

Transportation Safety Division

3M™ Diamond Grade™ Conspicuity Markings Series 983

Product Bulletin Series 983
July 2022

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1 Description

3M™ Diamond Grade™ Conspicuity Markings Series 983 (“**Markings**”) are highly retroreflective microprismatic markings designed to enhance the visibilities of the sides and rears of vehicles. The Markings consist of prismatic lenses that are formed in a transparent, synthetic resin, and sealed and backed with a pressure sensitive adhesive and clear polymeric liner. The Markings are highly durable, providing up to ten years of field performance. The 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 visibility and detection.
- Fluorescence enhances visibility.

For details of the features and benefits of Markings, please refer to the 3M Transportation Safety Division website (<http://www.3M.com/roadsafety/>).

The Markings are available in the following colors.

Table 1. Product codes by color.

Color	Product Code
White	983-10
Yellow	983-71
Red	983-72
Fluorescent Yellow	983-21
Fluorescent Yellow-Green	983-23
Red 11-inch/White 7-inch (alternating pattern)	983-32
Red 6-inch/White 6-inch (alternating pattern)	983-326

1.1 Easy to Apply

- Aggressive pressure sensitive adhesive
- Compressible, easy to remove liner
- Available in rolls, packaged pieces, or kiss-cut pieces on a roll. Please refer to the 3M Transportation Safety Division Pricing Catalog for the standard product offering.

1.2 Durable

- Pre-sealed edges
- Non-metallic construction

2 Typical Physical Properties

Table 2 presents typical physical property data for Markings. The information presented in Table 2 should be considered typical only, and not be used for specification purposes.

Table 2. Typical physical properties.

Property	Series 983 Markings Typical Values
Thickness (Caliper)	0.014–0.018 inch
Whiteness Daytime Luminance Limit Y _T ASTM E1164	45 White 27 Yellow 5 Red 75 Fluorescent Yellow 90 Fluorescent Yellow-Green
Gloss ASTM D523 at 85°	100
Shrinkage ASTM D4956	No substantial change
Flexibility - wrap around 0.125 inch mandrel at 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 B117 Salt Spray	No effect - 1000 Hours
Room Temperature Impact Resistance 100 in-lb, 5/8 inch tip	No damage outside impact
Cold Temperature Impact Resistance 60 in-lb at -20 °F	No damage outside impact

3 Coefficient of Retroreflection, R_A

The values in Table 3 are minimum average initial coefficients of retroreflection, R_A , expressed in candelas per lux per square meter ($\text{cd}/\text{lux}/\text{m}^2$). Conformance to coefficient of retroreflection requirements shall be determined instrumentally, in accordance with ASTM E810 “Test Method of Coefficient of Retroreflection of Retroreflective Sheeting.” Per ASTM E810, R_A values obtained at 0° and 90° rotations were averaged to determine the R_A values presented in Table 3.

Table 3. Minimum average coefficient of retroreflection, R_A , values for new Markings ($\text{cd}/\text{lux}/\text{m}^2$).

Observation Angle ^a	Entrance Angle ^b	Minimum R_A				
		White (983-10)	Red (983-72)	Yellow (983-71)	FL. Yellow (983-21)	FL. Yellow-Green (983-23)
0.2°	-4°	700	132	504	495	660
	30°	400	77	242	286	375
	45°	99	22	77	66	N/A
0.5°	-4°	275	55	198	165	220
	30°	132	22	105	121	121
	45°	50	11	39	39	N/A

a. Observation Angle - the angle between the illumination axis and the observation axis.

b. Entrance Angle - the angle between the illumination axis and the retroreflector axis. The retroreflector axis is an axis perpendicular to the retroreflective surface.

4 Typical Physical Characteristics

Table 4 describes the typical physical characteristics of Markings. The information in Table 4 should be considered typical only, and not be used for specification purposes.

Table 4. Typical physical characteristics of Markings.

Property	Description
Adhesive color and type	Clear, pressure sensitive
Liner	Translucent polymeric
Application surfaces	Painted or unpainted flat metal 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) in air
Recommended minimum application temperature (ambient and substrate)	50 °F (10 °C)
Performance range	-30–200 °F (-34–94 °C)

5 Photometrics

5.1 Fluorescence

Fluorescent materials absorb short wavelength, invisible, incident radiation (solar energy) and re-emit it as longer wavelength, visible light. This re-emission of visible light continues as long as exciting incident radiation is present. This means fluorescent materials are especially effective during dawn, dusk, and overcast days. Fluorescence adds to the daytime luminances (apparent brightnesses) of Markings and enhances the visibilities of emergency vehicles and other vehicles.

5.2 Color Test for Fluorescent Markings

Conformance to standard chromaticity (x , y) and luminance factor (Y) requirements shall be determined instrumentally, in accordance with ASTM E991, on Markings applied to smooth aluminum test panels cut from alloy 6061-T6 or 5052-H38. Chromaticity values shall be determined on a HunterLab ColorFlex 45/0 spectrophotometer. Calculations shall be performed using CIE Illuminant D65 and the 2° standard observer.

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

A marking's numerical Y_F value serves, under specified illumination and viewing conditions, to: 1) verify the fluorescence of the marking (for non-fluorescent markings $Y_F=0$) and 2) quantify the fluorescent efficiency of the marking. The magnitude of a marking's Y_F can be used to assess whether the fluorescence of the marking is sufficient for it to provide high daytime visibility performance under less than ideal conditions. Minimum average initial Y_F values for 983-21, fluorescent yellow, and 983-23, fluorescent yellow-green, Markings are provided in Table 5.

Table 5. Minimum average initial luminance factor values for 3M Diamond Grade 983-21, fluorescent yellow, and 983-23, fluorescent yellow-green, Markings.^a

Color	Total Luminance Factor (Y_T)	Luminance Factor (Y_F)	Luminance Factor (Y_R)
Fluorescent Yellow	45	20	25
Fluorescent Yellow-Green	60	20	40

a. 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.

6 Maintenance

6.1 Cleaning

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

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

6.2 Storage

The Markings should be stored in a dry area, out of direct sunlight, at a temperature of 65–75 °F (18–24 °C) and a relative humidity of 30–50%. Rolls should be stored horizontally in their shipping cartons or original packaging.

6.3 Shelf Life

Apply Markings within two years of date of manufacture.

7 Durability

The Markings will provide maximum durability when:

- All 3M recommended procedures are followed and
- The Markings are applied to vertical surfaces (within $\pm 20^\circ$ of vertical orientation).

The durability of Markings depends on use. Failure to follow 3M-required techniques may reduce durability. Below are some conditions and processing examples that may lead to reduced durability:

- o Failure to cut Markings around rivets, seams, and body panels
- o Improper use of high pressure cleaning
- o Contact with non-recommended chemicals or solvents
- o Improper application or surface preparation
- o Horizontal exposure
- o Open cells along the edges of a Marking may collect dirt
- o Damage due to external conditions may reduce adhesion and reflectivity near the damaged area

8 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 labels 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.

9 Warranty Information

9.1 3M Standard Warranty

The Markings are warranted (“**3M Standard 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 Markings are proven not to have met the 3M Standard Warranty on their shipment date, then a buyer's exclusive remedy, and 3M's sole obligation, at 3M's option, will be refund or replacement of the Markings.

9.2 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.

9.3 Disclaimer

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10 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>.

11 Literature References

PB 983	3M™ Diamond Grade™ Conspicuity Markings Series 983 for Emergency Vehicles
PB 983	3M™ Diamond Grade™ Conspicuity Markings Series 983 for Trucks and Trailers
PB 983 RR	3M™ Diamond Grade™ Conspicuity Markings Series 983 for Rail Cars
PB 983-71	3M™ Diamond Grade™ Conspicuity Markings Series 983 for School Buses
3M IF 4.9	3M™ Diamond Grade™ and Flexible Prismatic Conspicuity Markings Application Instructions for Trucks, Trailers, and Specialty Vehicles

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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