



Dry Elements

Dry Standard/S Elements for Paint and Thermoplastic Pavement Markings

Dry P Elements for 3M Polyurea Pavement Markings

Dry E Elements for Epoxy Pavement Markings

Dry M Elements for MMA Pavement Markings

Description

3M™ Dry Elements 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 dry elements, when used with compatible binders form markings that are highly visible day and night dry weather conditions. Elements are available in both standard and “S” (slightly smaller size).

Bonded Core Element Construction

3M’s bonded core elements consist of microcrystalline ceramic beads embedded on a center core to provide optimal performance in dry conditions. As the first drop of a double drop system, the elements are visible dry, providing the motorist visibility in dry weather conditions.

Features and Benefits

- Provides superior dry weather performance for the motorist and measured per ASTM E1710.

Binders compatible with Dry Elements

Table 1.

Binder Compatibility		
Binder System	Target Thickness (0.001")	Element Series for Best Dry Reflectivity
High Build Paint	25	Dry Standard
High Build Paint	20	Dry S**
Thermoplastic	60-120+	Dry Standard/S
Polyurea	18-25	Dry P
Epoxy	18-25	Dry E
MMA	30-150+	Dry M

* 3M Matched Component System Available

** For 20 mil High Build paint, use only “S” Series elements

Table 1 illustrates the general compatibility of dry elements with pavement marking binders. Also highlighted are available 3M matched component systems.

Dry Standard/S Elements in High Build Paint

Dry Standard Elements are generally compatible with paints formulated with Dow HD-21 high-builds resin. 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). For Dry S Elements target wet thickness of 20 mils (0.020 inches).

A matched component system in high build paint consisting of pre-tested components and optimized for performance is also available from 3M. Consult Product Bulletin “All Weather Paint”.

Dry Standard/S Elements in Thermoplastic Markings

Dry Standard and S Elements are generally compatible with formulations based on alkyd and hydrocarbon binders. 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 matched component system consisting of pre-tested components and optimized for performance is also available. Consult Product Bulletin “All Weather Thermoplastic”.

Dry E Elements in Epoxy Markings

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

Dry P Elements in Polyurea Markings

Dry P Elements are compatible in 3M Polyurea markings. It should be used as part of the matched component system. Consult Product Bulletin “LPM 1400” for product details.

Dry M Elements in MMA Markings

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

Weather and Pavement Conditions

Dry Elements should be applied within established application guidelines for the appropriate binders.

Equipment

Dry Elements must be installed using a double-drop element/bead delivery system. The elements are installed as the first drop of the two-drop system. The elements must be installed 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.

Thickness

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

Marking Dimensions

In accordance with the Manual on Uniform Traffic Control Devices (MUTCD) and the project.

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 imbedded into the thermoplastic between 50% to 60%. Under-sinking the beads and elements will result in premature loss and optical failure. Over-sinking the elements will result in low initial dry and wet brightness.

Typical Properties

The following are typical properties for markings with bonded core elements, as shown in Tables 2 and 3. For 3M matched component literature refer to respective binder type for additional information.

Table 2. Typical Properties

	Typical Initial Retroreflectivity (ASTM E1710)* Average values over many applications (mcd(ft-2)(fc-1); {metric equivalent mcd(m-2)(lux-1)})			
	Elements in Agency Binder Product Series Name		3M MATCHED COMPONENT SYSTEM Product Series Name	
	White	Yellow	White	Yellow
	Dry Standard, Dry S, Dry E, Dry P and Dry M	Dry Standard, Dry S, Dry E, Dry P and Dry M	Dry Standard, Dry S and Dry P	Dry Standard, Dry S and Dry P
Typical Initial Dry Retroreflectivity (ASTM E1710)*	1250	900	1600	1150
Typical minimum Initial Dry Retroreflectivity (ASTM E1710)*	1000	700	1250	900

* Note: Typical Retroreflectivity results represent average performance for smooth pavement surfaces.
Values represent both standard and "S" Series elements; however only standard size product designations shown
Results may vary due to differences in pavement type and surface roughness.
Increase element drop rate may be necessary to compensate for increased surface area characteristic of rough pavement surfaces.

Table 3. Other typical properties for Elements

Property	Expected Result	Test Method
Index of refraction of microcrystalline ceramic bead	1.9 minimum	ASTM E 1967-98
Acid resistance of glass	No more than 15% of beads showing distinct opaque surface upon microscopic examination (20x).	Exposure of 1% solution (by weight) of microcrystalline ceramic beads sulfuric acid.

Application Requirements

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 Dry Elements

Dry Elements must be installed using double-drop element/bead delivery system. The elements are installed as the first drop of the double-drop system. The bonded core elements shall be of Series type as designated by the governing agency to match the traffic marking binder. Refer to 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

Dry Element Application Rates

The minimum recommended application rates are stated in Table 5 & 6 for smooth or dense pavement surfaces. The application rates stated are designed to provide good initial dry reflectivity as well as to match the longevity or restripe frequency of the pavement marking binder system to which the elements are installed. Therefore durable marking binder systems will require 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. Dry Element Application Rates For Epoxy, MMA, Polyurea, 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 lf

Table 6. Dry 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 lbs.	116.4 pounds
Grams per 4-inch linear foot	5 grams per 4-inch lf	10 grams per 4-inch lf

For high build paints, increasing element drop rates will also improve performance on flat surfaces. Increases of 30% to 40% in initial dry 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 also provide some measure of increased visibility during dry conditions.

Many different glass bead gradations are currently used for pavement markings. Table 7 contains glass bead examples for paint, Polyurea, Epoxy, MMA and thermoplastic that have yielded best results in 3M matched component systems.

Table 7. Gradation of the Second Drop of Glass Bead

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 III	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 D 1213

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	Epoxy *	MMA	Thermoplastic
Pounds per 4" lineal foot	0.026 - 0.052 pounds/4 inch lf	0.026 - 0.052 pounds/4 inch lf	0.05 - 0.0917 pounds/4 inch lf	0.026 - 0.052 pounds/4 inch lf	** See note below
Grams per 4" lineal foot	12 - 24 grams/4 inch lf	12 - 24 grams/4 inch lf	22.7 - 41.6 grams/4 inch lf	12 - 24 grams/4 inch lf	** See note below
Pounds per gallon 20 mils ~ 240 ft/gal	6.4 to 12.8 pounds/gallon	6.4 to 12.8 pounds/gallon	12 to 22 pounds/gallon		
Pounds per gallon 25 mils ~ 190 ft/gal	5.0 to 10.0 pounds/gallon	5.0 to 10.0 pounds/gallon	9.5 to 17.4 pounds/gallon		
Pounds/100 Sq ft	7.8 - 15.6 lbs/100 sq ft	7.8 - 15.6 lbs/100 sq ft	15 - 27.5 lbs/100 sq ft	7.8 - 15.6 lbs/100 sq ft	10lbs /100 sq ft
Preferred Bead Type	Missouri Type P or Utah			Utah or FP 03 #718.19 Type 3	

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

** When using 10 grams (0.022 lbs) Dry Elements per 4 inch if area use either 12 grams (0.026 lbs) of Type III or 22 grams (0.049 lbs) of Utah blend glass beads.

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 dry 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 commendations for storage.

Health and Safety Information

Read all health hazard, precautionary, and first aid statements found in the Material Safety Data Sheet (MSDS) and/or product labels of chemicals prior to handling or use. Also refer to the MSDS 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. Electronically, visit us at www.3M.com/us and select search.

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Literature References

For additional application information please refer to the following:

- PB AWT All Weather Thermoplastic
- IF 5.24 Application Guidelines for 3M™ All Weather Thermoplastic
- PB AWP All Weather Paint
- IF 5.22 Application Guidelines for 3M™ All Weather Paint
- IF 5.20 Application Guidelines for Liquid Pavement Markings
- PB LPM 1400 All Weather Liquid Pavement Marking Series 1400
- PB 3M™ All Weather Elements

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