Description

3M™ Connected Roads All Weather Elements (“Large Elements”) are designed for use on roadways and highways, primarily as long line pavement markings, either as new marking applications or as parts of maintenance marking applications. Large Elements, when used with compatible binders and a second drop of glass beads, form markings that are highly visible, day and night, under both dry and wet conditions.

Table A. 3M™ Connected Roads All Weather Elements Product Family

Large Elements for All Dry Reflectivity	Large Elements for Majority Dry Reflectivity With Some Wet Reflectivity	Large Elements for Balanced Wet and Dry Reflectivity	Large Elements for High Wet Reflectivity	Large Elements for All Wet Reflectivity
Dry White	30	50	90	Wet White
Dry Yellow	31	51	91	Wet Yellow
Dry M White	30M	50M	70M	Wet M White
Dry M Yellow	31M	51M	71M	Wet M Yellow
Dry E White	30E	50E	70E	Wet E White
Dry E Yellow	31E	51E	71E	Wet E Yellow

Composite Optic Construction

Large Elements consist of an outer layer of microcrystalline ceramic beads partially embedded into composite cores to provide optimal performance under dry and/or wet conditions.

Specifications

Retroreflectivity

Large Elements, when tested according to the methods below, shall have the minimum wet and dry cup brightness values presented in Table B. See the Cup Reflectivity Tests for 3M™ Connected Roads All Weather Elements Technical Bulletin for test details.

Table B. Minimum Initial Coefficients of Retroreflection [cd/lx/m^2]

Property/Test Method	Series Dry, Dry E, Dry M	Series 30, 30E, 30M	Series 50, 50E, 50M	Series 90, 70E, 70M	Series Wet, Wet E, Wet M
Dry Cup Brightness R_A, cd/lx/m^2	**White:** 18.6 **Yellow:** 11.5	**White:** 11.1 **Yellow:** 5.9	**White:** 7.4 **Yellow:** 4.6	**White:** 1.8 **Yellow:** 1.1	N/A
Wet Cup Brightness R_A, cd/lx/m^2	N/A	**White:** 0.8 **Yellow:** 0.6	**White:** 2.4 **Yellow:** 1.2	**White:** 4.2 **Yellow:** 2.1	**White:** 6.0 **Yellow:** 3.0

Gradation

The gradation of Large Elements shall meet or be within the limits in Table C.

Table C. Element Gradation (ASTM D1921)

US Mesh	Micron	Mass Percent of Large Elements Passing Through the Sieve
10	2,000	95% to 100%
14	1,410	0% to 40%
20	850	0% to 5%

Ceramic Bead Typical Properties

Table D. Typical Properties of Ceramic Beads for 3M™ Connected Roads All Weather Elements.

Property	Test Method	Expected Result
Index of Refraction	**Dry:** ASTM E1967 **Wet:** 3M Proprietary Test Method	**Dry:** 1.89 **Wet:** 2.4
Acid Resistance	24 hour exposure of microcrystalline ceramic beads to a 1% (by weight) sulfuric acid solution	No more than 15% of beads showing distinct opaque surface upon microscopic examination

Large Elements Use and Binder Compatibility

Use a marking binder of a quality and type as designated by the governing agency. Ensure it is thoroughly mixed, homogeneous, and applied to the road surface per the manufacturer's specifications. Table E presents the general compatibilities of Large Elements with several common pavement marking binders.

Table E. General Compatibilities of 3M™ Connected Roads All Weather Elements

Binder	Target Binder Thickness, wet (mils)	Large Elements Series for All Dry Reflectivity	Large Elements Series for Majority Dry Reflectivity With Some Wet Reflectivity	Large Elements Series for Balanced Wet and Dry Reflectivity	Large Elements Series for High Wet Reflectivity	Large Elements Series for All Wet Reflectivity
High build water-borne paint	25 to 35	Dry	30	50	90	Wet
Thermoplastic	≥90	Dry	30	50	90	Wet
3M™ Liquid Pavement Marking Series 5000 (“LPM 5000”)	18 to 30	Dry	30	50	90	Wet
Epoxy and Polyurea (excluding LPM 5000)	18 to 30	Dry E	30E	50E	70E	Wet E
Methyl Methacrylate (MMA)	18 to 150	Dry M	30M	50M	70M	Wet M

Reflective Large Elements for High Build Waterborne Paint Binder

Series Dry, 30, 50, 90, and Wet are generally compatible with paints formulated with Dow® FASTRACK™ HD21-A binder. Since formulations may vary, use of such paints is on a user test-and-approve basis. Apply the paint at a target wet thickness of at least 25 mils (0.6 mm).

Reflective Large Elements for Thermoplastic Binder

Series Dry, 30, 50, 90, and Wet are generally compatible with formulations based on alkyd and hydrocarbon binders with a target thickness greater than 90 mils (2.3 mm). At a minimum, these materials should meet AASHTO M249 specifications. Since formulations may vary, use of such products is on a user test-and-approve basis.

Reflective Large Elements for Epoxy and Polyurea Binder

Series Dry E, 30E, 50E, 70E, and Wet E are generally compatible with formulations of epoxy and polyurea pavement markings. Since formulations may vary, use of such products is on a user test-and-approve basis. Equipment setup and operation, operating temperatures, and atmospheric conditions are all variables that affect the cure speed of liquid binders and, as a result, Element embedment and adhesion.

Reflective Large Elements for LPM 5000 Binder

Series Dry, 30, 50, 90, and Wet are compatible with LPM 5000 markings. See 3M Product Bulletin LPM 5000 for further information.

Reflective Large Elements for Methyl Methacrylate (MMA) Markings

Series Dry M, 30M, 50M, 70M, and Wet M are generally compatible with MMA pavement markings. Higher viscosity MMAs may negatively affect Element embedment. Since formulations may vary, use of such products is on a user test-and-approve basis.

Typical Applied Properties

Typical average initial retroreflectance values when applied as described in 3M Information Folder 5.23 are shown in Table F. Some variance should be expected across applications, and all values represent initial properties unless otherwise noted.

Table F. Typical Average Initial Coefficients of Retroreflected Luminance [mcd/m^2/lx]

Property/Test Method	Series Dry, Dry E, Dry M	Series 30, 30E, 30M	Series 50, 50E, 50M	Series 90, 70E, 70M	Series Wet, Wet E, Wet M
Retroreflectivity, Dry Average ASTM E1710	**White:** 1,250 **Yellow:** 900	**White:** 825 **Yellow:** 625	**White:** 700 **Yellow:** 525	**White:** 500 **Yellow:** 375	N/A
Retroreflectivity, Wet Recovery Average ASTM E2177	N/A	**White:** 150 **Yellow:** 125	**White:** 275 **Yellow:** 225	**White:** 375 **Yellow:** 300	**White:** 400 **Yellow:** 325
Retroreflectivity, Wet Continuous Average ASTM E2832	N/A	**White:** 100 **Yellow:** 75	**White:** 200 **Yellow:** 150	**White:** 275 **Yellow:** 225	**White:** 300 **Yellow:** 250

[a] Typical retroreflectivity results represent the average performance for smooth pavement surfaces. Results may vary due to differences in pavement type and surface roughness. Initial readings taken of "M" or "E" Large Elements must be performed after the treatment has been cleaned off of the Large Elements. Increased Large Elements drop rate may be necessary to compensate for the increased surface area characteristic of rough pavement surfaces. Wet retroreflectivity testing of markings applied in grooved or recessed surfaces is difficult since water pools in recesses. In such cases, consider installing sections of pavement markings for testing on either a smooth section of the pavement surface, or on rigid panels (50 mil aluminum). If markings are applied to panels, allow them to cure, then move them carefully for retroreflectivity testing - make sure to protect the optics during transportation. The addition of Type 4 beads may result in reduced initial retroreflectivity, but can provide better element protection for increased durability.

NOTE

Pavement marking hydrophobicity is reduced through exposure to traffic and the environment. Therefore, newly installed pavement markings must be exposed to traffic and the environment for a period of time to avoid false high wet retroreflectivity readings.

The testing procedures of ASTM E2832 and ASTM E2177 also recommend that retroreflectivity measurements taken under wet conditions be performed only after newly installed pavement markings have been exposed to traffic for a period of time sufficient to minimize the effects of hydrophobicity. 3M recommends exposing all new pavement markings to traffic for a period of time proportional to the road's lane annual average daily traffic ("Lane AADT") prior to taking initial retroreflectivity measurements, as described in Table G.

Table G. Recommended Traffic Exposure Time as a Function of Lane AADT

Lane AADT	Initial Reading Period (weeks of traffic exposure)
< 5,000	3 to 4
5,000 to 15,000	2 to 3
> 15,000	1 to 2

Since pavement marking panels prepared for laboratory measurements are typically NOT exposed to traffic, they are usually hydrophobic. When taking laboratory measurements on pavement markings installed on panels, particular care must be taken to avoid hydrophobic conditions. The use of surfactants in the water used for testing retroreflectivity under wet conditions can create microscopic foaming and bubbles, resulting in unacceptable measurement variability.

Large Elements with "E" and "M" designations have been treated to prevent them from over-sinking into the binder and to slow the wicking of the binder onto the Large Elements. This treatment causes a temporary reduction in retroreflectivity that is regained after exposure to weather and vehicle traffic. Retroreflectivity recovery may take up to five weeks, depending on the weather and vehicle traffic levels. Data presented in Table E were, therefore, taken after the treatment was cleaned off. Similarly, users should take initial retroreflectivity readings on E and M type Large Elements after the treatment has been cleaned off by exposure to weather and vehicle traffic. However, if spot checks are required for markings containing "E" and "M" Large Elements at the time of application, they should only be performed upon fully hardened markings and after the treatment has been manually cleaned off of the Large Elements.

To remove the treatment:

1. Soak the line section to be measured with Concentrated Simple Green® All Purpose Cleaner.
2. Let stand for 2 minutes.
3. Rinse clean with water.
4. Blot the line with a clean, dry cotton towel to remove excess water.
5. Allow the Large Elements to dry completely before performing dry or wet retroreflectivity tests.

Application

See 3M Information Folder 5.23 for detailed application instructions.

Select the Large Elements type based on the pavement marking binder type, according to the criteria described in Table E on page 2, ensuring the Large Elements are the same color as the binder. Always install Large Elements using the double-drop Large Elements/bead delivery system, with Large Elements being the first drop. Contact a 3M representative with any additional installation questions.

Follow the binder and glass bead manufacturers' instructions for application and storage requirements.

Storage and Shelf Life

Store Large Elements covered and off the ground in a dry area at a temperature of 40°F to 120°F (4°C to 49°C).

Use Large Elements within two years of the date of manufacture.

3M Related Literature

Always confirm you have the most current version of the applicable technical literature from 3M's website at www.3M.com/roadsafety.

- 3M Information Folder 5.18 Application Guidelines for Pavement Markings in Grooved Pavement Surfaces
- 3M Information Folder 5.23 3M™ Connected Roads All Weather Elements Application Guidelines
- 3M Information Folder 5.28 Liquid Pavement Marking Application Guidelines Series 5000
- 3M Product Bulletin LPM 5000 3M™ Liquid Pavement Marking Series 5000
- Cup Reflectivity Tests for 3M™ Connected Roads All Weather Elements Technical Bulletin
- ASTM Test Methods are available from ASTM International, West Conshohocken, PA.

Health and Safety

Chemicals

When handling any chemical products, read the manufacturers' container labels and the safety data sheets (SDS) for important health, safety, and environmental information.

Follow this link to obtain SDS sheets for 3M products.

Follow this link to obtain information about substances of very high concern (SVHC) for EU products.

Tools and Equipment Usage

When using any equipment, always follow the manufacturer's instructions for safe operation.

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Commercial Branding and Transportation
3M Center, Building 223-3N-30
St. Paul, MN 55144

1-800-328-3908
3M.com/roadsafety

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