3M™ Diamond Grade™ Fluorescent LDP Reflective Sheeting

3963 Fluorescent Yellow Green and 3924 Fluorescent Orange

Health and Safety

Refer to the package label and the Material Safety Data Sheet for health, safety, and handling information on the products referenced in this bulletin. For 3M products, if necessary, you may contact our Toxicology/Product Responsibility Department on 01344 858000.

Description

3M™ Diamond Grade™ Fluorescent LDP Reflective Sheetings are durable prismatic lens reflective sheetings that fluoresce when subjected to wavelengths in the visible spectrum. These sheetings are designed to be used for vehicle markings for greatly improved conspicuity. They will provide higher night-time brightness than glass bead based retroreflective sheetings and higher daytime brightness than ordinary (non-fluorescent) coloured sheeting. Applied to properly prepared substrates, Diamond Grade fluorescent LDP reflective sheeting should provide long-term service.

Colour	Material
Fluorescent Yellow Green	3963
Fluorescent Orange	3924

Photometrics

Daytime Colour (x, y, Y)

The chromaticity co-ordinates and total luminance factor of the retroreflective sheetings meet the requirements of Table A below.

Colour Test

Daytime colour requirements of sheeting applied to aluminium test panels shall be determined instrumentally using a 2-monochromator spectrophotometer employing annular $45^o/0^o$ (or equivalent $0^o/45^o$) illuminating /viewing geometry.[1,2] The chromaticity co-ordinates and total luminance factor shall be calculated from the total spectral radiance factors computed for CIE illuminant D65 in accordance with ASTM E-308 "Practice for Computing the Colours of Objects by Using the CIE System" for the CIE 1931 (2^o) standard colorimetric observer. The measurements shall be made on a Labsphere BPC-450 Bispectral Fluorescent Colorimeter or equivalent.

[1] "Design and testing of a two-monochromator reference spectrofluorimeter for high-accuracy total radiance factor measurements" by Joanne C Zwinkels, D.S. Gignac, M Nevins, I Powell and A Bewsher, Applied Optics, vol. 36 no. 4, pp 892-902 (1997).

[2] "Principles of Bispectral Fluorescent Colorimetry" by Jim Leland, N Johnson and A Arecchi, Proceedings of SPIE - The International Society for Optical Engineering: vol. 3140, pp. 76-87 (1997)

Table A - CIE Chromaticity Co-ordinate Limits* and Minimum Total Luminance Factor for New Sheeting

Colour	1		2		3		4		Luminance Factor Y (%)
	x	y	X	y	x	y	x	y	
Fluorescent Yellow Green	0.387	0.610	0.460	0.540	0.421	0.486	0.368	0.539	Min. 55
Fluorescent Orange	0.583	0.416	0.523	0.397	0.560	0.360	0.631	0.369	Min. 30

*The four pairs of chromaticity co-ordinates define the acceptable colour limits for CIE D65 illumination in terms of the CIE 1931 Colorimetric System.

Fluorescence (Y_F)

Fluorescent luminance properties differentiate fluorescent sheeting from ordinary (non-fluorescent) sheeting. The additional luminance produced by fluorescence is directly related to the increased visual performance of fluorescent markings under the varying conditions of daylight illumination encountered in outdoor applications. The Fluorescent Luminance Factor Y_F, provides a standardised measure of fluorescent luminance. The numerical value of Y_F under specified illumination and viewing conditions 1) verifies the fluorescent properties of the sheeting (for non-fluorescent sheeting Y_F=0) and 2) quantifies the fluorescent content (efficiency) of its Total Luminance Factor. The magnitude of Y_F can be used to assess whether the fluorescent content is sufficient to provide high daytime visibility under poor visibility conditions. The minimum fluorescence luminance factor (Y_F) values of the retroreflective fluorescent sheetings conform to Table B.

Table B- Minimum Fluorescence Luminance Factor for New Sheeting

Colour	Y_F (%) min
Yellow Green	35
Orange	10

Fluorescence Test

Fluorescence luminance factor requirements on sheeting applied to aluminium test panels shall be determined instrumentally using a 2- monochromator spectrophotometer employing annular $45^o/0^o$ (or equivalent $0^o/45^o$) illuminating / viewing geometry[1,2]. The fluorescence luminance factor shall be calculated from the fluorescence spectral radiance factors computed for CIE illuminant D65 in accordance with ASTM E-308 "Practice for Computing the Colours of Objects by Using the CIE System" for the CIE 1931 (2^o) standard colorimetric observer. The measurements shall be made on a Labsphere BFC-450 Bispectral Fluorescence Colorimeter or equivalent.

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Coefficients of Retroreflection (R_A)

The values in Table C are minimum coefficients of retroreflection expressed in candelas per lux per square metre (cd/lux/m^2). Measurements are made in accordance with CIE publication 54:1982.
R_A values are measured at 0^o and 90^o rotation and averaged to determine the minimum R_A value in Table C.

Table C - Minimum Coefficient of Retroreflection R_A for New Sheeting (cd/lux/m^2)

Observation Angle	Colour	Entrance Angle	
		-4°	30°
0.2°	Yellow Green	680	388
	Orange	200	120
0.5°	Yellow Green	198	103
	Orange	80	50

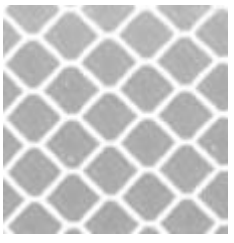
[2]Observation (Divergence) Angle - The angle between the illumination axis and the observation axis.

[3]Entrance (Incidence) Angle - the angle from the illumination axis to the retroreflector axis. The retroreflector axis is an axis perpendicular to the retroreflective surface.

Interlocking Diamond Seal Pattern

Diamond Grade Fluorescent 3963 and 3924 have the same interlocking seal pattern as Diamond Grade LDP 3970 series. This pattern is unique to 3M prismatic retroreflective sheetings. Under normal light, this seal pattern will appear lighter in colour than the reflective portion (Figure 1).

Seal legs have smooth edges



Application Orientation **Horizontal**



Application Orientation **Vertical**

Figure 1

Application Orientation

Diamond Grade Fluorescent 3963 and 3924 are designed to reflect effectively regardless of their orientation on the substrate or ultimate orientation after installation.

However, because the efficiency of light return from cube corner reflectors is not equal at all rotation angles, optimum entrance angle performance can be achieved when the sheeting is oriented in a particular way.

When extra wide entrance angle performance is important for a given situation, you may elect to apply the material with a specific orientation.

Optimum wide-angle entrance performance is achieved by orientating Diamond Grade LDP sheeting **horizontally**. The sharp ends of the cell pattern point horizontally.

However, unless the location and/or position calls for extra-wide entrance angularity performance, Diamond Grade LDP Series sheetings can be manufactured and installed using the orientation that most efficiently utilises the reflective sheeting.

NOTE:

- In cases where panels, strips and text are placed on the same surface, it is recommended they be placed in the same orientation.
- On overhead gantry signs horizontal orientation is recommended.

Important - For smooth flow and maximum control of sign fabrication using Diamond Grade LDP reflective sheeting note the following:

Ordering – The need to orient the sheeting may alter the sheeting roll widths that are required. For example, sheeting may have previously been ordered according to sign height. To orient the sheeting a particular way may mean ordering by sign width.

Application - The squeeze roll operator must determine the correct feed direction based on the pre-channeled blanks or on the sign shape if pre-channeled blanks are not used.

When applying borders, symbols etc. and for large panel application where more than one sheet is applied to a single substrate, only butt joints are recommended to join reflective sheets. **Do not overlap Diamond Grade LDP reflective sheeting**.

The printer must take the desired sheeting orientation into consideration before screening Diamond Grade LDP reflective sheeting.

Datum Marks

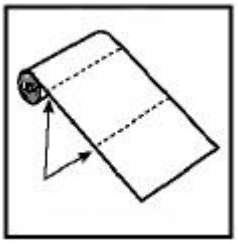
Unlike 3M™ Diamond Grade™ VIP Reflective Sheeting Series 3990, Diamond Grade Fluorescent 3963 and 3924 do not carry datum marks. The two different type of sheetings can therefore be distinguished on a roll by the presence of datum marks on the Diamond Grade VIP sheeting.

Tooling Lines

The manufacture of prismatic sheeting requires tooling lines. In Diamond Grade Fluorescent 3963 and 3924 these lines, slightly thicker than the seal pattern legs, occur across the web every 864mm (34 inches). Tooling lines are more noticeable in shop light but are not observable on the road either in daylight or night under reflected light (Figure 2).

Figure 2

Tooling Lines



Across the roll width 86.36cm (34") centres

Application

Diamond Grade Fluorescent 3963 and 3924 are pressure-sensitive sheetings that should be applied at room temperature (18 to 28°C) by any of the following methods:

- Mechanical squeeze roll laminator
- Hand squeeze roll applicator
- Hand application

Substrates

For traffic sign use, properly prepared aluminium and British Steel HP200 are the only substrates recommended by 3M.

Users are urged to carefully evaluate all other substrates for adhesion and sign durability. Sign failures caused by the substrate or improper surface preparation are not the responsibility of 3M.

Diamond Grade Fluorescent 3963 and 3924 reflective sheeting is designed primarily for application to flat substrates.

Any use that requires a radius of curvature of less than 125mm (5 ins) should also be supported by rivets or bolts. Aluminium substrates with a radius of curvature greater than 125mm can be used without additional fastening.

Plastic substrates are not recommended where cold shock performance is essential.

Screen Printing

Diamond Grade Fluorescent 3963 and 3924 signfaces can be produced by screen printing with 3M™ Process Color Series 880I (see Product Bulletin 880I) before or after mounting on a sign substrate. The recommended ambient conditions for screen printing Series 880I inks are 18-28°C and relative humidity of 30-60%. Use of PE61T/62T screen mesh with a fill pass is recommended. The use of any other type of ink is not recommended. 3M assumes no responsibility for failure of sign face legends or backgrounds that have been printed with non-3M process colours or 3M process colours other than Process Color Series 880I .

NOTE: Screen printed Diamond Grade Fluorescent 3963 and 3924 reflective sheeting should be kept flat especially during the drying process. Avoid bending sharply or folding when handling wet sheets to prevent cracking.

Edge Sealing

Edge sealing Diamond Grade Fluorescent 3963 and 3924 reflective sheeting is generally not required. Following outdoor exposure, dust particles may become trapped within the row of cut cells along the sheeting's edge. This should not adversely effect the performance of the rest of the applied copy. Narrow width markings or letters should be a minimum of 18mm stroke width. Where possible screen printing or 3M ElectroCut ™ Film is recommended.

3M ElectroCut Film ä (E.C. Film) Series 1170

As part of the 3M Matched Component System™, ElectroCut film can be applied over Diamond Grade LDP reflective sheeting using 3M TPM5 Transfer Tape. ElectroCut film is especially suitable for small quantities of signs where screen printing may be uneconomic.

Cutting and Matching

Diamond Grade Fluorescent 3963 and 3924 sheeting may be hand cut or die cut one sheet at a time, and band sawed or guillotined in stacks. The sheeting can be hand cut from either side with a sharp knife or other sharp hand tool.

Cutting equipment such as guillotines and metal shears that use pressure plates to hold the sheeting when cutting may damage the optics. To reduce pressure on and eliminate damage to the sheets the pressure plate should be padded. Stack heights may vary with condition and type of equipment used.

NOTE: As with all reflective sheetings, when two or more pieces are used side by side on a surface. They must be matched to assure uniform daytime colour and night appearance.

Multi-panel applications should have all panels or pieces oriented identically for uniform appearance under all viewing conditions (orientation arrow and seal pattern in the same direction).

Prespacing

Use 3M™ Scotchcal™ Prespacing Tape Series SCPS-100 as a carrier for die cut letters, numerals or symbols for rapid, accurate application of legends.

Cleaning

Signs that require cleaning should be flushed with water, then washed with a dilute solution of mild, non-abrasive detergent and soft bristle brush or sponge. Avoid pressure that may damage the sign face. Flush with water following washing. Do not use solvents to clean signs.

N.B. Dew Resistant Coated signfaces must be flushed with clean water only. Detergents must not be used.

Storage

Diamond Grade Fluorescent 3963 and 3924 reflective sheeting should be stored in a cool, dry area, preferably at 18-28°C and 30-60% relative humidity and should be applied within one year from date of delivery.

Rolls should be stored horizontally in the shipping carton. Partially used rolls should be returned to the shipping carton or suspended horizontally from a rod or pipe through the core. Unprinted sheets should be stored flat. Unmounted-screened faces must be interleaved with SCW-82 slipsheet, glossy side against the sign face.

Indoor Storage of Finished Signs

Finished signs and applied blanks should be stored face to face, on edge on wooden battens. Signs must be protected with SCW-82 slipsheet paper. Place the glossy side of the slipsheeting against the sign face and pad with closed cell packaging foam. Double-faced signs must have the glossy side of the slipsheet against each face of the sign.

Outdoor Storage of Finished Signs

If outdoor storage is necessary, remove all packaging and store face to face, on edge on wooden battens with a gap between the signfaces to allow air movement.

Signs kept in metal containers must be stored as above for outdoor storage.

Panels or finished signs must remain dry during shipment and storage. If packaged signs become wet, unpack immediately and store as for outside storage to allow signs to dry.

Avoid banding, crating, or stacking signs or faces. Package for shipment in accordance with commercially accepted standards to prevent movement and chafing.

Effective Performance Life

The effective performance life of Diamond Grade LDP reflective sheeting will depend on substrate selection and preparation, compliance with recommended application procedures, weather, exposure and maintenance.

Permanent static road traffic signs incorporating Diamond Grade Fluorescent 3963 and 3924 reflective sheetings applied to aluminium or British Steel HP200 substrates which have been prepared according to 3M recommended procedures, have an expected performance life of 7 years when mounted vertically. Application to substrates other than those above or incorrect substrate preparation may shorten the effective performance life of the sheeting. Application to unprimed, excessively rough or non-weather resistant surfaces will shorten the effective life.

The user must determine the suitability of any substrate other than aluminium or BS HP200 for the intended use. Under certain conditions effective performance life may be shorter due to sign location, climatic conditions and method of installation.

Important Notice to Purchaser

Technical information provided by 3M is based on experience and/or tests believed to be reliable but its accuracy is not guaranteed and the results may not be relevant to every user's application. 3M does not accept responsibility or liability, direct or consequential, arising from reliance upon any information provided and the user should determine the suitability of the products for their intended use.

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Technical Assistance

For help on specific questions relating to 3M Traffic Control Materials, contact your local Technical Service Representative.

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