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Traffic Safety and Security Division

3M™ Diamond Grade™ Conspicuity Markings

Series 983

Product Bulletin 983
April 2017

Replaces PB 983 dated June 2016

Description

3M™ Diamond Grade™ Conspicuity Markings Series 983 are highly retroreflective microprismatic markings designed to enhance the visibility of the sides and rear of vehicles. The reflective marking consists of prismatic lenses that are formed in a transparent, synthetic resin, sealed and backed with a pressure sensitive adhesive and clear polymeric liner. Diamond Grade Conspicuity Markings are highly durable providing up to ten years of field performance. 3M's Series 983 markings have excellent angularity which provides enhanced visibility for drivers.

For warranty and product information on specific applications such as trucks and trailers, rail cars, school buses or emergency vehicles, please see the specific product bulletins. This product bulletin applies to applications other than trucks and trailers, rail cars, school buses or emergency vehicles.

- Combined fluorescence and retroreflection provides 24-hour enhanced visibility and detection.
- Fluorescence enhances visibility for improved safety.

Easy to Apply

- Aggressive pressure sensitive adhesive
- Easy to remove liner
- Available in convenient rolls, packaged pieces, or kiss-cut pieces on a roll. Reference the 3M Traffic Safety and Security Division Pricing Catalog for the standard product offering.

Durable

- Pre-sealed edges
- Non-metallic construction

Table 1. Product Codes by Color

Product Code	Color
983-10	White
983-71	Yellow
983-72	Red
983-21	Fluorescent Yellow
983-23	Fluorescent Yellow-Green

Typical Physical Properties

Table 2 provides the typical physical properties of Series 983. The information in Table 2 should be considered typical only and should not be used for specification purposes.

Table 2. Typical Physical Properties

Property	Series 983 Typical Values
Thickness (Caliper)	0.014 inch - 0.018 inch
Whiteness Daytime Luminance Limit Y_T ASTM E1164	45 White 5 Red 27 Yellow 75 Fluorescent Yellow 90 Fluorescent Yellow-Green
Gloss ASTM D523 @ 85°	100
Shrinkage ASTM D4956	No substantial change
Flexibility - wrap around 0.125 inch mandrel @ 32° F (0° C)	No cracking
High pressure wash test 45° angle, 1200 psi, 8 inch away	Passes
Adhesion 90° Hanging Weight ASTM D4956	0.2 inch (4 mm)
Minimum Application Temp.	50° F (10° C)
Instron Peel Adhesion 12 inch/minute, 90° pullback	Degreased aluminum 5.3 lb/in (.95 kg/cm) Prepainted panel 3.0 lb/in (0.55 kg/cm) Stainless steel 6.0 lb/in (1.1 kg/cm) FRP 2.5 lb/in (0.52 kg/cm) Tedlar® 3.0 lb/in (0.54 kg/cm) Aluminum Rail 3.5 lb/in (0.56 kg/cm)
Chemical Resistance SAE J1967	Not affected by toluene, #2 diesel fuel, gasoline (leaded) kerosene, TSP detergent, xylene, dilute metal brighteners
Corrosion Resistance ASTM B-117 Salt Spray	No effect - 1000 Hours
Impact Resistance Room Temperature 100 in-lb, 5/8 inch tip	No damage outside impact
Cold Temperature 60 in-lb at -20° F	No damage outside impact

Coefficient of Retroreflection

The values in Table 3 are typical coefficients of retroreflection expressed in candelas per lux per square meter (cd/lux/m²). Conformance to coefficient of retroreflection requirements shall be determined by instrumental method in accordance with ASTM E810 “Test Method of Coefficient of Retroreflection of Retroreflective Sheeting”, and per ASTM E810 the values of 0° and 90° rotation are averaged to determine the R_A in Table 3.

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

Observation Angle ¹	Entrance Angle ²	983 Typical White	983 Typical Red	983 Typical Yellow	983 Typical (Fl. Yellow)	983 Typical (Fl. Yellow-Green)
0.2 °	-4°	800	160	645	400	700
	30°	430	110	420	220	430
	45°	175	45	235	120	160
0.5 °	-4°	460	95	360	150	385
	30°	215	40	180	75	180
	45°	55	15	65	40	30

Typical Physical Characteristics

Table 4 provides the typical physical characteristics of Series 983. The information in Table 4 should be considered typical only and should not be used for specification purposes.

Table 4. Typical Physical Characteristics of Series 983

Property	Description
Adhesive color and type	Clear, pressure sensitive
Liner	Translucent polymeric
Application surfaces	Metal or painted metal flat without rivets
Heat resistance	Maintains 70% of original coefficient of retroreflection at ($\alpha=0.2, \beta=-4$) after 24 hr. exposure to 170° F (77° C) air
Recommended minimum application temperature (ambient and substrate)	50° F (10° C)
Performance range	-30° F to 200° F (-34° C to +94° C)

Photometrics

Fluorescence

Fluorescent materials absorb short wavelength, invisible, incident radiation (solar energy) and re-emit the radiation as longer wavelength, visible light. This re-emitted energy continues as long as incident radiation is present. These materials are especially effective during dawn, dusk, and overcast days. Fluorescence adds to daytime luminance (apparent brightness) of markings and enhances the visibility of rail cars and other vehicles.

¹ Observation Angle – The angle between the illumination axis and the observation axis.

² Entrance Angle – The angle from the illumination axis to the retroreflector axis. The retroreflector axis is an axis perpendicular to the retroreflective surface.

Color Test – Fluorescent Sheetings

Conformance to standard chromaticity (x, y) and luminance factor (Y) requirements shall be determined by instrumental method in accordance with ASTM E991 on sheeting applied to smooth aluminum test panels cut from Alloy 6061-T6 or 5052-H38. The values shall be determined on a HunterLab ColorFlex 45/0 spectrophotometer. Computations shall be done for CIE Illuminant D65 and the 2° standard observer.

Fluorescence Luminance Factor (Y_F) differentiates fluorescent markings from ordinary (nonfluorescent) markings. The additional daytime luminance provided by fluorescence is directly related to the increased conspicuity of fluorescent vehicle markings under varying conditions of daylight illumination encountered in outdoor safety marking applications. The fluorescence luminance factor, Y_F , provides a standardized measure of the marking's fluorescence.

The numerical value of Y_F under specified illumination and viewing conditions: 1) verifies the fluorescence of the marking (for nonfluorescent markings $Y_F=0$) and 2) quantifies the fluorescent efficiency of the marking. The magnitude of Y_F can be used to assess whether the fluorescence of the marking is sufficient to provide high daytime visibility performance under poor visibility conditions. Typical fluorescence luminance factor (Y_F) values of 983-21 fluorescent yellow and 983-23 fluorescent yellow-green are given in Table 5.

Table 5. Typical Luminance Factor Values for 3M™ Diamond Grade™ 983-21 Fluorescent Yellow and 983-23 Fluorescent Yellow-Green Conspicuity Markings³

Color	Total Luminance Factor (Y_T)	Luminance Factor (Y_F)	Luminance Factor (Y_R)
Fluorescent Yellow	75	55	20
Fluorescent Yellow-Green	90	55	35

Maintenance

Cleaning

Routine washing is recommended for maximum performance. The following cleaning methods are recommended.

- Wash with sponge, cloth or soft brush using water and detergent.
- Automatic truck/car wash or standard high-pressure hand spray:
 - Maximum pressure: 1200 PSI/80 bar.
 - Maximum water/wash solution temperature: 140° F/60° C.
 - Minimum of 12 inches/30 cm distance of cleaning jet(s) from markings.
 - Cleaning wand or jets to be at no greater angle than 45 degrees from perpendicular to the marking surface.
 - Use Spray Tip #1505 (15 degree spray angle, 05 capacity size).
- When using metal brighteners, follow manufacturer's recommendations for dilution. Thoroughly rinse from markings after soaking vehicle.

Storage

- Cool, dry area out of direct sunlight.
- Temperature 65-75° F (18-24° C), humidity 30-50%.
- Store rolls horizontally, in carton or in original packaging.

³ Total luminance is defined as the sum of fluorescent and reflected luminance ($Y_T=Y_F+Y_R$) and is determined in accordance with ASTM E2152 and ASTM E2153.

Shelf Life

- Apply Series 983 markings within one year of receipt of material.

General Performance Considerations

Series 983 will provide maximum durability when:

- All 3M™ recommended procedures are followed.
- Marking is applied to vertical surfaces (within $\pm 20^\circ$ from vertical).

Durability will depend on customer use. Failure to follow the 3M-required techniques may reduce durability. Below are some examples and conditions that may lead to reduced durability:

- Failure to cut markings around rivets, seams and body panels.
- Improper use of high pressure cleaning.
- Contact with non-recommended chemicals or solvents.
- Improper application or surface preparation.
- Horizontal exposure is not recommended.
- Open cells along the edge of the marking may collect dirt but will not reduce the performance of the marking.
- Damage due to external conditions may show loss of adhesion and reflectivity in the immediate area.

Health and Safety Information

Read all health hazard, precautionary, and first aid statements found in the Safety Data Sheet (SDS), Article Information Sheet and/or product label of chemicals prior to handling or use. Consult local regulations and authorities for possible restrictions. Visit us at www.3M.com/us and select SDS search to obtain current Safety Data Sheets.

Warranty

3M Basic Product Warranty, Exclusive Limited Remedy and Disclaimer

3M™ Diamond Grade™ Conspicuity Marking Series 983 (“Product”) is warranted (“Basic Warranty”) 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 the Product 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 a refund or replacement of the Product.

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Additional Warranty

For additional warranty information on specific applications such as trucks and trailers, rail cars, school buses or emergency vehicles, please see the specific product bulletins for those applications.

Limitation of Liability

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Literature Reference

PB Series 983	Conspicuity Markings Series 983
PB Series 983	For Use on Emergency Vehicles
PB Series 983	For Use on Trucks and Trailers
PB Series 983 RR	For Use on Rail Cars
PB Series 983-21	For Use on School Buses
PB Series 983-71	For Use on School Buses
IF 4.9	Application Instructions for Diamond Grade Conspicuity Markings Series 983

For Information or Assistance

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