

**DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA**

SPECIAL PROVISION

Section 657— Preformed Plastic Pavement Markings

Delete Section 657 and substitute the following:

657.1 General Description

This work includes placing plastic pavement markings or legends according to the Plans and Specifications or as otherwise directed.

657.1.01 Definitions

General Provisions 101 through 150.

657.1.02 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

ASTM D 638

ASTM D 4061

ASTM D 4505

ASTM D 4592

ASTM E 303

ASTM E 1710

ASTM E 2177

US EPA Method 3052

US EPA Method 6010C

Manual on Uniform Traffic Control Devices for Streets and Highways

Federal Test Standard 141, Method 6192

[QPL 74](#)

SOP 39

657.1.03 Submittals

Transfer to the Department manufacturer warranties or guarantees for heat-applied and wet reflective preformed plastic marking materials. Ensure that warranties or guarantees state that they are subject to transfer.

657.2 Materials

Select one of the following types of preformed marking material according to the Plans and Proposal:

- Type TR – Temporary Removable Plastic Marking
- Type TN – Temporary Non-Removable Plastic Marking
- Type PA – Permanent Plastic Marking
- Type PB – Permanent Patterned Plastic Marking
- Type PB-WR – Permanent Patterned Wet Reflective Plastic Markings

For a list of sources, see [QPL-74](#).

A. General Requirements for Preformed Pavement Markings

1. Shapes and Sizes

Use markings that conform to the shapes and sizes outlined in the Manual on Uniform Traffic Control Devices for Streets and Highways.

2. Pigmentation

Use white or yellow pigmented plastic according to each marking type.

3. Adhesion

Use markings that can be affixed to bituminous or Portland cement concrete pavements by pressure-sensitive precoated adhesive or a liquid contact cement.

Ensure that marking adhesive adheres to the roadway under normal climactic and traffic conditions.

4. Conformability

Use markings that will mold to pavement contours, breaks, faults, and the like, by normal action of traffic at normal pavement temperatures.

5. NTPEP Evaluation

Use markings evaluated by the National Transportation Product Evaluation Program (NTPEP).

6. Glass Spheres and/or Reflective Composite Optics

Use markings with a layer of glass spheres and/or reflective composite optics bonded to the surface according to the marking type. Type PB and PB-WR contain glass beads and/or reflective composite optics. Types TR, TN, and PA contain only glass beads.

Do not use glass spheres and /or reflective composite optics containing greater than 200 ppm total arsenic, 200 ppm total antimony, or 200 ppm total lead when tested according to US EPA Methods 3052 and 6010C, or other approved methods.

Use glass spheres with less than 2% by weight showing any milkiness, scoring or scratching. Use clear, transparent spheres that are free from air inclusions and conform to the following:

	Glass Spheres
Refractive Index, (tested by oil immersion)	1.50 minimum
Uniform Distribution of Spheres	0.75 minimum

7. Reflective Intensity (Types TR, TN and PA)

Determine reflective intensity in accordance with ASTM D4061 or E1710.

Ensure that marking types TR, TN, and PA use white or yellow film with the initial reflective intensity indicated in the table below, when measured at the angles shown.

	White	Yellow
Observation Angle	1.05°	1.05°
Entrance Angle	88.8°	88.8°
Reflective Intensity – Millicandelas per square meter per lux	500	300

8. Composition

Use markings made of high-quality polymeric materials and pigments. Ensure types TR and PA contain the following composition of materials:

Material	Min% By Weight
Resins and Plasticizers	20
Pigments	30
Graded Glass Spheres	33

B. Requirements for Temporary Markings (Types TR and TN)

1. Temporary Removable Markings (Type TR)

Use temporary, removable markings that meet the following requirements:

a. Removability

Ensure the marking material can be removed from asphaltic and Portland cement as follows:

- Lifted intact or in large pieces.
- Lifted either manually or with a roll-up device.
- Lifted at temperatures above 40 °F (5 °C) without using heat, solvents, sand blasting, or grinding.

Ensure the pavement shows no objectionable staining or damage after removing the marking.

b. Elongation and Tensile Strength

Provide temporary markings with the following elongation and tensile strength when tested according to ASTM D 638:

Elongation	50% maximum
Tensile Strength	40 lbs/in ² (275 kPa) minimum

Test as follows:

- 1) Cut a 1 in by 6 in (25 mm by 150 mm) specimen.
- 2) Test at a temperature between 70 °F and 80 °F (21 °C and 27 °C).
- 3) Test at a jaw speed of 12 in/min (300 m/min).

c. Adhesion

Ensure that temporary marking material meets the adhesion requirements of ASTM D4592.

d. Glass Sphere Retention

Confirm the glass Sphere retention quality of marking material in both of the following ways:

1) Laboratory Test

- Take a 2 in by 6 in (50 mm by 150 mm) sample.
- Bend the sample over a ½ in (13 mm) diameter mandrel, leaving the 2 in (50 m) side perpendicular to the mandrel axis.
- Ensure that the area on the mandrel shows no more than 10 percent of the beads entrapped by the binder less than 40 percent.

2) Field test

Ensure the Spheres cannot be easily removed by scratching the material firmly with the thumbnail.

e. Skid Resistance

Ensure that the material surface provides a 35 BPN minimum skid resistance value when tested according to ASTM E 303.

f. Thickness

Ensure that the removable marking material is at least 20 mils (0.50 mm) thick not including the backing adhesive.

2. Temporary Non-Removable markings (Type TN)

This type of pavement marking may use a conformable metallic foil backing with a precoated pressure-sensitive adhesive. Skid Resistance

- a. Ensure the retroreflective pliant polymer surface provides a skid resistance value of at least 35 BPN. Test according to ASTM E 303.
- b. Elongation and Tensile Strength
No test for elongation and tensile strength is required for type TN marking.
- c. Glass Sphere Retention
Refer to [Subsection 657.2.B.1.d, “Glass Sphere Retention”](#).
- d. Thickness

Ensure the nonremovable marking material is at least 20 mils (0.50 mm) not including the adhesive backing.

C. Requirements for Permanent Markings (Types PA, PB and PB-WR)

1. Permanent Plastic Marking (Type PA)

Provide permanent plastic markings with these features:

a. Adhesive and Backing

Use markings supplied with the following:

- A precoated adhesive
- An easily removable backing to protect the adhesive
- An adhesive backing that allows repositioning of the marking on the surface before permanently sticking with greater pressure

In addition, supply rolls of lane lines with a precoated adhesive but without the protective backing material.

b. Pigments

1) White

Use white marking material meeting the initial color requirements of ASTM D4505.

2) Yellow

Use yellow marking material meeting the initial color requirements of ASTM D4505.

3) Appearance

Ensure that each marking meets the following appearance standards:

- Markings are extruded to a uniform thickness.
- Edges are smoothly cut and true.
- Glass spheres are retained on all sides by the plastic base material.
- The wearing surface is free of indentations, displaced spheres, or other irregularities that retain dirt, dust, or other foreign materials.

c. Thickness

Ensure the permanent material is at least 60 mils (1.52 mm) thick, without the pre-coated adhesive.

d. Glass Sphere Retention

Confirm that the surface glass spheres are strongly bonded and are not easily removed by traffic. Test them as follows:

- 1) Use a Taber Abraser with an H-18 wheel and 125 gram load.
- 2) Inspect the sample at 200 cycles under the microscope to observe the extent and type of bead failure.
- 3) Ensure that no more than 15 percent of the spheres have popped-out.
- 4) Verify that the predominant mode of failure is “wear-down” of the spheres.

e. Tensile Strength and Elongation

Ensure that the permanent markings have the following elongation and tensile strength when tested according to ASTM D 638:

Elongation	50% maximum
Tensile Strength	150 psi (1035 kPa) minimum

Test as follows:

NOTE: Run this test 3 times and base the result on an average of the 3 tests.

- 1) Cut 3 specimens, 1 in by 6 in (25 mm by 150 mm) each.
 - 2) Place 1 in² (625 mm²) of carborundum extra-coarse emery cloth or its equivalent at each end of the test specimens to prevent the adhesive from sticking to test equipment.
 - 3) Test at a temperature between 70 ° and 80 °F (21 ° and 27 °C).
 - 4) Test at a jaw speed of 10 to 12 in/min (250 mm to 300 mm/min).
- f. Skid Resistance
Test the plastic surface to verify that it provides a skid resistance value of at least 45 BPN. Test according to ASTM E 303.
- g. Adhesive
Ensure permanent markings meet the adhesion requirements of ASTM D4505.
2. Permanent Patterned Plastic Marking (Type PB)
Use patterned plastic markings with these features:
- a. Patterned Surface
Ensure that the patterned surface has the following characteristics:
 - A reflective layer of glass spheres and/or reflective composite optics bonded to a durable polyurethane topcoat.
 - The raised area comprises approximately 40% ± 15% of the total marking face.
 - The surface presents a near vertical face (β angle of 0° to 60°) to traffic from any direction.
 - The Office of Materials and Research approves the pattern configuration.
 - The channels between raised areas are free of exposed beads or particles.
 - b. Adhesive and Backing
Refer to [Subsection 657.2.C.1.a, “Adhesive and Backing”](#).
 - c. Pigments
Refer to [Subsection 657.2.C.1.b, “Pigments”](#).
 - d. Glass Spheres and Reflective Composite Optics
Ensure that the top layer of glass spheres and/or reflective composite optics are bonded to a durable polyurethane surface.
 - e. Thickness
Ensure the permanent material is at least 60 mils (1.52 mm) thick at the thickest portion of the patterned cross-section, and at least 20 mils (0.508 mm) at the thinnest portion of the cross-section.
 - f. Tensile Strength and Elongation
Refer to [Subsection 657.2.C.1.e, “Tensile Strength and Elongation”](#).
 - g. Skid Resistance
Refer to [Subsection 657.2.C.1.f, “Skid Resistance”](#).
 - h. Dry Reflective Intensity
Determine reflective intensity in accordance with ASTM D 4061 or E1710. Initial minimum dry reflective values are as follows:

	White	Yellow
Observation Angle	1.05°	1.05°

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	White	Yellow
Entrance Angle	88.8°	88.8°
Reflective Intensity – Millicandelas per square meter per lux	600	400

3. Permanent Patterned Wet Reflective Plastic Marking (Type PB-WR)

Use patterned plastic markings with these features:

a. Patterned Surface

Ensure that the patterned surface has the following characteristics:

- A reflective layer of glass spheres and/or reflective composite optics bonded to a durable polyurethane topcoat.
- The raised area comprises approximately 40% ± 15% of the total marking face.
- The surface presents a near vertical face (β angle of 0° to 60°) to traffic from any direction.
- The Office of Materials and Research approves the pattern configuration.
- The channels between raised areas are free of exposed beads or particles.

b. Adhesive and Backing

Refer to [Subsection 657.2.C.1.a, “Adhesive and Backing”](#) .

c. Pigments

Refer to [Subsection 657.2.C.1.b, “Pigments”](#) .

d. Glass Spheres Beads and Reflective Composite Optics

Ensure that the top layer of glass spheres and/or reflective composite optics are bonded to a durable polyurethane surface.

e. Thickness

Ensure the permanent material is at least 60 mils (1.52 mm) thick at the thickest portion of the patterned cross-section, and at least 20 mils (0.508 mm) at the thinnest portion of the cross-section.

f. Tensile Strength and Elongation

Refer to [Subsection 657.2.C.1.e, “Tensile Strength and Elongation”](#).

g. Skid Resistance

Refer to [Subsection 657.2.C.1.f, “Skid Resistance”](#).

h. Dry Reflective Intensity

Determine reflective intensity in accordance with ASTM D 4061 or E1710. Initial minimum dry reflective values are as follows:

	White	Yellow
Observation Angle	1.05°	1.05°
Entrance Angle	88.8°	88.8°
Reflective Intensity – Millicandelas per square meter per lux	600	400

i. Wet Reflective Intensity

Determine wet reflective intensity in accordance with ASTM E2177.

Ensure that markings meet the following initial minimum wet retroreflective intensity.

	White	Yellow
Divergence Angle	1.05°	1.05°
Incidence Angle	88.8°	88.8°
Reflective Intensity --Millicandelas per square meter per lux	250	200

657.3 Construction Requirements

General Provisions 101 through 150.

657.3.01 Personnel

Send a factory-trained representative from the material manufacturer to the jobsite at the start of each project.

657.3.02 Equipment

General Provisions 101 through 150.

657.3.03 Preparation

General Provisions 101 through 150.

657.3.04 Fabrication

General Provisions 101 through 150.

657.3.05 Construction

Remove existing pavement markings according to [Subsection 653.3.05.B, “Removing Existing Stripe.”](#)

A. Pre-Conditions for Applying Markings (Types PB and PB-WR)

1. Meet the following conditions before applying markings onto new asphaltic pavements:
 - The ambient temperature is 40 °F (4 °C) and rising.
 - New asphaltic pavement temperature is at least 120 °F (49 °C).
 - The plastic can be applied to new asphaltic pavement immediately before the new surface is rolled for the final time.
 - Conventional steel rollers and water used with them do not impede the plastic’s application.
2. Meet the following conditions before applying markings onto all pavements:
 - The ambient temperature is 40 °F (4 °C) and rising.
 - The pavement temperature is at least 40 °F (4 °C) and rising.
 - The previous night temperature did not fall below 40 °F (4 °C).
 - No significant rainfall occurred 24 hours prior to the plastic’s application.

B. Pre-Conditions for Applying Markings (Types TR, TN, and PA)

1. Meet the following conditions before applying markings onto new asphaltic pavements:
 - The ambient temperature is 60 °F (15 °C) and rising.
 - New asphaltic pavement temperature is at least 120 °F (49 °C).
 - The plastic can be applied to new asphaltic pavement immediately before the new surface is rolled for the final time.
 - Conventional steel rollers and water used with them do not impede the plastic’s application.
2. Meet the following conditions before applying markings onto all pavements:
 - The ambient temperature is 60 °F (15 °C) and rising.
 - The pavement temperature is at least 70 °F (21 °C) and rising.
 - The previous night temperature did not fall below 40 °F (4 °C).
 - No significant rainfall occurred 24 hours prior to the plastic’s application.

C. Remove Existing Stripe

Remove at least 90% of existing traffic stripe under either of the following conditions:

- On Portland cement concrete pavement where the new stripe is to be placed at the same location as the existing marking
- On all pavements where the new stripe is to be placed at a location different from the existing marking

D. Applying Markings

Apply markings as follows:

1. Thoroughly clean the pavement. Clean with compressed air, hand brooms, rotary brooms, scrapers, or other approved methods which leave the pavement thoroughly clean and undamaged. Remove all vegetation and road film from the area to be striped. Mechanically wire brush or abrasive blast clean all new Portland cement concrete pavement surfaces to remove all laitance and curing compound from the area to be striped.
2. Apply an adhesive activator according to the manufacturer’s recommendations, when required.
3. Position markings according to the Plans.
4. Press positioned markings firmly onto the pavement.
5. Offset longitudinal lines at least 2 in (50 mm) from construction joints of Portland cement concrete pavements.

E. Tolerances and Appearance

1. Cut off all stripe ends squarely and cleanly.
2. The length of the 10 ft (3 m) segment for skip stripe and the 30 ft (9 m) gap between segments may vary plus or minus 1 in (25 mm). Do not allow the alignment of skip stripe to deviate from the intended alignment by more than 0.5 in (13 mm). Do not allow the alignment of edge stripe to deviate from the intended alignment by more than 0.5 in (13 mm) on tangents and on curves with a radius up to and including one degree. Do not allow the alignment of edge stripe to deviate from the intended alignment by more than 1 in (25 mm) on curves exceeding one degree.
3. Stop work when deviation exceeds the above dimensions, and remove the nonconforming stripe.

657.3.06 Quality Acceptance

A. General

Segments of preformed plastic traffic stripe that have been placed according to the Plans and Specifications may be accepted 30 days after the required work is complete in that segment. If Preformed Plastic Traffic Stripe fails to meet Plan details or Specifications or deviates from stated dimensions, correct it at no additional cost to the Department. If removal of pavement markings is necessary, perform it according to [Section 656](#) and replace it according to this Specification. No additional payment will be made for removal and replacement of unsatisfactory striping.

Obtain pavement marking retroreflectivity values with a 30 meter geometry retroreflectometer.

B. Initial Retroreflectivity

1. Longitudinal Lines

Within 30 days of installation, ensure the in place markings meet the following minimum reflectance values:

a. Type PB

	White	Yellow
Dry (ASTM E 1710)	600 mcd/lux/m ²	400 mcd/lux/m ²

b. Type PB-WR

	White	Yellow
Dry (ASTM E 1710)	600 mcd/lux/m ²	400 mcd/lux/m ²
Wet recovery (ASTM E 2177)	250 mcd/lux/m ²	200 mcd/lux/m ²

For each center line, edge line, and skip line, measure retroreflectivity 9 times for each mile; 3 times within the first 500 ft (152 m), 3 times in the middle, and 3 times within the last 500 ft (152 m). For projects less than one mile in length, measure retroreflectivity 9 times as above.

Record all retroreflectivity measurements on the form OMR CVP 66 in SOP 39.

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2. Messages, Symbols, and Transverse Lines

Within 30 days of installation, ensure both Type PB and Type PB-WR in-place markings when tested according to ASTM E 1710 meet the following minimum reflectance value of 600 mcd/lux/m².

Perform at a minimum, one retroreflectivity measurement at one message, one symbol and one transverse line per intersection. Take one measurement per mile for locations other than intersections (i.e. school messages, railroad messages, bike symbols etc.)

C. Six Month Retroreflectivity (Longitudinal Lines)

Maintain the following minimum reflectance values for 180 days after installation:

1. Type PB

	White	Yellow
Dry (ASTM E 1710)	600 mcd/lux/m ²	400 mcd/lux/m ²

2. Type PB-WR

	White	Yellow
Dry (ASTM E 1710)	600 mcd/lux/m ²	400 mcd/lux/m ²
Wet recovery (ASTM E 2177)	250 mcd/lux/m ²	200 mcd/lux/m ²

Retest the in-place markings according to [Subsection 657.3.06.B.1](#) 180 days after installation to ensure these minimum retroreflectance values are maintained.

Note: The Contractor is responsible for retroreflectivity testing. Furnish initial test results to the Engineer within 30 days of application. Furnish 6 month test results to the Engineer within 180 days of application or prior to final acceptance, whichever comes first.

E. Corrective Work

For each mile section, if preformed plastic pavement marking traffic stripe fails to meet Plan details or Specifications or deviates from stated dimensions, correct it at no additional cost to the Department. If removal of pavement markings is necessary, perform it according to [Section 656](#) and place it according to this Specification. No additional payment will be made for removal and replacement of unsatisfactory striping. Ensure corrective work is completed at no additional cost to the Department. Perform testing according to this Specification. Any retest due to failures will be performed at no additional cost to the Department. Furnish all test reports to the Department.

Retroreflectivity Longitudinal Line Deficiency: A deficiency will ensue when two or more Location Average results as recorded on form OMR CVP 66 within a One-Mile Section do not meet the performance criteria herein. The entire line within this one mile section will be determined to be deficient. If the evaluated section is less than 1.0 mile, a single Location Average result not meeting the performance criteria herein will result in the entire line to be determined to be deficient.

Retroreflectivity Transverse Markings and Symbol Deficiency: A single Location Average result on the marking or symbol not meeting the performance criteria herein will result in the marking or symbol to be determined to be deficient.

657.3.07 Contractor Warranty and Maintenance

A. Warranties

Transfer all warranties or guarantees normally furnished by the manufacturer to the Department. Include a provision that warranties are subject to transfer. Warrant Type PB and Type PB-WR Plastic Markings to adhere to the pavement and to provide a minimum (ASTM E 1710) dry coefficient of retroreflection of 100 mcd/lux/m² when measured using a 30 meter geometry retroreflectometer for a period of at least 6 years for longitudinal markings and at least 2 years for intersection markings and symbols under normal traffic conditions.

B. Maintenance

Use the following according to manufacturer's instructions to ensure effective marking performance:

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- Solvents or adhesives
- Appropriate equipment
- Recommendations for application

657.4 Measurement

Preformed plastic pavement markings complete in place and accepted are measured as follows:

A. Solid Traffic Stripe

Solid stripe is measured by the linear foot (meter) or linear mile (kilometer) as specified. Breaks or omissions in solid lines and stripes at street or road intersections are not measured for payment.

B. Skip Traffic Stripe

Skip stripe is measured by the gross linear foot (meter) or gross linear mile (kilometer) as specified. The unpainted spaces between the stripes are included in the overall measurement, if the Plan ratio is not interrupted. Measurement begins and ends on a stripe.

C. Payment by Square Yard (Meter)

When preformed pavement markings are paid for by the square yard (meter), the number of square yards (meters) covered is measured. The space between the markings is included in the overall measurement. The color, width, and type are according to the Plans.

D. Preformed Plastic Word or Symbol

Each preformed plastic word or symbol, complete according to Plan dimensions, is measured by the unit. The code for each word or symbol is stated in the Plans.

E. Removing Existing Pavement Markings

Measurement and payment for removing pavement markings will be according to [Section 656](#) when shown in the Proposal as a payment Item. Otherwise, removal will not be paid for separately, but will be included in the payment for other Work under this Section.

657.4.01 Limits

General Provisions 101 through 150.

657.5 Payment

Payment in each case is full compensation for applying markings, including adhesives, cleaning, application, and traffic control necessary to complete the Item.

Payment will be made under:

Item No. 657.	Preformed plastic solid pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per linear foot (meter)
Item No. 657.	Preformed plastic solid pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per linear mile (kilometer)
Item No. 657.	Preformed plastic skip pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per gross linear foot (meter)
Item No. 657.	Preformed plastic skip pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per gross linear mile (kilometer)
Item No. 657.	Preformed plastic pavement markings	Per square yard (meter)
Item No. 657.	Preformed plastic pavement markings, words or symbols (<u>color</u>), (<u>type</u>)	Per each
Item No. 657.	Wet reflective preformed solid pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per linear foot (meter)
Item No. 657.	Wet reflective preformed solid pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per linear mile (kilometer)
Item No. 657.	Wet reflective preformed skip pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per gross linear foot (meter)

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Item No. 657.	Wet reflective preformed skip pavement markings _____ in (mm), (<u>color</u>), (<u>type</u>)	Per gross linear mile (kilometer)
Item No. 657.	Wet reflective preformed pavement markings	Per square yard (meter)
Item No. 657.	Wet preformed pavement markings, words or symbols (<u>color</u>), (<u>type</u>)	Per each

657.5.01 Adjustments

General Provisions 101 through 150.

Office of Materials and Research