3M™ Diamond Grade™ LDP Reflective Sheetings Series 9970

Health & 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.

Product Description
3M Diamond Grade Reflective Sheetings Series 9970 is a prismatic lens reflective sheeting designed for the production of durable vehicle conspicuity markings. The reflective sheeting consists of prismatic lenses that are formed in a transparent, synthetic resin, sealed, and backed with a pressure-sensitive adhesive and clear poly liner. Applied to properly prepared substrates, Diamond Grade LDP Series 9970 should provide long-term service. The pressure-sensitive sheeting is available in roll widths up to 915mm (36 inches) in the following traffic signing colours.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Product Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>9970</td>
</tr>
<tr>
<td>Yellow</td>
<td>9971</td>
</tr>
<tr>
<td>Red</td>
<td>9972</td>
</tr>
<tr>
<td>Traffic Blue</td>
<td>9975</td>
</tr>
<tr>
<td>Standard Green</td>
<td>9976</td>
</tr>
<tr>
<td>Interstate Green</td>
<td>9977</td>
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</table>

Photometrics and Coefficients of Retroreflection
The values in Table A are minimum coefficients of retroreflection expressed in candelas per lux per square meter (cd/lux/m²). Measurements are made in accordance with CIE Publication 54: 1982.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Entrance Angles</th>
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<tr>
<td>Angle</td>
<td>-5°</td>
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<tr>
<td>White</td>
<td>800</td>
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<tr>
<td>Yellow</td>
<td>660</td>
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<tr>
<td>Red</td>
<td>215</td>
</tr>
<tr>
<td>Standard Green</td>
<td>65</td>
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<tr>
<td>Blue</td>
<td>43</td>
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Table A

<table>
<thead>
<tr>
<th>Colour</th>
<th>x</th>
<th>y</th>
<th>x</th>
<th>y</th>
<th>x</th>
<th>y</th>
<th>x</th>
<th>y</th>
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</thead>
<tbody>
<tr>
<td>White</td>
<td>0.345</td>
<td>0.355</td>
<td>0.305</td>
<td>0.305</td>
<td>0.285</td>
<td>0.325</td>
<td>0.355</td>
<td>0.375</td>
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<tr>
<td>Yellow</td>
<td>0.545</td>
<td>0.454</td>
<td>0.487</td>
<td>0.423</td>
<td>0.427</td>
<td>0.483</td>
<td>0.465</td>
<td>0.534</td>
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<tr>
<td>Red</td>
<td>0.680</td>
<td>0.310</td>
<td>0.595</td>
<td>0.315</td>
<td>0.569</td>
<td>0.341</td>
<td>0.655</td>
<td>0.345</td>
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<tr>
<td>Standard Green</td>
<td>0.313</td>
<td>0.258</td>
<td>0.313</td>
<td>0.453</td>
<td>0.248</td>
<td>0.409</td>
<td>0.127</td>
<td>0.557</td>
</tr>
<tr>
<td>Blue</td>
<td>0.078</td>
<td>0.171</td>
<td>0.150</td>
<td>0.220</td>
<td>0.210</td>
<td>0.160</td>
<td>0.137</td>
<td>0.038</td>
</tr>
</tbody>
</table>

Table B

Luminance Factor
Colours

The chromaticity and the luminance factor shall comply with the limits defined in Table B; when measured using the apparatus described in Clause 6.2 of BS 873: Part 1: 1983; and the procedure described in Clause 6.3 of BS 873: Part 1: 1983, varied as follows:

Measurements shall be made using a polychromatic Standard Illuminant D65. The sample shall be illuminated at 0° to the surface and measure the reflected light in the direction of 45° to the normal to its surface (CIE O/45 geometry).

Interlocking Diamond Seal Pattern

3M™ Diamond Grade™ LDP Reflective Sheeting Series 9970 have the same interlocking seal pattern as other Diamond Grade sheetings. 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

Orientation

The 3M™ Diamond Grade™ LDP Sheetings 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 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.

Datum Marks

Unlike 3M™ Diamond Grade™ VIP Reflective Sheet Series 3990, Diamond Grade LDP does not carry datum marks. The two sheetings can therefore be distinguished on a roll by the presence of datum marks on the Diamond Grade VIP sheeting.

Test Methods of Adhesive and Film

Standard Test Panels

Unless otherwise specified, the reflective sheeting shall be applied according to the manufacturer’s recommendations to smooth 1.6mm (0.0063 inches) minimum thickness 6061-T6, 5052-H38 or equivalent aluminium panels that have been degreased and lightly acid etched. Lack of contamination of test panels must be confirmed by passing the water break test and tape snap test as described in Information Folder 1.7.
Properties
Standard Conditioning – all mounted and unmounted test specimens shall be conditioned for 24 hours at 23°C ± 1°C and 50% ± 4% R.H. before testing.

1. Adhesion
Test Weight 0.8kg (1-¾ lbs). Test Method - Apply 10cm (4”) of 2.54 x 15 cm (1” x 6”) stripe to panel and condition, face panel down and suspend test weight from free end.
Requirement - Not more than 5.0cm (2”) of peel in 5 minutes.

2. Impact Resistance
Test Method - Apply sheeting to a standard panel 7.6cm x 15.2cm (3” x 6”) and condition. Subject sheeting to a 5.7Nm (50 inch pounds) impact in accordance with ASTM D-2794.
Requirement - No separation from panel or cracking outside immediate impact area.

3. Shrinkage
Test Method - Following condition 22.9cm x 22.9cm (9” x 9”) samples, remover liner, place specimen on flat surface with adhesive side up.
Requirement - shrinkage not greater than 0.8mm (1/32”) in 10 minutes or more than 3.2mm (1/8”) in 24 hours in any dimension.

4. Flexibility
Test Method - Following conditioning of 2.54cm x 15.2cm (1”x6”) sample, remove liner and dust adhesive with talc. At standard conditions, bend in one second around 3.22mm (1.8”) mandrel with adhesive side facing mandrel.
Requirement - No cracking, peeling or delamination.

5. Gloss
Test Method - Test in accordance with ASSTM D523 using a 85° glossmeter.
Requirement - Rating not less than 50.

Fabrication Methods
Application
Diamond Grade LDP Series 9970 incorporates a pressure-sensitive adhesive and should be applied to the substrate at room temperature (15°C) or higher.

Splicing
Diamond Grade LDP Series 9970 should be butt spliced when more than one piece of sheeting is used on one piece of substrate. All pieces must be applied with the same orientation on the finished sign.

Screen Printing
Diamond Grade LDP Series 9970 may screen printed using 3M™ Process Colour Series 880I (see Product Bulletin 880I). Series 880I can be screen processed at 16-24°C at relative humidity of 30-50%. Use of PE61T/62T screen mesh with a fill pass is recommended. See relevant Instruction Bulletin for details. Use of other screen printing inks is not recommended. 3M assumes no responsibility for failure of printed Diamond Grade that has been processed with non-3M process colours or 3M process colours other than Series 880I.

NOTE: For vehicle applications, screen processed sheeting must be clear coated using 880I toner.

Care should be taken to avoid creasing or folding Diamond Grade LDP Series 9970 before and after screening to eliminate the possibility of cracking from improper handling techniques.

Edge Sealing
Edge sealing Diamond Grade LDP Series 9970 is generally not required. Following extended exposure, airborne dust particles may become trapped within the row of cut cells along the sheeting edge. This should have no adverse effect on sheeting performance unless legends have narrow stroke widths (small letters or numbers). If legends have narrow stroke widths, reverse or direct screening processing is recommended. If the user chooses to edge seal, Series 880I Clear should be used.

Mechanical methods of edge sealing Diamond Grade LDP Series 9970 are available. Although the performance of these systems are not warranted by 3M, they may limit the possibility of dirt and water ingress into cut cells.

Substrates
See Instruction Bulletin 5.1 for recommended substrate preparation.

Users are urged to carefully evaluate all other substrates for adhesion and sheeting durability. Sheeting failures caused by the substrate or improper surface preparation are not the responsibility of 3M. Diamond Grade LDP Series 9970 is designed primarily for application to flat substrates.
Cutting and Matching

The sheeting may be hand cut or die cut one sheet at a time, and band sawed or guillotined in stacks. 3M™ Diamond Grade LDP Series 9970 can be hand cut from either side with a razor blade or other sharp hand tool. 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 day colour and night appearance.

Cutting equipment such as guillotines and metal shears, which have 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 eliminate damage. Maximum stack height for cutting Diamond Grade LDP Series 9970 is 38.1mm (1½”) or 50 pieces. Details on cutting can be found in Information Folder 1.10.

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

Cleaning

Diamond Grade LDP Series 9970 may be washed with a sponge or soft cloth using cold or warm water and soap or detergent, followed by a clean water rinse.

When using pressure washing equipment, limit nozzle pressure to 80 bar (1000psi). Nozzle should be held at least 1 metre away from the vehicle using a wide fan pattern, and at an angle no more than 15 degrees from square on to the vehicle surface.

Caution:

Any dirt collecting at the outer edges of the Diamond Grade sheeting will not affect the products’ overall performance. Do not attempt to remove this dirt with aggressive use of the pressure washing equipment as it may result in the edge lifting and/or top film layer delamination.

Acid brightening and cleaning solutions can have an adverse affect on Diamond Grade LDP Series 9970 over time by lowering the surface gloss and retroreflection. These solutions should not be allowed to soak on the sheeting to avoid immediate damage.

Storage and Packaging

Diamond Grade LDP Series 9970 should be stored in a cool, dry area, preferably at 18-24°C and 30-50% relative humidity and should be applied within one year of purchase.

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. Unprocessed sheets should be stored flat. Screen processed material must be protected with SCW-82 or SCW 568 slipsheet paper. Place the glossy side of the ship sheeting against the sheeting face and pad the face with closed cell packaging foam. Unmounted-screened sheeting must be stored flat and interleaved with SCW-82 or SCW 568 slipsheet, glossy side against the sheeting face. Avoid banding, crating, or stacking of Diamond Grade sheeting. Package for shipment in accordance with commercially accepted standards to prevent movement and chafing.

Finished material must remain dry during shipment and storage. If packaged material becomes wet, unpack immediately and allow to dry.

Expected Effective Performance Life

When fabricated and applied in accordance with 3M recommended procedures, and exposed vertically, the following performance typically may be expected. Performance is based upon field experience and exposure tests conducted throughout Europe and the United States. Performance can be affected by substrate selection and preparation, exposure conditions and maintenance of the marking. The warranty for and durability of Sheeting Series 9970 for commercial vehicles contained herein does not extend to automotive or personal vehicle applications which have to conform to O.E.M. automotive specifications.
**Vertical Exposure**

<table>
<thead>
<tr>
<th>Unprinted</th>
<th>7 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printed using 3M™ Process Colour Series 880I</td>
<td>7 years</td>
</tr>
</tbody>
</table>

Exceptions to the above are:

1. Horizontal exposure is not recommended.
2. The warranty applies to sheetings that are exposed at a vertical angle (defined as 90± 10°). A significant decrease in durability may be experienced if sheetings are exposed other than vertical. Such non-vertical applications must be on a test and approval basis to determine acceptability. 3M does not warrant non-vertical exposures.
3. Application to areas having frequent or long periods of continuous high heat (above 65°C (150°F) such as applications to areas on railroad engines, vehicle engine compartments, or repeated internal steam cleaning or non-insulated tankers, will decrease the effective performance life of the sheeting, by as much as two years.

**General Performance Considerations**

The durability of Diamond Grade LDP Series 9970 will depend upon substrate selection and preparation, compliance with recommended application procedures, geographic area, exposure conditions, and maintenance.

Maximum durability of Diamond Grade LDP Series 9970 can be expected in applications subject to vertical exposure when processed and applied to properly prepared substrates. Horizontal applications are subjected to maximum environmental effects and a reduction in durability can be accepted. 3M does not warrant non-vertical applications.

The user must determine the suitability of any non-metallic substrate for its intended use.

Application to rusted, severely pitted, loose or chalking painted surfaces is not recommended. These surfaces must be clean of rust and painted using recommended practises before applying Diamond Grade sheeting

3M process colours, when used according to 3M recommendations, are generally expected to provide durability comparable to coloured reflective sheeting, except for certain lighter colours, such as yellow, gold, or heavily toned colours or blends containing yellow or gold, whose durability depend on how much of each colour is used. Dilution of colour and atmospheric conditions in certain geographical areas may result in reduced durability. 3M™ Scotchcal™ Film 3655 Black, Scotchcal film 7720-12 and 3M™ Controltac™ Plus Graphic Marking Film 180-12 Black can be expected to perform satisfactorily for the life of the sign when directly applied to series Diamond Grade LDP sheetings, except where shortened durability is stated in the literature.

**Literature**

<table>
<thead>
<tr>
<th>Related 3M Literature</th>
<th>Bulletins</th>
</tr>
</thead>
<tbody>
<tr>
<td>3M™ Process Colour Series 880I</td>
<td>880i</td>
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<tr>
<td>Substrate selection and preparation</td>
<td>5.1</td>
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<tr>
<td>Application, storage and cleaning</td>
<td>5.13.1</td>
</tr>
<tr>
<td>Removal</td>
<td>6.4.1</td>
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Important Notice To Purchaser

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If any goods supplied or processed by or on behalf of 3M prove on inspection to be defective in material or workmanship 3M will (at its option) replace the same or refund to the Buyer the price of the goods or services. Except as set out above, all warranties and conditions, whether expressed or implied, statutory or otherwise are excluded to the fullest extent permissible at law.

Technical Assistance

For help on specific questions relating to 3M Traffic Safety Systems Division products, contact your local Technical Service Representative.

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