

Traffic Safety and Security Division

3M™ Reflective Elements

Series Dry, Series All Weather 50 and 90 for Paint, 3M LPM 5000 & Thermoplastic Pavement Markings
Series Dry E, Series All Weather 50E and 70E for Epoxy and Polyurea Pavement Markings
Series Dry M, Series All Weather 50M and 70M for MMA Pavement Markings

Product Bulletin
March 2016

Description

3M™ Reflective Elements Series Dry and Series All Weather 50, 70, and 90 are designed for use on roadways and highways primarily as long line pavement markings. They can be used in either new marking applications or as part of a maintenance marking application.

3M Series All Weather Elements 50, 70, 90, when used with compatible binders, form markings that help improve visibility at night under both dry and wet weather conditions. 3M Series Dry Elements, when used with compatible binders, form markings that help improve visibility at night under dry conditions. Series Dry, 50 and 90 are available in two different sizes: standard and small (S). Standard size elements will generally perform better under wet conditions compared to their small (S) size counterparts.

For optimal usage recommendations of small (S) versus standard size elements, please refer to Table 1.

Series Dry E, 50E, 70E, Dry M, 50M and 70M are available only in a standard size.

The term “polyurea” in this bulletin refers to polyurea type binders other than 3M LPM 5000.

Bonded Core Element Construction

3M's bonded core elements consist of microcrystalline ceramic beads bonded to a center core to provide optimal performance in both dry and wet conditions.

Features and Benefits (All Weather Elements)

- Provides all weather performance for the motorist.
- Outstanding wet recovery retroreflectance comparable to dry retroreflectance of ordinary glass-bead markings per ASTM E2177.
- Effective performance under rain conditions as shown by measured retroreflectance per ASTM E2176-08 and ASTM E2832.

Binders/Element Compatibility

Table 1 illustrates the general compatibility of All Weather Elements with pavement marking binders. Also highlighted are available 3M systems of matched components.

Table 1. General Compatibility of All Weather Elements

Binder/element compatibility				
Binder system	Target thickness (0.001")	Element series for high wet reflectivity	Element series for balanced wet and dry reflectivity	Element series for high dry reflectivity
High build paint	>22	90*	50*	Dry*
High build paint	18-22	90S*	50S*	Dry*
Thermoplastic	60-90	90S*	50S*	Dry S*
Thermoplastic	>90	90*	50*	Dry*
Polyurea	18-25+	90*	50*	Dry*
Epoxy and Polyurea (excluding LPM 5000)	18-25+	70E	50E	Dry E
MMA	30-150+	70M	50M	Dry M

*3M system of matched components binder available

Reflective Elements for High Build Paint

Standard Elements Series 50 and 90 are generally compatible with paints formulated with Dow® FASTRACK™ HD21-A binder. Since formulations may vary, user should test for ultimate compatibility and performance. Markings should be applied at a target wet thickness of 25 mils (0.025 inches). Small Element Series Dry S, 50S and 90S should be applied at a target wet thickness of 20 mils (0.020 inches).

A system of matched components in high build paint consisting of pre-tested components and optimized for performance is also available from 3M. Please see 3M Product Bulletin "All Weather Paint" for further information.

Reflective Elements for Thermoplastic Markings

Small Elements Series Dry S and All Weather 50S and 90S are generally compatible with formulations based on alkyd and hydrocarbon binders with a target thickness of 60-90 mils. Elements Series Dry and All Weather 50 and 90 are generally compatible with formulations based on alkyd and hydrocarbon binders with a target thickness greater than 90 mils. At a minimum, these materials should meet AASHTO M249 specifications. Since formulations may vary, users should test for ultimate compatibility and performance. Markings should be applied at a minimum thickness of 60 mils.

A thermoplastic system of matched components consisting of pre-tested components and optimized for performance is also available. Please see 3M Product Bulletin "All Weather Thermoplastic" for further information.

Reflective Elements for epoxy and Polyurea Markings

Standard Elements Series Dry E, 50E and 70E are generally compatible with formulations of epoxy and polyurea pavement markings. Since formulations may vary, users should test for ultimate compatibility and performance.

Reflective Elements for 3M LPM 5000 Markings

Standard Elements Series Dry, 50 and 90 are compatible in 3M LPM 5000 markings. They should be used as part of the system of matched components. Please see 3M Product Bulletin “3M LPM 5000” for further information.

Reflective Elements for MMA markings

Standard Elements Series Dry M, 50M and 70M are compatible in MMA markings. Since formulations may vary, users should test for ultimate compatibility and performance.

Weather and Pavement Conditions

3M Reflective Elements should be applied within established application guidelines for the appropriate binders.

Installation Equipment

3M Reflective Elements must be installed using a double-drop element/bead delivery system. The Elements must be installed as the first drop of the two-drop system, at a truck speed no greater than 8 mph to minimize loss, prevent rolling and ensure adequate sink. Contact 3M Technical Service at 1-800-553-1380 for additional information on modifications to existing equipment.

Binder Thickness

3M Reflective Elements should be applied at target binder thickness per the guidelines in Table 1. Contact 3M Technical Service for product recommendations and additional application information and restrictions.

Placement of Elements and Beads

Elements and beads must be applied to all pavement marking binders so their upper exposed portions are free of binder material due to rolling. When used with thermoplastic binders, for maximum performance, the elements and beads must be embedded (sunk) into the thermoplastic between 50% to 60% of their diameter. Under-sinking the beads and elements will result in premature loss and optical failure. Over-sinking the elements will result in low dry and wet brightness.

Typical Properties

Table 2 and Table 3 show typical properties for markings with bonded core elements. For 3M system of matched components binders, refer to the respective product bulletins, information folders, and related literature for additional information.

Table 2. Average initial coefficients of retroreflected luminance* [mcd/m²/lx] — standard elements for 25 mil high build paint, polyurea (except for 3M LPM 5000), epoxy, and MMA

Property/test method	Series Dry, Dry E, Dry M	Series 50, 50E, 50M	Series 90, 70E, 70M
Retroreflectivity Dry Average ASTM E1710	White: 1250 Yellow: 900	White: 700 Yellow: 525	White: 500 Yellow: 375
Retroreflectivity Wet Recovery Average ASTM E2177	N/A	White: 275 Yellow: 225	White: 375 Yellow: 300
Retroreflectivity Wet Continuous Average ASTM E2176-08	N/A	White: 100 Yellow: 75	White: 150 Yellow: 125
Retroreflectivity Wet Continuous Average ASTM E2832	N/A	White: 200 Yellow: 150	White: 275 Yellow: 225

Table 2a. Average initial coefficients of retroreflected luminance* [mcd/m²/lx] — standard elements in 3M LPM 5000

Property/test method	Series Dry	Series 50	Series 90
Retroreflectivity Dry Average ASTM E1710	White: 1250 Yellow: 900	White: 800 Yellow: 600	White: 600 Yellow: 450
Retroreflectivity Wet Recovery Average ASTM E2177	N/A	White: 300 Yellow: 250	White: 400 Yellow: 325
Retroreflectivity Wet Continuous Average ASTM E2176-08	N/A	White: 100 Yellow: 75	White: 150 Yellow: 125
Retroreflectivity Wet Continuous Average ASTM E2832	N/A	White: 250 Yellow: 200	White: 300 Yellow: 250

Table 2b. Average initial coefficients of retroreflected luminance* [mcd/m²/lx] — small elements in 18 to 22 mil high build paint and thermoplastic

Property/Test Method	Series Dry S	Series 50/51 S	Series 90/91 S
Retroreflectivity Dry Average ASTM E1710	White: 1250 Yellow: 900	White: 750 Yellow: 550	White: 550 Yellow: 400
Retroreflectivity Wet Recovery Average ASTM E2177	N/A	White: 250 Yellow: 200	White: 325 Yellow: 275
Retroreflectivity Wet Continuous Average ASTM E2176-08	N/A	White: 100 Yellow: 75	White: 150 Yellow: 125
Retroreflectivity Wet Continuous Average ASTM E2832	N/A	White: 175 Yellow: 125	White: 225 Yellow: 175

***Note:** Typical retroreflectivity results represent average performance for smooth pavement surfaces. Results may vary due to differences in pavement type and surface roughness. Increased element drop rate may be necessary to compensate for increased surface area, characteristic of rough pavement surfaces. Wet retroreflectivity testing of markings applied in a grooved recessed surface is difficult as water pools in the recess. Consider either installing a section of pavement marking on the pavement surface or on rigid panels (50 mil aluminum). If markings are applied to panels, allow to cure, then move carefully for retroreflectivity testing – make sure to protect optics when transporting.

Table 3. Other typical properties for elements

Property	Expected result	Test method
Minimum Index of refraction of microcrystalline ceramic beads	1.89 for Dry, 2.4 for Wet	ASTM E1967-98
Acid resistance of glass	No more than 15% of beads showing distinct opaque surface upon microscopic examination (20x)	24-hr exposure of microcrystalline ceramic beads to 1% solution (by weight) sulfuric acid

Traffic Marking Binder Material

The marking binder shall be of quality and type as designated by governing agency. The quality binder shall be thoroughly mixed, homogeneous, and applied to the road surface per manufacturer's specifications.

3M Reflective Elements

3M Reflective Elements must be installed using the double-drop element/bead delivery system. The Elements must be installed as the first drop of the double-drop system. The bonded core Elements shall be of the color of the traffic marking binder. Element types shall also be chosen for each binder type according to the recommendations in Table 1. Typical Gradation for the 3M Elements are shown in Table 4.

Table 4. Element gradations

Element gradations Mass percent passing (ASTM D1214)			
US mesh	Micron	Standard elements	"S" Series
12	1700	80 – 100	85 – 100
14	1410	45 – 80	70 – 96
16	1180	5 – 40	50 – 90
18	1000	0 – 20	5 – 60
20	850	0 – 7	0 – 25
30	600		0 – 7

3M Reflective Element Application Rates

The minimum recommended application rates are stated in Table 5 and Table 6 for smooth or densely-packed pavement surfaces. The application rates stated are designed to provide good initial wet and dry reflectivity as well as to match the longevity or restripe frequency of the pavement marking binder system to which the elements are installed. Durable marking binder systems will require a greater amount of elements for longer term performance.

For rough pavement surfaces (open-graded mixes, large stone mixes, etc.), the surface area can increase up to 50% greater than the corresponding foot-print of a flat surface. As a result it becomes necessary to increase materials (binder, elements and beads) used for the same coverage. A minimum element usage rate of 10 grams per 4-inch linear foot is necessary for all binder materials for rough pavement surfaces.

Table 5. 3M Reflective Element application rates for epoxy, MMA, polyurea, 3M LPM 5000 and thermoplastic

Element application rates	
Units	Minimum for smooth surface
Pounds per 4-inch linear foot	0.022 lbs
Pounds per mile, 4-inch width	116.4 pounds
Grams per 4-inch linear foot	10 grams per 4-inch linear foot

Table 6. 3M Reflective Element application rates for high build paint

Element application rates		
Units	Minimum for smooth surface	Improved durability and/or rough pavement surfaces
Pounds per 4-inch linear foot	0.011 lbs	0.022 lbs
Pounds per mile, 4-inch width	58.2 pounds	116.4 pounds
Grams per 4-inch linear foot	5 grams per 4-inch lf	10 grams per 4-inch linear foot

For high build paints, increasing element drop rates will also improve performance on flat surfaces. Increases of 30% to 40% in initial dry and wet reflectivity are common when increasing the element drop rate from 5 grams per 4-inch linear foot to 10 grams per 4-inch linear foot. Improved durability of the traffic marking also results from an increase in element drop rates adding significantly to the longevity of the reflectivity performance.

Second Drop Glass Beads

A second drop of glass beads is necessary to improve physical characteristics, durability of finished markings, and to assure expected track-free times. The glass beads usually provide some measure of increased visibility during dry conditions as well.

Many different glass bead gradations are currently used for pavement markings. Table 7 contains glass bead examples for paint, polyurea, epoxy, 3M™ LPM 5000, MMA and thermoplastic that have yielded the best results in the 3M system of matched components.

Table 7. Typical gradation of the second drop of glass beads

Common bead types with liquid pavement markings Bead gradations - mass percent passing (ASTM D1214)					
US mesh	Micron	AASHTO M247 Type I	Missouri specification Type P**	FP03 718.19 Type 3	18/50 (Utah) performance specification*
12	1700			100	
14	1410			95 – 100	
16	1180	100		80 – 95	
18	1000			10 – 40	65 – 80
20	850	95 – 100	90 – 97	0 – 5	
25	710			0 – 2	
30	600	75 – 95	60 – 87		0 – 30
40	425				
50	300	15 – 35	0 – 15		0 – 5
70	212		0 – 5		
80	180				
100	150	0 – 5			

*A minimum of 15% of total weight shall be from direct melt glass. All +30 US mesh beads shall be 85% minimum rounds and minimum crush strength of 30 lb. in accordance with ASTM D1213.

The range of typical glass bead application rates are shown in Table 8.

Table 8. Typical glass bead application rates

Typical glass bead application rates					
Binder type units	High build paint	Polyurea/ 3M LPM 5000	Epoxy*	MMA	Thermoplastic
Pounds per 4" linear foot	0.026 – 0.053 pounds/4 inch lf	0.033 – 0.053 pounds/4 inch lf	0.05 – 0.0917 pounds/4 inch lf	0.033 – 0.053 pounds/4 inch lf	0.033 – 0.053 pounds/4 inch lf
Grams per 4" linear foot	12 – 24 grams/4 inch lf	15 – 24 grams/4 inch lf	22.7 – 41.6 grams/4 inch lf	15–24 grams/4 inch lf	15 – 24 grams/4 inch lf
Pounds per gallon	6.4 – 12.8 pounds/gallon	8.0 – 12.8 pounds/gallon	12 – 22 pounds/gallon		
20 mils ~ 240 ft/gal					
Pounds per gallon	5.1 – 10.2 pounds/gallon	6.4 – 10.2 pounds/gallon	9.5 – 17.4 pounds/gallon		
25 mils ~ 190 ft/gal					
Pounds/100 Sq ft	7.94 – 15.87 lbs/100 sq ft	9.92 – 15.87 lbs/100 sq ft	15 – 27.5 lbs/100 sq ft	9.92 – 15.87 lbs/100 sq ft	9.92 – 15.87 lbs/100 sq
Preferred bead type	Missouri type P or 18/50 (Utah)			18/50 (Utah) or FP 03 #718.19 Type 3	

*Bead Drop Rate may be adjusted to achieve adequate track-free time.

Quality of Second Drop Glass Beads

The required glass beads shall have an index of refraction of 1.5 when tested by the immersion method at 25°C (77°F). The glass beads shall be surface treated for optimal performance with the liquid binder traffic marking. The glass beads shall have a minimum of 70% rounds as measured according to ASTM D1155. The surface of the glass beads shall be free of pits and scratches. The glass beads retained on the #40 U.S. Mesh Sieve (425 microns) shall have minimum crush strength of 30 pounds in accordance with ASTM D1213.

Storage

For best results store 3M reflective elements in a cool (40-100°F, 4-38°C), dry area indoors, or outdoors off the ground in a dry location and covered. Use elements within one year of receipt. Follow binder and glass bead manufacturer recommendations for storage.

Health and Safety Information

Read all health hazard, precautionary, and first aid statements found in the Safety Data Sheet (SDS) and/or product labels of chemicals prior to handling or use. Also refer to the SDS for information about the volatile organic compound (VOC) content of chemical products. Consult local regulations and authorities for possible restrictions on product VOC content and/or VOC emissions. Visit us at www.3M.com/us and select search.

Quality Policy and Warranty

All statements, technical information and recommendations furnished by 3M are true and reliable to the best of our knowledge. However, no guarantee of accuracy or completeness is given or implied, and the following is made in lieu of all warranties, express or implied.

1. 3M has no control over application, or the quality of the surface to which the materials are applied. Therefore, 3M's warranty for 3M Dry and All Weather Elements shall be limited to the quality of materials supplied to the applicator. 3M warrants that those materials shall, at the time of shipment, be free of manufacturing defects or during the stated warranty period, be free from defects and shall conform to 3M's manufacturing standards. In the case the warranty is not met, 3M's only obligation shall be to provide replacement materials in the quantity proved to be defective. The applicator shall bear the application costs associated with repair or replacement of 3M Reflective Elements.
2. 3M assumes no responsibility for any injury, loss or damage arising out of the use of product that is not of our manufacture. Where reference is made in our literature to a commercially available product made by another manufacturer, for example application equipment, it shall be the user's responsibility to ascertain its effectiveness and any precautionary measures for its use, outlined by its manufacturer.
3. 3M provides application recommendations with the goal of enabling users to achieve the best results possible. Recommendations provided by 3M are based upon our best knowledge, experience and judgment. However, statements or recommendations, technical or otherwise, not contained herein shall have no force or effect, unless in an agreement signed by officers of 3M.
4. 3M shall not be liable for any injury, loss or damage, direct, indirect or consequential, arising out of the use of or the inability to use the 3M Reflective Elements. Before using, the user shall determine the suitability of the 3M Reflective Elements for his/her intended use, and the user assumes all risk and liability whatsoever in connection therewith.

Literature Reference

For additional application information please refer to the following:

Product Bulletin AWP	All Weather Paint
Product Bulletin AWT	All Weather Thermoplastic
Product Bulletin LPM 5000	Liquid Pavement Marking Series 5000
Information Folder 5.20	Application Guidelines for Liquid Pavement Markings
Information Folder 5.22	Application Guidelines for 3M™ All Weather Paint
Information Folder 5.24	Application Guidelines for 3M™ All Weather Thermoplastic

For Information or Assistance

Call: 1-800-553-1380

In Canada Call:

1-800-265-1840

Internet:

www.3M.com/roadwaysafety

3M is a trademark of 3M. Used under license in Canada. U.S. Patent Nos. 6,166,106 and 6,451,874 B1. Patents applied for or granted in U.S. and other countries.

Dow and FASTRACK are trademarks of the Dow Chemical Company.

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.

Important Notice

All statements, technical information and recommendations contained herein are based on tests we believe to be reliable, but the accuracy or completeness thereof is not guaranteed, and the following is made in lieu of all warranties, or conditions express or implied. Seller's and manufacturer's only obligation shall be to replace such quantity of the product proved to be defective. Neither seller nor manufacturer shall be liable for any injury, loss or damage, direct, special or consequential, arising out of the use of or the inability to use the product. Before using, user shall determine the suitability of the product for his/her intended use, and user assumes all risk and liability whatsoever in connection therewith. Statements or recommendations not contained herein shall have no force or effect unless in an agreement signed by officers of seller and manufacturer.



Traffic Safety and Security Division

3M Center, Building 0225-04-N-14
St. Paul, MN 55144-1000 USA

Phone 1-800-553-1380
Web 3M.com/roadwaysafety

Please recycle. Printed in USA © 3M 2016.
All rights reserved. Electronic Only