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Transportation Safety Division

3M™ Diamond Grade™ Conspicuity Markings Series 983 for Rail Cars

Product Bulletin Series 983 for Rail Cars
July 2022

Replaces Product Bulletin 983 for Use on Rail Cars Dated April 2021

1 Description

3M™ Diamond Grade™ Conspicuity Markings Series 983 for Rail Cars (“**Markings**”) are highly retroreflective microprismatic markings designed to enhance the visibilities of the sides and rears of rail cars. 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.

- Combined fluorescence and retroreflection provides 24-hour visibility and detection.
- Fluorescence enhances visibility.

The Markings meet or exceed FRA 49 CFR Part 224 requirements.

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	983-10FRA
Yellow	983-71FRA
Fluorescent Yellow	983-21FRA

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
- 10-year warranty

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 for Rail Cars Typical Values
Thickness (Caliper)	0.014–0.018 inch
Whiteness Daytime Luminance Limit YT ASTM E1164	45 White 27 Yellow 75 Fluorescent Yellow
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 (cd/lux/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 (cd/lux/m^2).

		Minimum R_A					
		Series 983 Markings			FRA-224 Requirement		
Observation Angle[a]	Entrance Angle[b]	White (983-10FRA)	Yellow (983-71FRA)	FL. Yellow (983-21FRA)	White	Yellow	Fluorescent Yellow
0.2°	-4°	700	504	660	600	400	400
	30°	400	242	375	350	220	220
0.5°	-4°	275	198	220	160	100	100
	30°	132	105	121	75	45	45

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 (α=0.2, β=-4) after 24 hr. exposure to 170 °F (77 °C) air
Recommended minimum application temperature (ambient and substrate)	50 °F (10 °C)
Performance range	-30–200 °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 Sheetings

Conformance to standard chromaticity (x, y) and luminance factor (Y) requirements shall be determined instrumentally, in accordance with ASTM E991, on sheeting 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 Markings are provided in Table 5.

Table 5. Minimum average initial luminance factor values for 983-21, fluorescent yellow, Markings.[a]

Color	Total Luminance Factor (Y_T)	Luminance Factor (Y_F)	Luminance Factor (Y_R)
Fluorescent Yellow	45	20	25

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:

- Clean with sponge, cloth, or soft brush using water and detergent
- 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)
- 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
- Markings are applied to vertical surfaces (within ± 20° 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:

- 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
- Open cells along the edges of a Marking may collect dirt
- 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

3M warrants ("**3M Warranty**") that Markings sold by 3M to be used for conspicuity markings on Rail Cars in the United States and Canada will remain visible by resisting excessive fading, cracking, peeling, lifting or discoloration for ten (10) years ("**Warranty Period**") from the date of original installation ("**Installation Date**").

9.3 Terms and Conditions

- The Markings must be processed and applied to a vertically-mounted (±20°) 3M recommended substrate as described in this product bulletin and in accordance with all 3M application, fabrication, and cleaning procedures provided in 3M's product bulletins, information folders (including but not limited to 3M Information Folder 4.9), and applicable technical memos (which will be furnished to the manufacturer upon request).
- Any third-party imaging or altering of the Marking not endorsed by 3M will void the 3M Warranty.
- A Marking's failure to meet the 3M Warranty must be solely the result of design or manufacturing defects in the Marking and not of (a) outside causes including improper storage, fabrication, handling, maintenance, or installation; (b) use of process colors, thinners, coatings, or other chemicals not recommended by 3M; (c) use of application procedures not recommended by 3M; (d) exposure to chemicals or solvents not recommended by 3M; (e) abrasion and other physical damage; (f) snow or any other burial of the marking; (g) collisions, vandalism, or malicious mischief; or (h) an act of God.
- 3M reserves the right to determine the method of replacement. Replacement product will carry the unexpired warranty of the Marking it replaces.
- Claims made under this warranty will be honored only if 3M is presented with a traceable record of the Marking's Installation Date, 3M is notified of a potential failure within thirty days of discovery, reasonable information requested by 3M is provided, and 3M is permitted to verify the cause of the failure.

9.4 Exclusive Limited Remedy

If a Marking is proven not to have met the 3M Warranty during the Warranty Period, then the purchaser's and user's exclusive remedy, and 3M's sole obligation, at 3M's option, shall be that 3M will provide replacement of the Product.

9.5 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.

9.6 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 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.

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

3M IF 4.9 3M™ Diamond Grade™ and Flexible Prismatic Conspicuity Markings Application Instructions for Trucks, Trailers, and Specialty Vehicles
3M IF 4.18 3M™ Diamond Grade™ Series 983 Rail Car Conspicuity Markings
3M IF 4.19 3M™ Diamond Grade™ Series 983FRA and 973FRA Rail Car Markings

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

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.

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