

**DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA**

SUPPLEMENTAL SPECIFICATION

Add the following:

Section 661—Standard and Wet Weather Epoxy Traffic Stripe

661.1 General Description

This work includes furnishing and applying reflectorized standard and wet weather epoxy traffic stripe according to the Plans and these Specifications.

This Item also includes applying words and symbols according to Plan details, Specifications, and the current Manual on Uniform Traffic Control Devices.

661.1.01 Definitions

Painted Stripes: Solid or broken (skip) lines. The location and color are designated on the Plans.

Skip Traffic Stripes: Painted segments between unpainted gaps on a designated sequence with a ratio of 1:3 [10 ft (3 m) segment and 30 ft (9 m) gap] as specified on the Plans. The location and color are designated on the Plans.

661.1.02 Related References

A. Standard Specifications

General Provisions 101 through 150.

[Section 656—Removal of Pavement Markings](#)

B. Referenced Documents

[QPL 46](#)

[QPL 71](#)

AASHTO M 247

ACI Method 503

ASTM			
D 476	D 711	D 6628	E 303
E 1710	E 2177	G 53-77	

Federal Standard No. 595A-17778

SOP 39

US EPA Method 3052

US EPA Method 6010

661.2 Materials

A. General Requirements

- Use epoxy material that has been evaluated (2 year field evaluation) by the National Transportation Product Evaluation Panel (NTPEP) test facility or other approved test facility.

- Use epoxy material produced from an approved source listed on [QPL 46](#).
- Use an epoxy composition that is specifically formulated for use as a durable pavement marking material.
- Ensure the liquid markings consist of a two-component (Part A and Part B), 100% solids epoxy film formulated and designed to provide a simple volumetric mixing ratio as recommended by the manufacturer.
- Use white or yellow films for the markings, and use colors for bike lanes as required on the Plans. Ensure that these films are manufactured without the use of lead chromate pigments or other similar, lead-containing chemicals.
- Ensure that the mixed white epoxy contains not less than 13% by weight ASTM D 476 rutile titanium dioxide pigment to insure adequate opacity, hiding power, and reflective properties.

B. Glass Spheres and Reflective Composite Optics

Use glass spheres and/or reflective composite optics for the reflective media system that ensures the epoxy pavement markings meet the reflectance performance requirements in Subsection 661.3.04. Do not use beads and/or optics containing greater than 200 ppm total arsenic, 200 ppm total antimony, or 200 ppm total lead when tested according to the most recent US EPA Methods 3052 and 6010, or other approved methods.

Ensure glass spheres meet the requirements of AASHTO M 247. Use glass spheres produced from an approved source listed on QPL 71. Glass spheres conforming to an alternative gradation may be used provided all other requirements of AASHTO M 247 and this specification are met.

C. Finished Product Requirements:

1. Composition

Ensure that the retroreflective pavement markings consist of a mixture of high-quality resins, curing agent and pigments, with a reflective layer bonded to the top surface consisting of glass spheres and/or reflective composite optics.

2. Color

Meet these color requirements:

- White markings are pure white and free from dirt or tint.
- Yellow markings are “Federal Yellow” in color.
- Colors for bike lanes match the colors as shown on the Plans.
- The material does not change its color and brightness characteristics after prolonged exposure to sunlight.

3. Skid Resistance

Ensure the surface of the retroreflective marking provides an initial average skid resistance value of 45 BPN when tested according to ASTM E 303.

4. Color and Weathering Resistance

Ensure that the mixed epoxy compound, both white and yellow, when applied to 3 in (75 mm) x 6 in (150 mm) aluminum panels at 15 ± 1 mils ($0.381 \text{ mm} \pm 0.025 \text{ mm}$) thick without glass beads and exposed in a Q.U.V. Environmental Testing Chamber, as described in ASTM G 53-77, conforms to the following minimum requirements:

- The color of the white epoxy compound is not darker than Federal Standard No. 595A-17778, as measured by the Luminance factor Y according to ASTM D 6628.
- The color of the yellow epoxy compound meets the requirements of the “Federal Yellow” color chart.

5. Drying Time (Laboratory)

When tested in accordance with ASTM D 711 the epoxy marking material shall reach a no-pick-up condition in 30 minutes or less. Perform this test with AASHTO M247 Type 1 beads applied at a rate of 0.099 pounds per square foot (0.483 kg/m^2). Ensure that the drying time does not increase substantially with decreasing temperature.

6. Drying Time (Field)

When installed at 77 °F (25 °C), at a thickness of 25 ± 2 mils ($0.635 \text{ mm} \pm 0.051 \text{ mm}$) above the surface of the pavement on open graded asphalt concrete friction courses and 20 ± 2 mils ($0.508 \text{ mm} \pm 0.051 \text{ mm}$) on all other pavement types, and reflectorized with glass spheres and/or reflective composite optics, ensure that the epoxy markings reach a no-track condition in less than 30 minutes. Dry to “no-tracking” will be

considered as the condition where no visual deposition of the epoxy marking to the pavement surface is observed when viewed from a distance of 50 feet (15 m), after a traveling vehicle's tires have passed over the marking.

7. Adhesion to Concrete

Ensure that the epoxy pavement marking materials, when tested according to ACI Method 503, have such a high degree of adhesion to the specified concrete surface that there is a 100% concrete failure in the performance of this test. Condition the prepared specimens at room temperature 75 ± 2 °F (24 °C) for a minimum of 24 hours and maximum of 72 hours prior to the performance of this test.

8. Adhesion to Asphalt

Ensure that the epoxy pavement marking materials, when tested according to ACI Method 503, have such a high degree of adhesion to the specified asphalt surface that there is a 100% asphalt failure in the performance of this test. Condition the prepared specimens at room temperature 75 ± 2 °F (24 °C) for a minimum of 24 hours and maximum of 72 hours prior to the performance of this test.

661.3 Construction Requirements

661.3.01 Equipment

A. Traveling Traffic Striping Machine

To apply the traffic marking material, use a mobile, truck mounted and self contained pavement marking machine, specifically designed to apply two-component liquid materials, and glass beads, in a continuous and skip-line pattern.

Apply the two-component liquid materials through airless impingement mixing guns or static mix tubes. The guns must accommodate a plural component material system at the manufacturer's recommended volumetric mixing ratio. The guns must have the capacity to deliver materials from approximately 1.5 gal (5.7 L) to 3 gal (11.4 L) per minute to compensate for a typical range of application speeds of 3 mph (5 km/h) to 6 mph (10 km/h). Ensure that the machine travels at a uniform rate of speed both uphill and downhill.

Select the necessary accessories such as spray tip, mix chamber or static tube, and rod diameter to ensure proper mixing.

Ensure that the machine meets the following:

- The machine is capable of applying three separate stripes, either solid or skip, in any specified pattern by utilizing two adjacent spray nozzles at the same time.
- Each nozzle is equipped with satisfactory cutoff valves that will apply skip lines automatically.
- The application equipment is maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc.
- The truck-mounted unit is provided with accessories to allow for the marking of symbols and legends.

Ensure that the mobile applicator also includes the following features:

- The mobile applicator provides individual material reservoirs for the storage of Part A and Part B of the resin composition.
- The applicator is equipped with glass spheres dispensing equipment and capable of applying the glass spheres at a uniform rate.
- The application equipment is equipped with metering devices or pressure gauges on the proportioning pumps as well as stroke counters to monitor volumetric usage. Ensure that the metering devices or pressure gauges and stroke counters are visible.
- The applicator is equipped with all the necessary spray equipment, mixers, compressors, and other appurtenances to allow for the placement of reflectorized pavement markings in a simultaneous sequence of operations.

B. Hand Equipment

Use hand equipment for projects with small quantities of bike lanes, lane lines, edge lines, and center lines, or for conditions that require the equipment. Use hand equipment approved by the Engineer.

C. Cleaning Equipment

Use brushes, brooms, scrapers, grinders, high-pressure water jets, or air blasters to remove dirt, dust, grease, oil, and other foreign matter without damaging the underlying pavement.

661.3.02 Preparation

Notify the Engineer prior to the placement of the epoxy materials. Furnish the Engineer with the manufacturer's name and batch numbers of the epoxy materials and glass spheres to be used. Ensure that the approved batch numbers appear on the epoxy materials and glass spheres packages.

Before striping, thoroughly clean pavement surfaces of dust, dirt, grease, oil, and all other foreign matter.

Remove concrete curing compounds on new Portland cement concrete surfaces and existing pavement markings on both concrete and asphalt surfaces.

661.3.03 Construction

A. Atmospheric Conditions

1. Apply pavement markings only during conditions of dry weather and subsequently dry pavement surfaces. Ensure that the pavement surface temperature and the ambient temperature at the time of installation are both greater than 40 °F (4 °C) and that the relative humidity is not greater than 85%.

2. Moisture

Do not apply when the surface is moist. When directed by the Engineer, perform a moisture test on the Portland cement concrete pavement surface. Perform the test as follows:

- a. Place approximately 1 yd² (1m²) of roofing felt on the pavement surface.
- b. Pour approximately 1/2 gallon (2 L) of mixed epoxy onto the roofing felt.
- c. After 2 minutes, lift the roofing felt and inspect to see if moisture is present on the pavement surface or underside of the roofing felt.
- d. If moisture is present, do not proceed with the striping operation until the surface has dried sufficiently to be moisture free.

B. Alignment

Ensure that the traffic stripe is the specified length, width, and placement. On sections where no previously applied markings are present, ensure accurate stripe location by establishing control points at spaced intervals. The Engineer will approve control points.

C. Application

Apply the pavement markings as follows:

1. Apply the liquid marking material by spray method and according to the manufacturer's installation instructions.
2. Ensure marking configurations are in accordance with the "Manual on Uniform Traffic Control Devices."
3. Place the reflectorized pavement markings only on properly prepared surfaces and at the widths and patterns designated on the Plans. Do not begin marking operations until applicable surface preparation work is completed and approved by the Engineer.
4. Air-blast the surface first, to remove any dirt and residues from the pavement. Then apply the pavement markings as a continuous operation.
5. Ensure that mixing of the two components occurs in a static tube or impingement chamber prior to reaching the application spray nozzle.
6. Spray the mixed resin onto the pavement at a rate to obtain a minimum uniform dry thickness of 25 mils ± 2 mils (0.635 mm ± 0.051 mm) above the surface of the pavement on open graded asphalt concrete friction courses and 20 mils ± 2 mils (0.508 mm ± 0.051 mm) above the surface of the pavement on all other pavement types .

7. Glass Spheres and Reflective Composite Optics

- a. Apply glass spheres and/or reflective composite optics to installed stripe surface above the minimum rate recommended by the epoxy material manufacturer to produce the required retroreflectivity value in accordance with Subsection 661.3.04.
- b. Apply the glass sphere and/or reflective composite optics top-coating with a pressure-type gun specifically designed for applying glass spheres and/or reflective composite optics that will embed at least one-half of the sphere's and optic's diameter into the epoxy immediately after the material has been applied to the pavement.
- c. Do not apply glass spheres or reflective composite optics to bike lanes.

Following an application of glass spheres and/or reflective composite optics, and upon curing, ensure that the resulting marking is an adherent reflectorized stripe of the specified thickness and width that is capable of resisting deformation by traffic.

D. Protective Measures

Protect newly applied striping as follows:

1. Traffic

Control and protect traffic with warning and directional signs during application. Set up warning signs before beginning each operation and place signs well ahead of the equipment. When necessary, use a pilot car to protect both the traffic and the striping operation.

2. Fresh Striping

Protect the freshly applied stripe using cones or other satisfactory devices. Repair stripe damage or pavement smudges caused by traffic according to Subsection 661.3.04.

E. Appearance and Tolerance of Variance

Continually deviating from stated dimensions is cause for stopping the work and removing the nonconforming stripe. (See [Section 656.](#)) Adhere to the following measurements:

1. Width

Do not lay stripe less than the specified width. Do not lay stripe more than 1/2 in (13 mm) over the specified width.

2. Length

Ensure that the 10 ft (3 m) skip stripe and the 30 ft (10 m) gap between skip segments vary no more than ± 1 ft (300 mm) each.

3. Alignment

- a. Ensure that the stripe does not deviate from the intended alignment by more than 1 in (25 mm) on straight lines or curves of 1 degree or less.
- b. Ensure that the stripe does not deviate by more than 2 in (50 mm) on curves exceeding 1 degree.

661.3.04 Quality Acceptance

A. General

For a minimum of 30 days from the time of placement, ensure the epoxy traffic pavement marking material shows no signs of failure due to blistering, excessive cracking, chipping, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, diesel fuel, or gasoline drippings, spilling, poor adhesion to the pavement material, vehicular damage, and normal wear. In the event that failures mentioned above occur, ensure corrective work is completed at no additional cost to the Department.

Ensure that stripes and segments of stripes are clean-cut and uniform. Markings that do not appear uniform or satisfactory, either during the day or night, or do not meet Specifications or become marred or damaged by traffic or from other causes, will be corrected at the Contractor's expense.

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

1. Correction of Alignment

When correcting a deviation that exceeds the permissible tolerance in alignment, do the following:

- a. Remove the affected portion of stripe, plus an additional 25 ft (8 m) in each direction in accordance with [Section 656](#).
- b. Apply a new stripe according to these Specifications.

2. Removal of Excess Marking Material

Remove misted, dripped, or spattered markings to the Engineer’s satisfaction. Do not damage the underlying pavement during removal.

Refer to the applicable portions of [Section 656](#).

B. Initial Retroreflectivity

1. Longitudinal Lines

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

a. Standard Epoxy Traffic Material

	White	Yellow
Dry (ASTM E 1710)	400 mcd/lux/m ²	300 mcd/lux/m ²

b. Wet Weather Epoxy Traffic Material

	White	Yellow
Dry (ASTM E 1710)	400 mcd/lux/m ²	300 mcd/lux/m ²
Wet recovery (ASTM E 2177)	150 mcd/lux/m ²	125 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.

2. Messages, Symbols, Transverse Lines, and Bike Lanes

Within 30 days of installation, ensure the in-place markings when tested according to ASTM E 1710 meet the following minimum reflectance value of 275 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, etc.) Do not measure retroreflectivity of bike lanes.

C. Six Month Retroreflectivity (Longitudinal Lines)

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

1. Standard Epoxy Traffic Material

	White	Yellow
Dry (ASTM E 1710)	400 mcd/lux/m ²	300 mcd/lux/m ²

2. Wet Weather Epoxy Traffic Material

	White	Yellow
Dry (ASTM E 1710)	400 mcd/lux/m ²	300 mcd/lux/m ²
Wet recovery (ASTM E 2177)	150 mcd/lux/m ²	125 mcd/lux/m ²

Retest the in-place markings 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.

D. Thickness

Check the thicknesses on all skip lines, edge lines and center lines by placing durable tape, film, or metal plate of known and uniform thickness on an area to be striped. After the striper has passed over, remove the sample and measure the thickness with calipers or a micrometer.

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

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

Submit results to Engineer.

E. Corrective Work

For each mile section, if epoxy 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, remove 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. 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 and Thickness 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.

661.3.05 Verification

See SOP 39.

661.4 Measurement

When traffic stripe is paid for by the square yard (meter), the number of square yards (meters) striped is measured and the space between stripes is included in the overall measurement.

Linear measurements are made on the striped surface by an electronic measuring device attached to a vehicle. On curves, chord measurements, not exceeding 100 linear feet (30 linear meters), are used.

Traffic stripe and markings, complete in place, are measured and accepted for payment as follows:

A. Solid Traffic Stripe

Solid traffic stripe is measured by the linear foot (meter), linear mile (kilometer), or square yard (meter). Breaks or omissions in solid lines or stripes at street or road intersections are not measured.

B. Skip Traffic Stripe

Skip traffic stripe is measured by the gross linear foot (meter) or gross linear mile (kilometer). Unstriped spaces between the skips are included in the overall measurements if the Plan ratio of 1 to 3 remains uninterrupted. Measurement begins and ends on a skip.

C. Pavement Markings

Pavement markings, words and symbols completed according to Plan dimensions are measured by the unit.

661.5 Payment

Payment will be full compensation for the work under this Section, including the following:

Cleaning and preparing surfaces

Furnishing materials, including epoxy, beads, and thinners

Applying, curing, and protecting epoxy

Protecting traffic, including providing and placing necessary warning signs

Furnishing tools, machines, and other equipment necessary to complete the Item

Payment will be made under:

Item No. 661	Standard solid epoxy traffic stripe, _____ in (mm), (color)	Per linear mile (kilometer)
Item No. 661	Standard skip epoxy traffic stripe, _____ in (mm), (color)	Per gross linear mile (kilometer)
Item No. 661	Standard solid epoxy traffic stripe, _____ in (mm), (color)	Per linear foot (meter)
Item No. 661	Standard skip epoxy traffic stripe, _____ in (mm), (color)	Per gross linear foot (meter)
Item No. 661	Standard epoxy pavement markings, words, and symbols, (color)	Per each
Item No. 661	Standard epoxy traffic stripe, _____ in (mm), (color)	Per square yard (meter)
Item No. 661	Wet weather solid epoxy traffic stripe, _____ in (mm), (color)	Per linear mile (kilometer)
Item No. 661	Wet weather skip epoxy traffic stripe, _____ in (mm), (color)	Per gross linear mile (kilometer)
Item No. 661	Wet weather solid epoxy traffic stripe, _____ in (mm), (color)	Per linear foot (meter)
Item No. 661	Wet weather skip epoxy traffic stripe, _____ in (mm), (color)	Per gross linear foot (meter)
Item No. 661	Wet weather epoxy pavement markings, words, and symbols, (color)	Per each
Item No. 661	Wet weather epoxy traffic stripe, _____ in (mm), (color)	Per square yard (meter)

Office of Materials & Testing