2009edition.pdf

* https://safety.fhwa.dot.gov/roadway_dept/night_visib/sign_visib/ sheetguide/

* https://apps.itd.idaho.gov/apps/manuals/Traffic_Manual.pdf

* http://multimedia.3m.com/mws/media/254031O/3m-highintensity-prismatic-reflective-sheeting-series-3930-productbulletin.pdf

* https://cdn.grimco.com/Pdf/Home/Viewer?file=https://grimcoasset.azurewebsites.net/product/3M4000SeriesDG3Sheeting/ datasheet/ProductBulletin4000.pdf

* https://multimedia.3m.com/mws/media/1180988O/3m-mcswarranty-for-traffic-product-bulletin.pdf