



Transportation Safety Division

3M™ High Intensity Prismatic Reflective Sheeting Series 3930

Product Bulletin Series 3930

June 2021

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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 and delineators that are exposed vertically in service (“Signs”). Applied to properly prepared Sign substrates, the Sheeting provides long-term reflectivity and durability.

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.

Table 2. Daytime color specification limits.^a

Color	1		2		3		4		Reflectance Limit (Y%)	
	x	y	x	y	x	y	x	y	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

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

2.1.1 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.

2.2 Coefficient of Retroreflection (R_A)

The values shown in Table 3 are minimum coefficients of retroreflection.

Table 3. Minimum coefficient of retroreflection, R_A, for new Sheeting (cd/lux/m²).

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

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.

2.2.1 Test for Coefficient of Retroreflection

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.

2.3 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

The manufacture of prismatic Sheeting results in the presence of fabrication lines in the final product, as shown in Figure 1. The Sheeting's fabrication lines are slightly thicker than its seal pattern legs and noticeable under shop light but not observable on the road, either in daylight or at night, under typical use conditions.

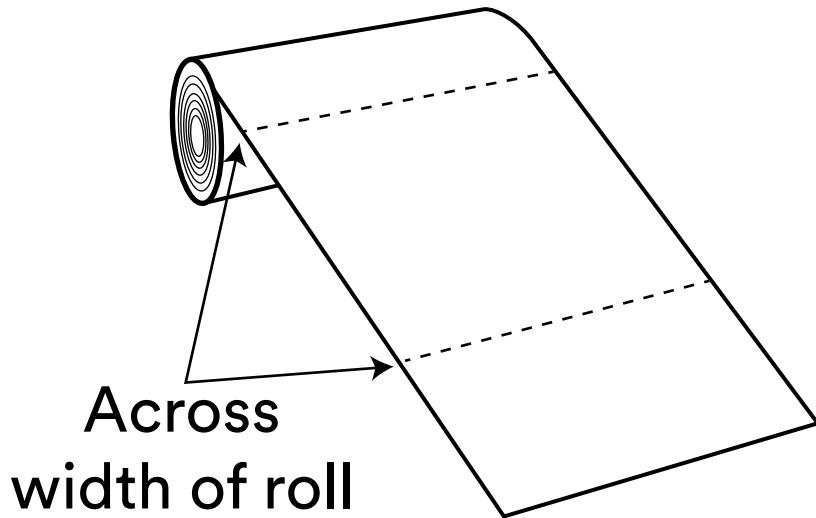


Figure 1. Fabrication lines.

3.2 Adhesive

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

3.3 Entrance Angularity Performance and Orientation

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 ($>50^\circ$) performance is required for a given Sign (e.g. “keep right” symbols), it can be obtained easily by properly orientating the Sheeting on the Sign substrate. 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 on the completed Sign, the 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.

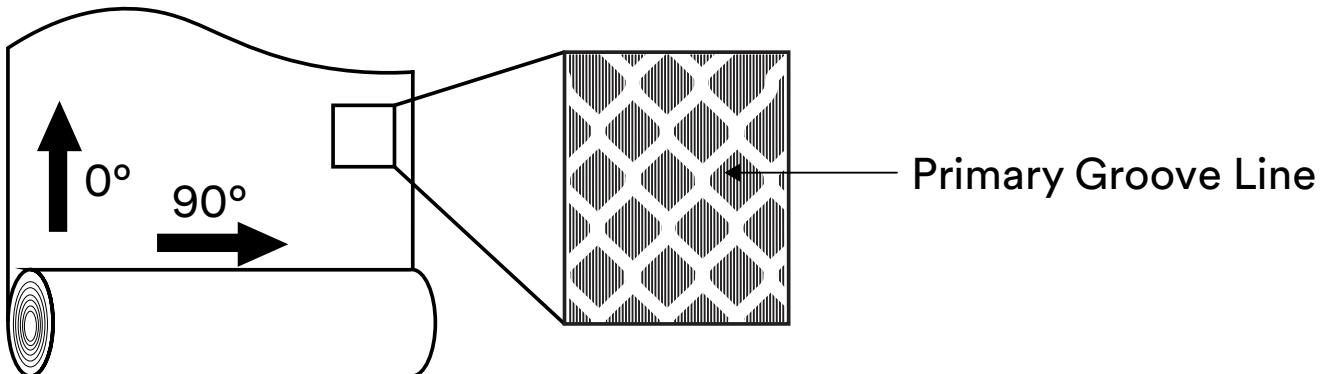


Figure 2. Primary groove lines used to define Sheeting orientation.

Unless a Sign’s 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 applied with the Sheeting oriented in the same direction.

4 Sign Fabrication Methods

4.1 Squeeze Roll Application

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

Mechanical squeeze roll applicator – refer to [3M Information Folder 1.4](#). Applications to extrusions that are edge wrapped require sufficient softening of the Sheeting prior to edge wrapping. Softening 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 [3M Information Folder 1.6](#) for details.

Background and complete Sign applications of Sheeting must be performed using a roll laminator, either mechanical or hand driven.

4.2 Hand Application

Hand application is recommended for legend and copy only. Refer to [3M Information Folder 1.5](#) for more details.

Hand applications are more likely to show visual irregularities that 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

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. Avoiding overlap prevents 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 using an unprotected steel bottom roller. The use of a semi-soft flat sheet between the steel roller and the applied Sign face will protect the Sign face from damage. Use of a rubber mat, tag board, or cardboard is recommended.

5 Substrates

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 the adhesion and Sign durability properties of all other substrates.** Other substrates suitable for secure and durable applications of Sheeting have the following characteristics:

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

Refer to [3M Information Folder 1.7](#) 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.

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

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

Sheeting 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 MCSTM Warranty and 3M MCS Warranty for Traffic when the printing guidelines in [3M Information Folder 1.18](#) are followed and 3M ElectroCut™ Film 1170C Clear is applied over the finished graphics. See Section 13 of this document for more information regarding the MCS Warranties.

6.2 Screen Processing

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 [3M Information Folder 1.8](#) 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 Sheeting to provide transparent colored background copy for traffic control Signs. Refer to [3M Product Bulletin 1170](#) for fabrication procedures.

6.4 Applied Cut-Out Copy

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 [3M Information Folder 1.10](#) for more information.

7 Cutting

Sheeting may be cut into letters and shapes with heights of at least 3 inches and stroke widths of at least $\frac{1}{2}$ inch. Smaller sizes are not recommended. Sealing the cut edges of 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 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, 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

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 Sheeting is $1\frac{1}{2}$ inches, or 50 sheets. Cutting procedure details can be found in [3M Information Folder 1.10](#).

8 Installation

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

9 Shelf-Life, Storage, and Packaging

Sheeting should be stored in a cool, dry area, preferably at a temperature of 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 3M™ Slipsheeting (“**Slipsheeting**”). Place the glossy side of the Slipsheeting against the Sign face. 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 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 [3M Information Folder 1.11](#) 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 durability of the Sheeting and finished Signs made using 3M MCSTM materials will depend upon substrate selection and preparation, compliance with recommended application procedures, geographic area, exposure conditions, and maintenance practices. Maximum Sheeting durability 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 [3M Information Folder 1.7](#). 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 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

Sheeting 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 (“**Basic Warranty**”). If 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 3M MCS™ Warranty and MCS Warranty for Traffic

For warranty on digitally printed Sheeting, please refer to the [3M Digitally-Imaged Sign Warranty Bulletin](#).

13.3 Additional Warranty

3M additionally warrants 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 (“**Additional Warranty**”).

Table 4. Matched component materials.

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

13.3.1 Additional Warranty and Limited Remedy for Sheeting Colors Other than Orange

The Additional Warranty for a Sign made with any Sheeting that is not orange warrants that the Sign will: (a) remain effective for its intended use when viewed by a driver with normal vision from a moving vehicle under normal day and night driving conditions 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.

Limited Remedy Period	Minimum Percentage R_A Retained	Limited Remedy
1–7 Years	80%	Sign Restoration
8–10 Years	70%	Materials Replacement

If any Sign made with the Sheeting 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:

Sign Restoration

During the Sign Restoration period, as provided in Table 5, 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 matched component materials and (ii) the aluminum sign substrate (as needed), restoring the Sign's surface to its **original effectiveness**. 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 5, 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 and matched component materials, or provide the necessary Sheeting and matched component materials, in the quantities required to restore the Sign's surface to its **original effectiveness**. However, 3M will not provide the substrate or any labor to refabricate or reinstall the Sign.

13.3.2 Additional Warranty & Limited Remedy for 3934 Orange Sheeting

The Additional Warranty for a Sign made with 3934, orange Sheeting ("Orange Sheeting") warrants that the Sign will: (a) remain effective for its intended use when viewed by a driver with normal vision from a moving vehicle under normal day and night driving conditions; (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 Sheeting will maintain daytime luminance equal to or greater than the minimum value specified in Table 2.

Table 6. Minimum coefficient of retroreflection for Orange Sheeting ($cd/lux/m^2$) (0.2° observation angle and -4° entrance angle).

Warranty Period	Minimum R_A
3 Years	80

If any Sign made with the Orange Sheeting 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, listed in Section 15, for detailed information about application procedures and equipment.

13.4 3M Warranty Terms and Conditions

- o The Basic Warranty, MCS Warranty, MCS Warranty for Traffic, and any applicable Additional Warranty are collectively referred to as the “**3M Warranty**.”
- o 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 documentation listed in Section 15.
- o 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) use of any material or product not recommended by 3M in this product bulletin, the 3M documentation listed in Section 15, or 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.
- o Claims made under this the 3M Warranty will be honored only if (a) the Sign was dated with the Fabrication Date, which constitutes the start of the Warranty Period, 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.
- o 3M reserves the right to determine method of replacement.
- o Any replacement Sheeting or Sign restoration will carry the unexpired warranty of the Sheeting it replaces.
- o 3M is not responsible for any additional warranties that the Sign Manufacturer offers to its customers beyond the 3M Warranty.

13.5 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.

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

15 Literature References

3M IF 1.4	Instructions for Interstate Squeeze Roll Applicator
3M IF 1.5	Hand Application Instructions
3M IF 1.6	Hand Squeeze Roll Applicator
3M IF 1.7	Sign Base Surface Preparation
3M IF 1.8	Process Colors Series 880 and 900 Instructions for Use
3M IF 1.10	Cutting, Premasking, and Prespacing
3M IF 1.11	Sign Maintenance Management
3M IF 1.17	User Guide 3M™ Reflective Sheeting and HP Latex 360/365 Printers
3M IF 3.5	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 PB 880I	3M™ Process Color Series 880I
3M PB 880N	3M™ Process Color Series 880N
3M PB 1160	Premium Protective Overlay Film
3M PB 1170	3M™ ElectroCut™ Film Series 1170
3M PB Slipsheeting	3M™ Slipsheeting
3M Digitally-Imaged Sign Warranty Bulletin	
3M MCST™ Warranty Matrix for HP Latex 360/365/370/375 Printers	
3M MCS™ Warranty for Traffic Matrix for HP Latex 360/365/370/375 Printers	

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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