

DATE: March 4, 2016

SPECIFICATIONS
Pavement Restriping Macon-Bibb County

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01005 - STATEMENT OF WORK

PART 1 - GENERAL

1.01 STATEMENT OF WORK: This is a general overview of the project. Follow details shown by the specifications and drawings, interpreted in accordance with contract clauses.

A. Accomplish Work at locations shown in Attachment A. This describes the road segments and provides some detail on number of lanes and other features that will alert the contractor to features which will require work. The contractor must investigate the road segments on his own and determine the quantity of striping required for each road segment.

B. Omitted

C. Provide all labor, material, plant, equipment, supplies, and coordination required to restripe various roads in Macon-Bibb County. All restriping will be done using paint. The contractor shall also repaint existing crosswalks, turn arrows and words, stop bars, railroad markings and other miscellaneous features. The contractor shall use thermoplastic or a combination of paint and thermoplastic as described in the technical specifications. The contractor shall also install raised pavement markings on those segments indicated in Attachment A.

D. General Congestion:

1. Work area is restricted to the area shown. Congestion will vary from road to road.
2. Roads may not be completely closed completely during the road work.

1.02 CONTRACT SITE AND WORK RESTRICTIONS:

A. Maintain traffic. Provide traffic control as needed to maintain safe traffic flow.

B. Beneficial Occupancy: The Government reserves the right to take beneficial occupancy of parts of the project area before the total project completion date. This is not final acceptance, and identified deficiencies must still be corrected.

1.03 HOURS OF WORK:

A. Standard work hours for this project are normal work hours of 8:00 AM to 5:00 PM local time, Monday through Friday. Work must stop on official County holidays unless specifically approved in advance.

B. Alternate Work Hours

1. If the Contractor desires to work another set of standard hours submit written request five workdays before the date desired to work the different standard.
2. To work special hours or days such as to continue paving until dark, request verbal approval from the Engineer at least four hours in advance.

01005 - STATEMENT OF WORK

3. The Government reserves the right to refuse these requests. In addition, work requiring inspector presence such as placing concrete may not be possible outside normal hours on short notice. Digging outside of normal hours will normally not be approved.

C. All references to days mean calendar days unless otherwise noted.

1.04 SUBMITTALS: Provide submittals as required by the specifications and as directed by the engineer.

PART 2 - PRODUCTS - OMITTED

PART 3 - EXECUTION

3.01 COORDINATION: The contractor shall coordinate work between different disciplines.

3.02 GOVERNMENT-FURNISHED WORK

A. Shoulders will be scraped and broomed prior to the painting of the edge lines by the contractor. The county will also do spot street sweeping of selected intersections and other areas of concentrated debris on the road. Any further surface preparation of the surface for painting will be the contractor's responsibility.

Section 01005 Submittals

<u>Para #</u>	<u>Description</u>	<u>Date Required</u>	<u>Inspector Check Mark</u>
1.03 B	Alternate Work Hours	5 days prior	_____

<<<<< END OF SECTION >>>>>

Section 652—Painting Traffic Stripe

652.1 General Description

This work includes furnishing and applying reflectorized traffic line paint 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.

652.1.01 Definitions

Painted Stripes: Solid or broken (skip) lines. The location and color are to match existing. New stripes are to be yellow for centerline and dual turn lanes and white for lane lines separating traffic in the same direction and edge lines

Skip Traffic Stripes: Painted segments between unpainted gaps to match existing.

652.1.02 Related References

A. Standard Specifications

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

[Section 870—Paint](#)

B. Referenced Documents

[QPL 46](#)

AASHTO M 247

652.1.03 Submittals

Section 1300

652.2 Materials

Ensure that materials for painting traffic stripe, words, and symbols meet the following requirements:

Material	Section
Traffic Line Paint 5A and 5B	870.2.02.A.2 and 870.2.02.A.3
Glass Beads for Use in Luminous Traffic Lines	AASHTO M 247 Type 1*

*In addition, meet the following requirements for glass beads:

- Maximum quantity of angular particles is less than 1% by weight
- Maximum quantity of particles with milkiness, scoring, or scratching is less than 2% by weight
- Glass beads do not impart any noticeable hue to the paint film
- Glass beads conforming to the following alternate gradation may be used provided that all other requirements of AASHTO M 247 and this Specification are met.

Alternate Gradation	
Sieve Size	Percent Passing
No. 16 (1.190 mm)	99 - 100
No. 20 (0.850 mm)	75 - 95
No. 30 (0.600 mm)	55 - 85
No. 50 (0.300 mm)	10 - 35
No. 100 (0.150 mm)	0 - 5

652.2.01 Delivery, Storage, and Handling

Omitted

Section 652—Painting Traffic Stripe

652.3 Construction Requirements

652.3.01 Personnel

Omitted

652.3.02 Equipment

A. Traveling Traffic Stripe Painter

Use a traffic stripe painter that can travel at a predetermined speed both uphill and downhill, applying paint uniformly. Ensure that the painter feeds paint under pressure through nozzles spraying directly onto the pavement.

Use a paint machine equipped with the following:

1. Three adjacent spray nozzles capable of simultaneously applying separate stripes, either solid or skip, in any pattern.
2. Nozzles equipped with the following:
 - Cutoff valves for automatically applying broken or skip lines
 - A mechanical bead dispenser that operates simultaneously with the spray nozzle to uniformly distribute beads at the specified rate
 - Line-guides consisting of metallic shrouds or air blasts
3. Tanks with mechanical agitators
4. Small, portable applicators or other special equipment as needed

B. Hand Painting Equipment

Use brushes, templates, and guides when hand painting.

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 from painting surfaces without damaging the underlying pavement.

652.3.03 Preparation

Locate approved paint manufacturers on [QPL 46](#).

Before starting each day's work, thoroughly clean paint machine tanks, connections, and spray nozzles, using the appropriate solvent.

Thoroughly mix traffic stripe paint in the shipping container before putting it into machine tanks.

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

652.3.04 Fabrication

Omitted

652.3.05 Construction

A. 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.

B. Application

Apply traffic stripe paint by machine. If areas or markings are not adaptable to machine application, use hand equipment.

1. Application Rate

All work will be subject to application rate checks for both paint and beads.

Apply 5 in (125 mm) wide traffic stripe at the following minimum rates:

- a. Solid Traffic Stripe Paint: At least 25 gal/mile (58.8 L/km)
- b. Skip Traffic Stripe Paint: At least 6.3 gal/mile (14.8 L/km)

NOTE: Change minimum rate proportionately for varying stripe widths.

Section 652—Painting Traffic Stripe

2. Thickness

Maintain a 15 mils (0.38 mm) minimum wet film thickness for all painted areas.

3. Do not apply paint to areas of pavement when:

- The surface is moist or covered with foreign matter.
- Air temperature in the shade is below 40 °F (5 °C)
- Wind causes dust to land on prepared areas or blows paint and beads around during application.

4. Apply a layer of glass beads immediately after laying the paint. Apply beads at a minimum rate of 6 lbs to each gallon (700 grams to each liter) of paint.

C. Protective Measures

Protect newly applied paint as follows:

1. Traffic

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

2. Fresh Paint

Protect the freshly painted stripe using cones or drums. Repair stripe damage or pavement smudges caused by traffic according to [Subsection 652.3.06](#).

D. 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) painted skip stripe and the 30 ft (10 m) gap between painted 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 tangents 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.

652.3.06 Quality Acceptance

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, will be corrected at the Contractor's expense. Work will be subject to application rate checks for both paint and beads.

The following will be accepted:

- Sections of painted stripe, words, and symbols that have dried so that paint will not be picked up or marred by vehicle tires
- Sections placed according to the Plans and Specifications

The Contractor will be relieved of responsibility for maintenance on accepted sections.

A. Correction of Alignment

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

1. Remove the affected portion of stripe, plus an additional 25 ft (8 m) in each direction.
2. Paint a new stripe according to these Specifications.

Remove the stripe according to [Section 656](#).

Section 652—Painting Traffic Stripe

B. Removal of Excess Paint

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

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

652.3.07 Contractor Warranty and Maintenance

See contract provisions

652.4 Measurement

Measurement will be by the mile of the entire road segment painted. Measurement will include all striping for that segment.

652.4.01 Limits

Omitted

652.5 Payment

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

- Cleaning and preparing surfaces
- Furnishing materials, including paints, beads, and thinners
- Applying, curing, and protecting paints
- 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:

	Line Striping	Per linear mile

Section 653—Thermoplastic Traffic Stripe

653.1 General Description

This work includes furnishing and applying thermoplastic reflectorized pavement marking compound. Ensure that markings conform to Plan details and locations, these Specifications, and the Manual on Uniform Traffic Control Devices.

Thermoplastic traffic stripe consists of solid or broken (skip) lines, words, and symbols according to Plan color, type, and location. **However, road centerline and edge line striping with thermoplastic is not anticipated.**

653.1.01 Definitions

Thermoplastic Marking Compound: A compound extruded or mechanically sprayed on the pavement that cools to pavement temperature. When combined with glass spheres it produces a reflectorized pavement marking.

Short Lines: Crosswalks, stop bars, arrows, symbols, and crosshatching. Extrude short lines rather than spraying them on. Unless otherwise specified, spray all other lines.

653.1.02 Related References

A. Standard Specifications

[Section 652—Painting Traffic Stripe](#)

B. Referenced Documents

[QPL 46](#)

Federal Test Method Standard 141, Method 4252

ASTM D 1155

ASTM D 620

ASTM D 570

ASTM D 256

ASTM D 2240

ASTM E 28

ASTM 121

653.1.03 Submittals

Ensure that the producers of the thermoplastic compound and glass spheres furnish to the Department copies of certified test reports showing results of all tests specified in this Section. Also ensure that producers certify that the materials meet the other requirements of this Section by submitting copies of certification at the time of sampling. Final Acceptance, however, will be based on satisfactory test results from samples obtained by the Department before delivery.

653.2 Materials

A. General Characteristics of Thermoplastic

1. Deterioration

Use thermoplastic material with the following characteristics:

a. Does not deteriorate upon contact with:

- Pavement materials
- Petroleum droppings from traffic
- Chemicals, such as sodium chloride or calcium chloride, used to prevent formation of ice on roadways or streets

b. Does not scorch, discolor, or deteriorate if kept at the manufacturer's recommended application temperature, or at least 375 °F (190 °C), for up to 4 hours.

c. Has a temperature versus viscosity characteristic that remains constant from batch to batch through four re-heatings.

Section 653—Thermoplastic Traffic Stripe

2. Fumes

Use material that in the plastic state does not give off fumes that are toxic or harmful to persons or property.

B. Detailed Characteristics of Thermoplastic

1. Material Composition

Use material binder with the following characteristics:

- A mixture of synthetic resins, with at least one resin that is solid at room temperature, and high boiling point plasticizers
- A total binder content of 18 percent to 35 percent by weight
- A pigmented binder that is well-dispersed and free of dirt, foreign objects, or ingredients that cause bleeding, staining, or discoloration

The binder shall be Type A—alkyd. Ensure that at least 33% of the binder composition or at least 8% by weight of the entire material formulation is a maleic-modified glycerol ester of resin. Ensure that the finished thermoplastic pavement marking material is not adversely altered by contact with oily pavement materials or by contact from oil dropping onto the pavement surface from traffic.

Ensure that the filler has the following characteristics:

- White calcium carbonate or equivalent
- Compressive strength of 5,000 psi (34.5 MPa)

2. Suitability for Markings

Use thermoplastic material that is especially compounded for traffic markings and has the following characteristics:

- Prevents markings from smearing or spreading under normal traffic conditions at temperatures below 120 °F (49 °C)
- Gives a uniform cross section, with pigment evenly dispersed throughout the material
- Has a uniform material density and character throughout its thickness
- Allows the stripe to maintain its original dimensions and placement
- Ensures that the exposed surface is free from tack and is not slippery when wet
- Does not lift from the pavement in freezing weather
- Has cold ductility properties that permit normal movement with the road surface without chipping or cracking

3. Drying Time

When applied at a temperature range of 400 °F to 425 °F (204 °C – 218 °C) and a thickness of 1/8 in. to 3/16 in. (3 mm to 5 mm), the material shall set to bear traffic in a maximum of 2 minutes when the air temperature is 50 °F ± 3 °F (10 °C ± 2 °C) and shall set to bear traffic in a maximum of 10 minutes when the air temperature is 90 °F ± 3 °F (32 °C ± 2 °C).

4. Reflectorization

Ensure that during manufacturing, reflectorizing glass spheres were mixed into the compound to the following specifications:

- At least 16 percent by weight using glass spheres with a minimum refractive index of 1.65
- At least 25 percent by weight using glass spheres with a minimum refractive index of 1.50

C. Physical Requirements of Thermoplastic

1. Color

Confirm the color of thermoplastic as follows:

- a. White thermoplastic material contains at least 8 percent by weight titanium dioxide that meets the requirements of ASTM D 476, Type II, Rutile. The white thermoplastic material shall be pure white and free from dirt or tint.

The material, when compared to the magnesium oxide standard using a standard color spectrophotometer according to ASTM D 4960, shall meet the following:

Scale	Definition	Magnesium Oxide Standard	Sample
Rd	Reflectance	100	75 min.

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a	Redness-Greenness	0	-5 to + 5
b	Yellowness-Blueness	0	-10 to + 10

Compare yellow material to match Federal Test Standard Number 595, Color 13538.

2. Color Retention

Use thermoplastic stripe tested for color retention as follows:

- a. Test specimens prepared from samples submitted according to ASTM D 620 by the Department Inspector.
- b. Use an ultraviolet light source as specified in the test procedure, or use a 275 watt sunlamp with a built-in reflector.
- c. Ensure that after 100 hours of exposure to the light source, the test specimens show no color change when compared to an unexposed specimen.

3. Water Absorption

Ensure that materials have no more than 0.5 percent by weight of retained water when tested by ASTM D 570, procedure (a).

4. Softening Point

Ensure that materials have a softening point of at least 175 °F (79 °C) as determined by ASTM E 28.

5. Specific Gravity

Ensure that the specific gravity of the thermoplastic compound at 77 °F (25 °C) is between 1.9 to 2.5.

6. Impact Resistance

Use material with an impact resistance of at least 10 in-lbs at 77 °F (1.13 N·m at 25 °C), tested as follows:

- a. Heat for 4 hours at 400 °F (204 °C).
- b. Cast into bars of 1 in² (625 mm²) cross sectional area, 3 in (75 mm) long.
- c. Place with 1 in (25 mm) extending above the vise in a cantilever beam (Izod type) tester using the 25 in-lbs (2.82 N·m) scale. This instrument is described in ASTM D 256.

7. Indentation Resistance

Measure the hardness by a Shore Durometer, Type A2, as described in ASTM D 2240. Maintain the temperature of the Durometer, 4.4 lb. (2 kg) load and the specimen at 115 °F (45 °C). Apply the Durometer and 4.4 lb. (2 kg) load to the specimen and the reading shall be between 50 to 75 units, after 15 seconds.

8. Low Temperature Stress Resistance

- a. Furnish sample test blocks as follows:
 - 1) Coat the samples using the same method as the planned installation of the compound.
 - 2) Coat the samples with at least 32 in² (206 mm²) of the compound.
- b. Have the samples tested as follows:
 - 1) Immerse a sample in cold water for one hour.
 - 2) Immediately place the sample in a freezer chest or other insulated cold compartment and maintain at a temperature of -20 °F (-29 °C) for 24 hours.
 - 3) After 24 hours, remove the sample and bring it to normal room temperature.

Following the test, confirm that the sample does not crack, flake, or fail to adhere to the substrate.

9. Reheating

Ensure that the compound does not break down, deteriorate, scorch, or discolor if held for 6 hours at the plastic temperature of 425 °F (218 °C); or if reheated up to the plastic temperature 4 times.

10. Abrasion Resistance

Have the material tested for abrasion resistance as follows:

- a. Ensure that the maximum loss of the material does not exceed 0.4 grams when subjected to 200 revolutions on a Taber Abraser at 77 °F (25 °C), using H-22 Calibrade wheels that are weighted to 500 grams.
- b. Keep the wearing surface wet with distilled water throughout the test.

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- c. Prepare the panel by forming a representative lot of material at a thickness of 0.125 in. (3.18 mm) on a 4 in (100 mm) square steel plate with a thickness of 0.050 ± 0.001 in ($1.27 \text{ mm} \pm 0.03 \text{ mm}$), on which a primer has been previously applied.

11. Yellowness Index

The white thermoplastic material shall not exceed a yellowness index of 0.12 according to AASHTO T 250.

12. Flowability

After heating the thermoplastic material for 240 ± 5 minutes at $425 \text{ °F} \pm 3 \text{ °F}$ ($218 \text{ °C} \pm 2 \text{ °C}$) and testing the flowability, ensure that the white thermoplastic has a maximum of 21 percent residue according to AASHTO T 250.

13. Flowability-Extended Heating

After heating the thermoplastic material for 8.0 ± 0.5 hours at $425 \text{ °F} \pm 3 \text{ °F}$ ($218 \text{ °C} \pm 2 \text{ °C}$), while stirring the last 6 hours and testing for flowability, ensure that the thermoplastic has a maximum percent residue of 28 according to AASHTO T 250.

14. Storage Life

The material shall meet the requirements of this specification for 1 year. Ensure that the thermoplastic melts uniformly with no evidence of skins or unmelted particles during the 1-year period.

D. Physical Requirements of Glass Spheres

1. Premixed Glass Spheres

Ensure that the compound has been manufactured with glass spheres in the proportion specified in [Subsection 653.2 .B.4. —Reflectorization.I](#). The glass spheres contained in the material shall meet the following requirements:

- a. **Index of Refraction.** Determine the index of refraction of the premixed glass spheres by the liquid immersion method at 77 °F (25 °C).
- b. **Roundness.** Ensure that the minimum percentages of premixed glass spheres are true spheres according to the following table:

Percent of Premixed Glass Spheres That are True Spheres (when tested according to ASTM D 1155)		
Minimum Index of Refraction	Percent of Overall Beads	Percent of Beads Retained on any Sieve
1.65	At least 75%	At least 70%
1.50	At least 70%	At least 60%

- c. **Imperfections.** Ensure that no more than 5 percent of the spheres show air inclusions, bubbles, lap lines, chill wrinkles, or other imperfections when viewed through a 60-power microscope in the refractive index liquid.
- d. **Foreign Matter.** Ensure that the quantity of foreign matter does not exceed 1 percent.
- e. **Gradation.** Have the beads tested using ASTM: D 1214 to ensure they have the following gradations:

U.S. Sieve Standard Sieve Size	Percent Passing
No. 16 (1.18 mm)	100
No. 30 (600 μm^*)	60 to 90
No. 50 (300 μm)	15 to 40
No. 80 (180 μm)	0 to 10
No. 100 (150 μm)	0 to 5
* μ = micro meter	

- f. **Chemical Resistance.** Use material manufactured with glass spheres that withstand immersion in water and acids without corroding or etching, and withstand sulfides without darkening or decomposing.

Have the chemical resistance tested by placing a 3 g to 5 g sample in each of three glass beakers or porcelain dishes and immersing as follows:

- Cover the first with distilled water.

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- Cover the second with a 3N solution of sulfuric acid.
- Cover the third with a solution of 50 percent sodium sulfide, 48 percent distilled water, and 2 percent Aerosol 1B or similar wetting agent.

Ensure that after one hour no darkening, hazing, or other evidence of instability is evident when examined microscopically.

2. Drop-On Glass Spheres

Ensure that these spheres meet the requirements of [Subsection 652.2](#).

E. Requirements of Sealing Primer

Place the particular type of two-part epoxy binder-sealer at the application rate as recommended in writing by the thermoplastic material manufacturer.

653.2.01 Delivery, Storage, and Handling

Use material delivered in 50 lb (22.7 kg) unit cardboard containers or bags strong enough for normal handling during shipment and on-the-job transportation without loss of material.

Ensure that each unit container is clearly marked to indicate the following:

- Color of the material
- Process batch number or similar manufacturer's identification
- Manufacturer's name
- Address of the plant
- Date of manufacture

653.3 Construction Requirements

653.3.01 Personnel

Omitted

653.3.02 Equipment

Depending on the marking required, use hand equipment or truck-mounted application units on roadway installations.

A. Spray Application Machine

Ensure that each spray application machine is equipped with the following features:

- Parts continuously mix and agitate the material.
- Truck-mounted units for lane, edge, and center lines can operate at a minimum of 5 mph (8 kph) while installing striping.
- Conveying parts between the main material reservoir and the shaping die or gun prevent accumulation and clogging.
- Parts that contact the material are easily accessible and exposable for cleaning and maintenance.
- Mixing and conveying parts, including the shaping die or gun, maintain the material at the plastic temperature with heat transfer oil or electrical element controlled heat. Do not use an external source of direct heat.
- Parts provide continuously uniform stripe dimensions.
- Applicator cleanly and squarely cuts off stripe ends and applies skip lines. Do not use pans, aprons, or similar appliances that the die overruns.
- Parts produce varying widths of traffic markings.
- Applicator is mobile and maneuverable enough to follow straight lines and make normal curves in a true arc.

B. Automatic Bead Dispenser

Apply glass spheres to the surface of the completed stripe using a dispenser attached to the striping machine to automatically dispense the beads instantaneously upon the installed line. Synchronize the glass sphere dispenser cutoff with the automatic cutoff of the thermoplastic material.

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C. Special Kettles

Use special kettles for melting and heating the thermoplastic material. Kettles equipped with automatic thermostatic control devices provide positive temperature control and prevent overheating. Ensure that the applicator and kettles are equipped and arranged according to the requirements of the National Fire Underwriters.

D. Hand Equipment

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

Ensure that hand equipment can hold 150 lbs (68 kg) of molten material and is maneuverable to install crosswalks, arrows, legends, lane, edge, and center lines.

E. Auxiliary Vehicles

Supply the necessary auxiliary vehicles for the operation.

653.3.03 Preparation

Omitted

653.3.04 Fabrication

Omitted

653.3.05 Construction

A. General Application

Thoroughly clean pavement areas to be striped. Use hand brooms, rotary brooms, air blasts, scrapers, or other approved methods that leave the pavement surface clean and undamaged. Take care to remove all vegetation and road film from the striping area. All new Portland Cement Concrete pavement surfaces shall be mechanically wire brushed or abrasive cleaned to remove all laitance and curing compound before being striped.

Lay stripe with continuous uniform dimensions.

Apply the type of stripe at each location according to the Plans, using one of the following methods:

- Spray techniques
- Extrusion methods wherein one side of the shaping die is the pavement, and the other three sides are contained by or are part of the suitable equipment to heat and control the flow of material.

1. Temperature

Apply thermoplastic traffic stripe only when the pavement temperature in the shade is above 40 °F (4 °C).

To ensure optimum adhesion, install the thermoplastic material in a melted state at the manufacturer's recommended temperature but not at less than 375 °F (190 °C).

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 molten thermoplastic 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.

3. Binder-Sealer

To ensure optimum adhesion, apply a binder-sealer material before installing the thermoplastic in each of the following cases:

- Extruded thermoplastic
- Where directed by the Engineer for sprayed thermoplastic
- Old asphaltic concrete pavements with exposed aggregates

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- Portland cement concrete pavements as directed by the Engineer

Ensure that the binder-sealer material forms a continuous film that mechanically adheres to the pavement and dries rapidly. Use a binder-sealer currently in use and recommended by the thermoplastic material manufacturer according to [QPL 46](#).

To ensure optimum adhesion, apply a two-part epoxy binder-sealer on all Portland cement concrete pavements for either sprayed or extruded thermoplastic material.

Apply the epoxy binder-sealer immediately in advance of, but concurrent with, the application of the thermoplastic material. Apply in a continuous film over the pavement surface.

4. Bonding to Old Stripe

The old stripe may be renewed by overlaying with new material. Ensure the new material bonds to the old line without splitting or cracking.

5. Offset from Construction Joints

Off-set longitudinal lines at least 2 in (50 mm) from construction joints of Portland cement concrete pavements.

6. Crosswalks, Stop Bars, and Symbols

Make crosswalks, stop bars, and symbols at least 3/32 in (2.4 mm) thick at the edges and no more than 3/16 in (4.8 mm) thick at the center.

7. Film Thickness

a. Maintain the following minimum average film thicknesses on all open graded asphalt concrete friction courses:

- 0.120 in (3.0 mm)* for lane lines
- 0.090 in (2.3 mm)* for edge lines
- 0.150 in (3.8 mm)* for gore area lines

b. Maintain the following minimum average film thicknesses on all other pavement types:

- 0.090 in (2.3 mm)* for lane lines
- 0.060 in (1.5 mm)* for edge lines
- 0.120 in (3.0 mm)* for gore area lines

(See below for *_* reference.)

Compute the minimums by the amount of material used each day, as follows:

(For 5 in wide stripe)	
* Average Film Thickness (in) =	$[(\text{lbs used}) \div (\text{total linear feet})] \times 0.236$
(For 125 mm wide stripe)	
*Average Film Thickness (mm) =	$[(\text{kg used}) \div (\text{total linear meters})] \times 4.0$
(For 10 in wide stripe)	
* Average Film Thickness (in) =	$[(\text{lbs used}) \div (\text{total linear feet})] \times 0.118$
(For 250 mm wide stripe)	
* Average Film Thickness (mm) =	$[(\text{kg used}) \div (\text{total linear meters})] \times 2.0$

8. Glass Spheres

- Apply glass spheres to installed stripe surface at a minimum rate of 14 lbs of spheres to each 100 square feet ((700 g/m²) of thermoplastic material.
- Apply the glass sphere top-coating with a pressure-type gun specifically designed for applying glass spheres that will embed at least one-half of the sphere's diameter into the thermoplastic immediately after the material has been applied to the pavement.

B. Removing Existing Stripe

Remove existing stripe according to [Section 656](#).

Remove 100 percent of existing traffic stripe from:

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- Portland cement concrete pavement where the new stripe will be placed at the same location as the existing marking
- Pavement where the new stripe will be placed at a different location from the existing markings

C. Tolerance and Appearance

No traffic stripe shall be less than the specified width and shall not exceed the specified width by more than 1/2 in (13mm). 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 ft (300 mm). The alignment of the stripe shall not deviate from the intended alignment by more than 1 in (25 mm) on tangents and on curves up to and including 1 degree (radius of 1745 m or greater). On curves exceeding 1 degree (radius less than 1745 m), the alignment of the stripe shall not deviate from the intended alignment by more than 2 in (50 mm).

Stop work when deviation exceeds the above dimensions, and remove the nonconforming stripe.

653.3.06 Quality Acceptance

Segments of the thermoplastic 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 thermoplastic 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.

653.3.07 Contractor Warranty and Maintenance

After segments are accepted, the Contractor will be relieved of maintenance on those segments.

653.4 Measurement

When stripe will be paid for by the square yard (meter), the actual number of square yards (meters) painted will be measured. The space between the stripes will be included in the overall measurement.

Linear measurements may be made by electronic measuring devices attached to a vehicle.

Thermoplastic traffic stripe, complete in place and accepted, is measured as follows:

A. Solid Traffic Stripe

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 for payment.

B. Skip Traffic Stripe

Skip stripe is measured by the gross linear mile (kilometer) as specified. The unpainted space between the painted stripes is included in the overall measurement if the Plan ratio of one to three (10 ft [3 m] segment and 30 ft [9 m] gap or other patterns as designated on the Plans) remains uninterrupted. Measurement begins and ends on a stripe.

C. Words and Symbols

Each word or symbol complete according to Plan dimensions is measured by the Unit. Crosswalks are measured by the average linear foot of the centerline of the crosswalk. Hatching is measured by the centerline linear foot of the hatched area. Note that the boundary of hatched areas formed by the extension of centerline or lane lines are to be painted. The boundary of other areas, such as hatching around raised concrete islands, shall be thermoplastic.

653.4.01 Limits

Omitted

653.5 Payment

Payment is full compensation for the Work under this section, including:

- Cleaning and preparing surfaces
- Furnishing all materials
- Applying, curing, and protecting stripe
- Protecting traffic, including providing necessary warning signs
- ~~Furnishing tools, machines, and other equipment necessary to complete the Item~~

Section 653—Thermoplastic Traffic Stripe

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.

Payment will be made under:

	Thermoplastic pavement markings, words, and symbols	Per Each
	Thermoplastic crosswalks	Per centerline linear foot
	Thermoplastic hatching	Per centerline linear foot
	Thermoplastic Railroad Symbol	Per each

Section 654—Raised Pavement Markers

654.1 General Description

This work includes furnishing and placing raised pavement markers according to the Plans or as directed by the Engineer. Use markers that conform to Plan shapes, dimensions, and tolerances.

654.1.01 Definitions

Omitted

654.1.02 Related References

A. Standard Specifications

[Section 868—Bituminous Adhesive for Raised Pavement Markers](#)

[Section 886—Epoxy Resin Adhesives](#)

[Section 919—Raised Pavement Marker Materials](#)

B. Referenced Documents

[QPL 74](#)

654.1.03 Submittals

General Provisions 101 through 150.

654.2 Materials

Ensure that materials meet the requirements of the following Specifications:

Material	Section
Bituminous Adhesive	868
Epoxy Resin Adhesives	886
Pavement Markers	919

654.2.01 Delivery, Storage, and Handling

Omitted

654.3 Construction Requirements

654.3.01 Personnel

Omitted

654.3.02 Equipment

Before beginning construction, clean marker replacement equipment and ensure that it is mechanically sound.

A. Containers and Stirring Devices

Clean containers and stirring devices (paddles, propellers for drills, etc.) before hand-mixing epoxy.

B. Automatic Mixing Device

1. Cleaning

Clean the mixing head to the automatic epoxy mixing equipment after stopping work for any extended period of time. The length of down-time allowed depends on the pot life of the adhesive system being used.

2. Mixing Ratio

Use an automatic mixing device that delivers separate components to the mixing head in a one-to-one ratio by volume.

3. Sample Valves

Equip the lines feeding the mixing head with suitable valves to allow samples to be taken for checking the ratio of each component.

Section 654—Raised Pavement Markers

C. Bituminous Adhesive Equipment

Clean and maintain equipment for melting, stirring, and dispensing bituminous adhesive according to the bituminous adhesive manufacturer's requirements.

654.3.03 Preparation

Omitted

654.3.04 Fabrication

Omitted

654.3.05 Construction

A. Adhesive Types

Cement markers to pavement surfaces with a Type I-R Epoxy or Type I-S Epoxy (see [Section 886](#)), or with a bituminous adhesive (see [Section 868](#)). Space markers according to the Plans.

1. **Type I-R Epoxy.** Use Type I-R Epoxy when the pavement temperature is above 50 °F (10 °C), or when traffic conditions require a rapid setting system.
2. **Type I-S Epoxy.** Use Type I-S Epoxy when the pavement temperature is above 60 °F (15 °C) and traffic conditions permit a slower setting system.
3. **Bituminous Adhesive.** Use bituminous adhesive when the pavement temperature is above 40 °F (4 °C) or when traffic conditions require a rapid setting material.

B. Handling and Applying Adhesives

Obtain an epoxy adhesive furnished as two separate components. Combine and use the components as follows:

1. Immediately before use, thoroughly stir the individual components with separate paddles. Reject material permanently increasing in viscosity or showing settling of pigments, filler, or thixotropic additives that cannot be readily redispersed.
2. After stirring or agitating the two separate components, mix them in a one-to-one ratio and blend thoroughly until obtaining a uniform color without streaks.
3. At time of mixing, ensure that the temperature of both components is 60 ° to 80 °F (15 ° to 27 °C). If necessary, heat components using indirect heat to avoid locally overheating and decomposing the material. Do not heat adhesive above 120 °F (49 °C).
4. Place markers between the start of mixing the epoxy system and the termination of the pot life. The Engineer will designate the allowable pot life based on environmental factors. Never use a partially set mixed system that does not readily extrude around the perimeter of the marker when pressed to the roadway.
5. When using an approved fast-setting epoxy system, mix the separate components with a two-component type automatic mixing and extrusion apparatus, and place markers immediately.
6. Use bituminous adhesive furnished in approximately 30 lb (14 kg) cubes.
 - a. Heat the cubes in an oil-jacketed melting pot.
 - b. Maintain the bituminous adhesive at the manufacturer-recommended temperature during placement of the markers.
 - c. Discard bituminous adhesive heated above 450 °F (232 °C).

C. Placement of Markers

1. Surface Cleaning

Clean pavement of dirt, curing compound, grease, oil, paint, moisture, loose or unsound layers, or other material that would impair the bond between the adhesive and the roadway.

- a. Use either sand-blasting or grinding equipment to clean. Remove the dust before placing the marker.
- b. Provide cleaning equipment air lines with suitable traps to prevent oil or moisture from being redeposited on the road surface.

2. Placement Limits

Place markers as follows:

- a. Do not place markers over joints in rigid pavement.

Section 654—Raised Pavement Markers

- b. Do not place markers when pavement temperature is below 40 °F (4 °C).
 - c. When possible, wait 60 to 90 days before placing markers using epoxy adhesive on newly constructed asphaltic concrete pavements.
3. Marker Placement Using Epoxy Adhesives
- Place markers using epoxy adhesives as follows:
- a. Place enough adhesive on the cleaned pavement or the bottom of the marker to completely cover the contact area of the marker.
 - b. Press the marker firmly to the pavement.
 - c. Allow a slight bead of epoxy adhesive to extrude from under the marker edges.
 - d. Remove adhesive on the face of the marker or adhesive that obscures the marker. Do not use thinners or solvents to clean epoxy adhesives from the markers.
4. Marker Placement Using Bituminous Adhesives
- Place markers using bituminous adhesives as follows:
- a. Place enough bituminous adhesive on the cleaned pavement or the bottom of the marker to completely cover the contact area of the marker.
 - b. Press the marker firmly to the pavement.
 - c. Allow a slight bead of adhesive to extrude from under the marker edges.
 - d. Remove adhesive on the face of the marker or adhesive that obscures the marker.
 - e. Place the marker before the bituminous adhesive cools and does not extrude around the perimeter of the marker when pressed to the roadway.

654.3.06 Quality Acceptance

Refer to [OPL 74](#) for raised pavement markers that have met these requirements.

654.3.07 Contractor Warranty and Maintenance

See contract provisions

654.4 Measurement

Measurement will be by the linear mile of properly installed markers

654.4.01 Limits

Omitted

654.5 Payment

Raised pavement markers will be paid for at the Unit Price per linear mile. Payment is full compensation for furnishing and installing each marker.

When designated, payment will also include recessing the marker.

Payment will be made under:

Item No. 654	Raised pavement markers	Per linear mile

Section 868—Bituminous Adhesive For Raised Pavement Markers

868.1 General Description

This section includes the requirements for bituminous hot-melt adhesive used to place raised pavement markers.

868.1.01 Related References

A. Standard Specifications

[Section 106—Certification of Materials](#)

B. Referenced Documents

AASHTO	ASTM	
T 48	C 430	D 1856
T 49	D 70	D 2669
T 53	D 1754	D 2712
T 202	D 1796	D 3407

868.2 Materials

868.2.01 Bituminous Adhesive

A. Requirements

1. Adhesive

Use an adhesive made of asphaltic material and a homogeneously mixed filler that meets the following physical requirements:

- a. Adhesive Properties: Use the asphaltic material with filler.

	Min.	Max.	Test Method
Softening point	200° F (95 °C)	—	AASHTO T 53
Penetration, mm 3.5 oz (100 g), 5 sec., 77 °F (25 °C)	10	20	AASHTO T 49
Flow	—	0.2 in (5 mm)	ASTM D 3407 (modified in Subsection 868.2.01.C)
Viscosity, 400 °F (204 °C)	—	75 Poises (7.5 Pa-s)	ASTM D 2669 (modified in Subsection 868.2.01.C)
Flash point, C.O.C.	550 °F (285 °C)	—	AASHTO T 48

- b. Asphalt Properties: Use the filler-free material derived from the extraction and Abson recovery process explained in [Subsection 868.2.01.C](#).

	Min.	Max.	Test Method
Penetration, mm 3.5 oz (100 g), 5 sec., 77 °F (25 °C)	25	—	AASHTO T 49
Viscosity, 275 °F (135 °C)	12 Poises (1.2 Pa-s)	—	AASHTO T 202

Section 868—Bituminous Adhesive For Raised Pavement Markers

Viscosity ratio, 275 °F (135 °C)	—	2.2	See Subsection 868.2.01.C
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- c. Filler Properties: Use the filler separation techniques described in [Subsection 868.2.01.C](#).

	Min.	Max.	Test Method
Filler content, percent by weight	50	75	See Subsection 868.2.01.C
Filler fineness, percent passing			
No. 325 (45 µm)	75		ASTM C 430 (modified in Subsection 868.2.01.C)
No. 200 (75 µm)	95		
No. 100 (150 µm)	100		

- d. Certification: Submit a certification from the manufacturer that includes the physical properties of the bituminous adhesives and that the material conforms with this Specification, as stated in [Subsection 106.05](#), “[Materials Certification](#)”

2. Packaging and Labeling

- a. Pack the adhesive in a self-releasing cardboard container of approximately 10 in (250 mm) that can be stacked properly.
- b. Fill the containers with two 30 lb (13.5 kg) cubes that have a net weight of 60 lbs (27 kg).
- c. Put the manufacturer, quantity, and batch number on the label.
- d. Print “Bituminous Adhesive for Pavement Markers” on the label.

B. Fabrication

Omitted

C. Acceptance

1. Flow

Determine flow according to Section 6, Flow, of ASTM D 3407.

- a. Set the oven temperature at 158 ° ± 2 °F (70 ° ± 1 °C).
- b. Prepare samples according to Subsection 7.1 of AASHTO T 49.

2. Viscosity

Determine viscosity according to ASTM D 2669 using a spindle speed of 10 rpm.

- a. Heat the adhesive to approximately 410 °F (210 °C) and then let cool.
- b. Determine viscosity at 400 ° ± 1 °F (204 ° ± 0.6 °C).

3. Asphalt Properties

Determine the base asphalt properties based on the material obtained from the following extraction and Abson recovery methods:

- a. Extract the asphalt by heating the adhesive to the point where it will easily flow.
- b. Add 125 to 150 g of adhesive to 400 mL of trichloroethylene that has a temperature of 125 ° to 150 °F (51 ° to 66 °C).
- c. Stir the mixture to dissolve the asphalt.
- d. Decant the trichloroethylene-asphalt mixture.
- e. Recover the asphalt using the Abson recovery method described in ASTM D 1856, except do not use the extraction methods of ASTM D 2712, and do not filter the solvent-asphalt mixture.

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- f. Centrifuge the extraction solution of trichloroethylene and asphalt for at least 30 minutes at 770 times gravity in a batch centrifuge.
- g. Decant the solution into a distillation flask. Do not include any filler sediment.
- h. Apply heat and bubble carbon dioxide slowly until the solution reaches a temperature of 300 °F (149 °C).
- i. Increase the carbon dioxide flow to between 800 to 900 mL per minute.
- j. Maintain the decanted solution temperature between 320 ° and 335 °F (160 ° and 168 °C) with this carbon dioxide flow for at least 20 minutes and until the trichloroethylene vapors are completely removed from the distillation flask.
- k. Repeat the extraction-recovery method as necessary to obtain the desired quantity of asphalt.
- l. Determine penetration, 275 °F (135 °C) viscosity, and viscosity ratio with the recovered asphalt.

4. Viscosity Ratio

Determine the 275 °F (135 °C) viscosity ratio by comparing the 275 °F (135 °C) viscosity on the base asphalt before and after the Thin-Film Oven Test.

- a. Perform the Thin-Film Oven Test as described in ASTM D 1754.
- b. Determine the specific gravity with a pycnometer as described in ASTM D 70 for use in the Thin-Film Oven Test.
- c. Calculate the 275 °F (135 °C) viscosity ratio by dividing the viscosity after the Thin-Film Oven Test by the original 275 °F (135 °C) viscosity.

5. Filler Material

Separate the filler material from the asphalt to determine filler content and filler fineness.

a. Filler Content

- 1) Determine the portion by weight of the adhesive that is insoluble in 1, 1, 1-trichloroethane by weighing 10.00 ± 0.01 g of solid adhesive into a centrifuge flask with a volume of approximately 100 mL, as specified in ASTM D 1796.
- 2) Add 50 mL of 1, 1, 1-trichloroethane to the adhesive.
- 3) Break the adhesive into small pieces to dissolve the solids.
- 4) Place the sample flask in a balanced centrifuge and spin with a minimum relative centrifugal force of 150 (as determined in Section 6 of ASTM D 1796) for 10 minutes.
- 5) Remove the sample flask and decant the solvent, without losing any solids.
- 6) Repeat the application of solvent and centrifuging until the solvent is clear and the filler is visually free of asphalt.
- 7) Dry the filler at 160 °, ± 5 °F (71°, ± 3 °C) to remove solvent and weigh the resulting filler.
- 8) Filter the decanted solvent to verify that no filler was lost.
- 9) Calculate the percent filler content as follows:

$$\text{Filler Content, \% by weight (g)} = \frac{\text{Filler Wt. (g)} \times 100}{\text{Original Adhesive Wt. (g)}}$$

b. Filler Fineness

- 1) Determine filler fineness according to ASTM C 430, using No. 325 (45 µm), No. 200 (75 µm), and No. 100 (150 µm) sieves.
- 2) Modify this method by using a water-soluble, non-ionic wetting agent, such as Triton X-100, to aid the wetting action. Use a surfactant solution that is approximately 1 percent by weight.
- 3) Thoroughly wet the 1-gram dry sample in the surfactant solution.

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- 4) Soak the sample for 30 minutes.
- 5) Transfer the filler to the sieve cup.
- 6) Spray water on the filler for two minutes.
- 7) Add surfactant solution as needed and physically disperse clumped particles.
- 8) Dry the sample and handle as directed in ASTM C 430.

The Department will reject any bituminous adhesive if it meets all requirements of this Specification but fails in actual use.

D. Materials Warranty

Omitted

Section 886—Epoxy Resin Adhesives

886.1 General Description

This section includes the requirements for all epoxy adhesives used in highway construction or maintenance.

886.1.01 Related References

A. Standard Specifications

Omitted

B. Referenced Documents

AASHTO T 237

ASTM 2240

Federal Hazardous Products Labeling Act

[GDT 58](#)

[QPL 15](#)

886.2 Materials

886.2.01 Epoxy Resin Adhesives

A. Requirements

1. Use the types of epoxy adhesives below:
 - a. Type I-R: Rapid-setting marker adhesive for bonding raised pavement markers to pavement.
 - b. Type I-S: Standard setting marker adhesive for bonding raised pavement markers to pavement.
 - c. Type II: Epoxy adhesive for bonding plastic concrete to hardened concrete.
 - d. Type III: Epoxy adhesive for bonding hardened concrete to hardened concrete, or for bonding miscellaneous materials such as metals.
 - e. Type IV: Epoxy adhesive for creating an epoxy mortar for use with clean concrete or mortar sand.
 - f. Type V: Epoxy adhesive for repairing cracks in concrete by intrusion grouting.
 - g. Type VI: Epoxy adhesive for a complete application or as a component in the application of a skid resistant or protective coating on hardened Portland cement concrete or asphaltic concrete.
 - h. Type VII: Discontinued.
 - i. Type VIII: Epoxy adhesive used for anchors and dowel bar implants. Either mix this epoxy by machine to the proper ratio or package it in a two-component cartridge with a mixing nozzle that thoroughly mixes the two components as they are dispensed. Use a nozzle at least 8 in (200 mm) long.
2. Furnish the epoxy adhesive as two separate components.
3. Viscosity

Ensure that the viscosities of the separate components are similar and conducive to easy blending of the epoxy adhesive system.

 - a. Submit the viscosity for the epoxy adhesive system to the Engineer.
 - b. Ensure that the viscosity of the mixed system is compatible with the intended use of the system.
4. Labeling

Clearly label each container of the separate components of an epoxy adhesive system with the following information:

Table 1
Mixed Epoxy Adhesive Systems Requirements

- Specification number and type
 - Component designation (A or B)
 - Manufacturer’s batch number—a batch is a single charge of all components in a mixing chamber
 - Expiration date (shelf life for separate components in original containers)
 - Mixing ratio and directions (by volume or weight as designated by the manufacturer)
 - Potential hazards and precautions according to the Federal Hazardous Products Labeling Act
5. Stencil the component designation on the top of each container.
 6. Physical Requirements

Ensure that the mixed epoxy adhesive system meets the applicable requirements of [Table 1](#).

B. Fabrication

Omitted

C. Acceptance

Each epoxy adhesive system shall meet the requirements of this Section.

If the Department qualifies or disqualifies a system for one of the types specified, it will not affect the qualification or disqualification of any other type.

The Department will reject any epoxy adhesive system that meets all the requirements of this Section, but fails in actual use. For a list of sources, see [QPL 15](#).

D. Materials Warranty

Omitted

Table 1
Mixed Epoxy Adhesive Systems Requirements

Property	Type Designation									Test Method
	I-R	I-S	II	III	IV	V	VI	VII	VIII	
Pot Life at 77 °F (25 °C) (minutes)	6-11	8-13	30	10-45	30-60	10-45	30-60	—	3-10	GDT 58
Elongation at 77 °F (25 °C) (percent)	—	—	—	—	30**	—	30**	—	5% Max.	GDT 58
Bond Strength, psi (MPa) at 1 hr and 77 °F (25 °C)	180 (1.2)	—	—	—	—	—	—	—	—	GDT 58
at 3 hr and 77 °F (25 °C)	—	180 (1.2)	—	—	—	—	—	—	250 (1.7)	
at 24 hr and 77 °F (25 °C)	400 (2.8)	400 (2.8)	400 (2.8)	400 (2.8)	250 (1.7)	400 (2.8)	250 (1.7)	—	400 (2.8)	
Shore D Hardness at 77 °F (25 °C)	—	—	—	—	75 Max.	—	35-65	—	—	ASTM: 2240
SAG Test	—	—	—	—	—	—	—	—	No Sag	AASHTO: T 237

Table 1
Mixed Epoxy Adhesive Systems Requirements

Wet Bond Test ,psi (MPa)	—	—	400 (2.8)	—	—	—	—	—	—	AASHTO: T 237 Section 31
Shelf Life*** (months)	6	6	6	24	12	24	6	—	6	

Note: * Values are minimums except where a range is shown, or otherwise noted.

** Epoxy adhesive system only. *** For separate components in original containers.

Section 870—Paint

870.1 General Description

This section includes the requirements for all paints, including pigments, vehicles, and the compositions of prepared paints for all purposes specified.

870.1.01 Related References

A. Standard Specifications

Omitted

B. Referenced Documents

[QPL 46](#)

SOP 14

AASHTO M 69

Military Specifications MIL-E-698 B

MIL-P-23236 or US Corps of Engineers Specification C-200

Federal Test Methods, Standard No. 141

Federal Specifications		ASTM			
TT-E-489	TT-P-791a	D 209	D 476	D 768	D 3021
TT-P-103b	TT-P-1952B	D 211	D 600	D 822	D 3721
TT-P-104b	TT-R-266	D 234	D 602	D 1199	D 4462
TT-P-320c	TT-T-291	D 235	D 604	D 1648	E 97
TT-P-460	TT-V-119	D 263	D 605	D 2805	G 23
		D 324	D 711		

870.2 Materials

A. Requirements

1. Ingredients

The Engineer shall approve all paint ingredients. Mix the paints in the proportions specified in this section for each kind of paint. The formulas given represent the proportions by weight of the materials to be used.

2. Condition of Mixed Paints

Ensure that mixed paints do not liver or curdle, and that the pigments remain in suspension to a reasonable degree satisfactory to the Engineer.

3. Filling and Packaging

The manufacturer shall strain paints before filling the containers. The manufacturer also shall ship paints in strong, substantial containers (according to [QPL 46](#)) plainly marked with the paint name and number, color, volume, manufacturer name and address, date of manufacture, and the manufacturer's lot number on every package. The inspection stamp on the paint container will be evidence of approval.

Traffic line paint manufactured for the Department shall be delivered in 55 gallon (208 L) drums. The manufacturer shall stencil on the head of each drum the kind of paint, requisition number, purchase order number, and gross and net weights. Ensure that the drums are the removable head types.

4. Finished Paints

Unless otherwise specified, deliver paints to the Project or the Department completely mixed and ready for use without adding oils or thinner. Use well ground paints that do not settle or badly cake in the container, and can readily be broken up to a smooth, uniform paint with good brushing consistency.

When brushed or rolled on a smooth, vertical surface, the paint shall dry hard and elastic without running, streaking, sagging, or spotting. Use paint for spray application that sprays satisfactorily and does not run, sag, or streak.

The first coat of paint applied in the shop or in the field to uncoated structural steel or wood is called the primer coat. The paint covering the primer coat is called the second coat, and the paint covering the second coat is called the third coat.

B. Fabrication

The formulas given in this specification represent proportions by weight.

C. Acceptance

1. Testing

Test methods for paint analyses shall be according to the Federal Test Methods, Standard No. 141 or the ASTM standard methods of tests for paint.

2. Color

Match color visually by comparing with standard color chips obtained from the Office of Materials and Research.

3. Inspection

Inspection and analysis will be made at the point of manufacture according to SOP 14. The manufacturer shall assist as necessary, permit the Inspector to test the ingredients before the paint is made, and witness the paint grinding.

The Department reserves the right to sample and test all paint at any time before it is used.

4. Tolerances

The Department will accept a tolerance of 1 percent of the required value for the paint formulation and property requirements.

EXCEPTION: This tolerance does not apply where maximum and minimum values are noted.

D. Materials Warranty

The following people shall furnish the Department a certificate of analysis and manufacturer's guarantee:

- The manufacturer of each brand of paint submitted for acceptance under these Specifications
- All Contractors proposing to use any paint specified in this Section

Ensure that the certificate of analysis shows the paint trade name to be furnished, including a facsimile of the label if the paint is ready-mixed, and an analysis showing the percentage of each of the chemical elements and compounds in the pigment and vehicle. The guarantee shall assert that all paint furnished conforms to the analysis shown on the certificate filed and to the statement of percentages of ingredients shown on the labels, which are required to be on each container.

The guarantee shall be sworn to by a person having authority to bind the manufacturer into an agreement.

870.2.01 Omitted

870.2.02 Traffic Line Paints

A. Requirements

Use traffic line paints that meet the applicable requirements of [Subsection 870.2](#) and the following:

1. No. 4C, Black Traffic Line Paint

- a. Paint Composition: (See [Table 10](#)).
- b. Finished Paint:

- 1) Flexibility: Ensure paint flexibility by following this procedure:

- a) Use a doctor blade or other suitable means to apply the paint to a 30-gauge (0.39 mm) clean tin plate panel. Apply to a wet film thickness of approximately 2 mils (0.05 mm).
 - b) Dry the panel in a horizontal position for 18 hours, and then bake it for 5 hours at 220 °F to 225 °F (105 °C to 110 °C).
 - c) Cool the panel to approximately 77 °F (25 °C) and bend double over a ½ inch rod (13 mm rod). Ensure that the film does not show cracking or flaking upon bending or straightening.
- 2) **Color:** Ensure that the paint dries to a pure, flat black and furnishes the maximum amount of opacity and visibility under both daylight and artificial light.
- Ensure that the paint does not discolor when exposed to weather or traffic and does not appreciably discolor with stains during service life on either concrete or bituminous surfaces.
- 3) **Weight per gallon (liter):** Use paint weighing at least 14.0 lb/gal (67 kg/L) at 77 °F (25 °C).
 - 4) **Consistency:** The paint viscosity when measured at 77 °F shall be 85 to 100 Krebs Units.
 - 5) **Moisture content:** The paint shall contain no more than 0.5% water.
 - 6) **Drying:** The paint shall dry to no pickup within 45 minutes when tested according to ASTM D 711.
 - 7) **Spraying:** The paint shall be factory-mixed ready for application through spray machines without using thinners.
 - 8) **Storage:** The paint shall not cake, liver, thicken, curdle, gel, or show other objectionable properties after storage for 6 months.
 - 9) **Coarse particles and skins:** The paint shall not contain more than 1.0 percent of coarse particles and skins.
 - 10) **Fineness of Grind:** The paint shall have a grind of 3 to 5 Hegman scale.
 - 11) **Packaging:** The finished paint shall be passed through a No. 40 mesh screen while filling the containers.

Table 10—No 4C, Black Traffic Line Paint

Requirement	Maximum	Minimum
Paint composition, percent by weight		
Pigment	43.0	41.0

Vehicle	59.0	57.0
Non-volatile vehicle, percent by weight of vehicle	—	42.0
Pigment composition, percent by weight		
Lamp Black, ASTM D 209	—	3.0
Calcium Carbonate, ASTM D 1199, Type GC (Note 1), Grade 1	34.0	32.0
Diatomaceous Silica, ASTM D 604, Type B	23.0	21.0
Magnesium Silicate, ASTM D 605	44.0	42.0
Organo Montmorillonite (Note 2)	0.8	0.3
Vehicle Composition, percent by weight		
Alkyd resin solution	—	70.0
Petroleum thinner, driers, and other additives	30.0	—
Alkyd Resin Solution Characteristics		
Type	Pure Drying Alkyd	
Type of oil	Soya, Linseed, or a mixture of the two	
Non-volatile, percent by weight	61	59
Volatile type	VM & P Naphtha	
Viscosity, Gardner-Holdt	Z ⁵	Z ³
Viscosity, at 45% solids	G	D
Color, Gardner—1953	10	3
Acid number, solids basis	8	—
Alkyd Resin Solution Characteristics,		
lbs/gal (kg/L) solution	7.75 (0.93)	7.66 (0.92)
Modifying oil iodine number (Note 3)	—	115
Phthalic Anhydride, percent by weight of non-volatile	—	33
Oil Acids, percent	55	48
Compatibility	500% in VM & P Naphtha	
Resin and/or Derivatives	None	
Phenolic Resin Modifiers	None	

Notes for Table 10:

1. You may use the following chemical composition requirements for calcium carbonate in lieu of those for Type GC. However, all physical properties prescribed for Type GC, Grade 1, are required.

Requirement	Maximum	Minimum
Moisture and other volatile matter, percent by weight	0.2	—
Total Calcium and Magnesium Carbonates, percent by weight	—	95
Magnesium Carbonate	3	

2. Prewet Organo Montmorillonite with 20-30% (95%) methyl alcohol by weight.
3. Use modifying oil acids, isolated by Federal Test Method No. 141, Method 7031 that have an Iodine Number as specified in Table 870.8, Alkyd Resin Solution Characteristics.

2. No. 5A, Waterborne White Traffic Line Paint

a. Paint Composition: (See [Table 11](#)).

b. Finished Paint

- 1) Flexibility: Apply the paint to a 30 gauge (0.39 mm), clean tin plate panel, to a wet film thickness of approximately 2 mils (0.05 mm). Use a doctor blade or other suitable means.
 - a) Dry the panel horizontally for 18 hours.
 - b) Bake the panel for 5 hours at 220 ° to 230 °F (105 ° to 110 °C).
 - c) Cool the panel to about 77 °F (25 °C) and bend it double over a 1/2 in (13 mm) rod. Ensure that the film does not crack or flake when bent or straightened.

- 2) Bleeding: Ensure that the paint does not bleed over a bituminous surface type used in Georgia.
- 3) Color: Ensure that the paint dries to a pure, intense white and furnishes the maximum amount of opacity and visibility under both daylight and artificial light.

Ensure that the paint does not discolor when exposed to weather or traffic and does not appreciably discolor with stains during service life on either concrete or bituminous surfaces.

- 4) Consistency: Use paint with a viscosity of 80 - 100 Krebs units at 77 °F (25 °C).
- 5) Drying: Ensure that the paint dries to no-pick-up within six minutes when tested according to ASTM D 711.

Ensure that the paint dries through within 20 minutes when applied at 15 mils (0.38 mm) wet thickness at 77 °F (25 °C).

- 6) Spraying: Mix the paint at the factory so it can be applied by spray machines without adding thinners.
- 7) Storage: Ensure that the paint does not cake, liver, thicken, curdle, gel, or show any other objectionable properties after storage for six months.
- 8) Coarse Particles and Skins: Ensure that the paint contains less than 1 percent of coarse particles and skins.
- 9) Fineness of Grind: Ensure that the paint has a grind of 2 to 5 Hegman scale.
- 10) Weight per liter gallon: Use paint weighing at least 14.00 lb/gal. at 77 °F (1.68 kg/L at 25 °C).
- 11) Packaging: Pass the finished paint through a No. 40 (425 µm) screen while filling the containers.
- 12) Freeze-Thaw and Heat Stability: Ensure that the paint shows no coagulation, discoloration, or change in consistency greater than 10 Krebs units, when tested according to TT-P-1952B.
- 13) pH: Ensure that the pH is greater than 9.5.

Table 11—No. 5A Waterborne White Traffic Line Paint

Requirement	Maximum	Minimum
Paint Composition, percent by weight		
Pigment	63.0	60.0
Vehicle	40.0	37.0
Non-Volatile Vehicle, percent by weight of vehicle	50.0	42.0
Pigment Composition, percent by weight		
Titanium Dioxide, ASTM D 476		

Requirement	Maximum	Minimum
Type II, Rutile	—	13.0
Calcium Carbonate, ASTM A 1199		
Type GC Grade 1	87.0	—
Vehicle Composition, percent by weight		
Acrylic Emulsion E-2706 or DT211NA (50% NV) ¹	90.0	85.0
Methanol	3.0	1.0
Texanol Coalsecent	5.0	4.0
Other Additives	5.0	0.0
Propylene Glycol	—	3.0
NOTE: ¹ Or approved equivalent		

3. No. 5B, Waterborne Yellow Traffic Line Paint

a. Paint Composition: (See [Table 12](#)).

b. Finished Paint:

- 1) Flexibility: Apply the paint with a doctor blade to a 30 gauge (0.39 mm), clean tin plate panel, to a wet film thickness of approximately 2 mils (0.05 mm).
 - a) Dry the panel horizontally for 18 hours.
 - b) Bake the panel for 5 hours at 220 ° to 230 °F (105 ° to 110 °C).
 - c) Cool the panel to about 77 °F (25 °C) and bend it double over a 1/2 in (13 mm) rod. Ensure that the film does not crack or flake when bent or straightened.
- 2) Bleeding: Ensure that the paint does not bleed on any bituminous surface type used in Georgia.
- 3) Color: Ensure that the paint dries to a bright yellow that matches color chip #33538 of Federal Color Standard #595B, within the limits of the Highway Yellow Color Tolerance Chart.
Ensure that the paint does not discolor when exposed to weather or traffic and does not appreciably discolor from stains during service life on either concrete or bituminous surfaces.
- 4) Consistency: Ensure a viscosity of 80 - 100 Krebs units at 77 °F (25 °C).
- 5) Drying: Ensure that the paint dries to no-pick-up within 6 minutes when tested according to ASTM D 711.
Ensure that the paint dries through within 20 minutes when applied at 15 mils (0.38 mm) wet thickness at 77 °F (25 °C).
- 6) Spraying: Mix the paint at the factory so it can be applied by spray machines without adding thinners.
- 7) Storage: Ensure that the paint does not cake, liver, thicken, curdle, gel, or show any other objectionable properties after storage for 6 months.
- 8) Coarse Particles and Skins: Ensure that the paint contains less than 1 percent of coarse particles and skins.
- 9) Fineness of Grind: Ensure that the paint has a grind of 3 to 5 Hegman scale.
- 10) Weight per Gallon (liter): Use paint weighing at least 13 lb/gal (1.56 kg/L) at 77 °F (25 °C).
- 11) Packaging: Pass the finished paint through a No. 40 (425 µm) screen while filling the containers.
- 12) Freeze-Thaw and Heat Stability: Ensure that the paint shows no coagulation, discoloration, or change in consistency greater than 10 Krebs units, when tested according to TT-P-1952B.
- 13) pH: Ensure that the pH is greater than 9.5.

Table 12—No. 5B, Waterborne Yellow Traffic Line Paint

Requirement	Maximum	Minimum
Paint Composition, percent by weight		
Pigment	63.0	60.0
Vehicle	40.0	37.0
Non-Volatile Vehicle, percent by weight of vehicle	50.0	42.0
Pigment Composition, percent by weight		
Titanium Dioxide, ASTM D 476 Type II, Rutile	—	4.0
Lead-free organic yellow No. 65	—	5.0
Calcium Carbonate, ASTM D 1199 Type GC Grade 1	91.0	—
Vehicle Composition, percent by weight		
Acrylic Emulsion E-2706 or DT211NA (50% NV) ¹	90.0	85.0
Methanol	3.0	1.0
Texanol Coalsecent	5.0	4.0
Other Additives	5.0	—
Propylene Glycol	—	3.0
NOTE: ¹ or approved equivalent		

B. Fabrication

Omitted

C. Acceptance

See [Subsection 870.2.C](#).

D. Materials Warranty

Omitted

870.2.03 Omitted

870.2.04 Omitted

870.2.05 Omitted

870.2.06 Miscellaneous Paint Materials

A. Requirements

Use other paint materials that meet the following requirements:

1. Raw Linseed Oil: Use oil that meets the requirements of ASTM D 234.
2. Boiled Linseed Oil: Use oil that meets the requirements of ASTM D260.
3. Turpentine: Use turpentine that meets the requirements of ASTM D 13.
4. Mineral Spirits: Use petroleum spirits (mineral spirits) that meets the requirements of ASTM D 235.
5. Spar Varnish: Use Varnish, Spar Phenolic Resin, as per Federal Specification TT-V-119.
6. Tinting Pigment Paste: Use lampblack, venetian blue, or iron blue as tinting pigments.

- The Engineer may approve other tinting pigments, subject to limitations.

- Add all tinting pigments in paste form.

7. Putty: Use putty that meets the requirements of Federal Specifications TT-P-791a, Type II.

B. Fabrication

Omitted

C. Acceptance

Omitted

D. Materials Warranty

Omitted

Section 919—Raised Pavement Markers

919.1 General Description

This section includes the requirements for raised pavement marker materials for use in reflective, ceramic, and channel markers.

919.1.01 Related References

A. Standard Specifications

Omitted

B. Referenced Documents

ASTM C 424

ASTM C 373

ASTM D 2240

ASTM D 4280

Federal Method TT-T-141, Method 4252

919.2 Materials

A. Requirements

Do not use any marker materials until the laboratory approves it.

1. Use raised pavement marker sources as listed in [QPL 76](#).
2. Use any raised pavement markers below that are reflective, two color, and non-flexible. This Specification references markers as follows:

Type	Description
1	One-way, one-color, 4 x 2 in (100 mm x 50 mm), reflective
2	Two-way, one-color, 4 x 2 in (100 mm x 50 mm), reflective
3	Two-way, two color, 4 x 2 in (100 mm x 50 mm), reflective
4	Round white, yellow or black ceramic, non reflective
5	Oval white, yellow or black ceramic, non-reflective
6	Oval white or yellow ceramic, reflective
7	White or yellow ceramic jiggle bar, non-reflective
8	White or yellow ceramic jiggle bar, reflective
9	White or yellow channel, non-reflective
10	White or yellow channel, reflective
11	Two-way, one-color, 4 x 4 in (100 mm x 100 mm), reflective
12	One-way, one color, 4 x 4 in (100 mm x 100 mm), reflective
13	Two-way, two color, 4 x 4 in (100 mm x 100 mm), reflective

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14	Two-way, one color, flexible reflective
15	One-way, one color, flexible reflective

3. Definitions

- a. **Angle of Incidence:** Formed by a ray from the light source to the marker, and the normal to the leading edge of the marker face.
- b. **Angle of Divergence:** Formed by a ray from the light source to the marker and the return ray from the marker to the measuring receptor.
- c. **Specific Intensity:** The mean candela of the reflected light at a given incidence and divergence angle for each lux at the reflector on a plane perpendicular to the incident light.

4. Sampling

The Department will select at random the required number of markers for initial tests for each shipment or lot, as follows:

Reflective Markers	Ceramic Markers	Channel Markers
50	25	5

5. Certification

Submit a certification to the Engineer from the manufacturer showing the physical properties of the markers and their conformance to this Specification.

6. Packaging

Pack shipments in containers that are acceptable to common carriers.

- a. Pack the containers to ensure delivery in perfect condition.
- b. Clearly mark each package of pavement markers with the size, color, type, and lot number.
- c. You are liable to replace any damaged shipments.

7. Acceptance

The Department will give conditional approval to raised pavement markers evaluated by the National Transportation Product Evaluation Program (NTPEP), the Georgia Department of Transportation, or other Department-approved test facilities and place them on [QPL 76](#).

All white raised pavement markers must meet the requirements of this Specification and the following field performance requirements.

- a. **Conditional [QPL](#) Placement:** The Department may add markers on a conditional basis to [QPL 76](#). These markers must maintain an average Coefficient of Retroreflected Luminous Intensity of 1.5 candles per footcandle (cd/fc)* after a one-year field evaluation period through at least one of the test facilities specified above.
- b. **Final Acceptance or Rejection:** The Department will accept or reject markers based on the marker maintaining an average Coefficient of Retroreflected Luminous Intensity of 0.5 candles per footcandle (cd/fc)* after a two-year field evaluation period through at least one of the test facilities specified above.

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NOTE: Measure the coefficient of retroreflected luminous intensity at the 0 degree incident angle and 0.2 degree divergence angle.

919.2.01 Reflective Pavement Markers

A. Requirements

Plastic reflective pavement markers are types 1, 2, 3, 11, 12, and 13 (rigid plastic reflective) and types 14 and 15 (flexible reflective).

1. Rigid Plastic Reflective Markers

- a. Use prismatic markers made with a methyl methacrylate or acrylonitrile butadiene styrene, a high-impact plastic shell filled with a mixture of inert thermosetting compound and filler material.
 - 1) Ensure that the exterior shell surface is smooth and contains one or two prismatic faces, molded to reflect incident light from a single direction or from opposite directions.
 - 2) Ensure that the shell is one color or a combination of two colors that will be the same as reflective elements and shall match the size and shape in the Plans.
- b. Use two basic sizes—a standard (a base of 4 x 4 in [100 mm x 100 mm]) or a low-profile (a base of 4 x 2 in [100 mm x 50 mm]).
 - 1) Ensure that reflective raised pavement markers have one or two lens surfaces that meet the requirements of ASTM D 4280, designation H—a marker with a hard, abrasion-resistant lens surface.
 - 2) Ensure the marker base is clean and has no gloss or substance that may reduce the adhesive's bond. The Department will reject the marker if it has a soft or resin-rich film on the base.

2. Flexible Reflective Markers (Type 14 and 15)

Use markers manufactured by extruding plastic into an “L” shape, with nominal dimensions of 4 in (100 mm) long x 2 in (50 mm) high (vertical face) x 1 in (25 mm) wide (base leg). Ensure that the markers have the following:

- A pressure-sensitive adhesive with a paper release liner to the bottom of the base leg.
- Strips of metallized acrylic reflective sheeting on either one or both sides of the vertical face.
- A clear plastic cover to protect the reflective strip. Ensure that the cover withstands a chip-seal operation and is easily removed after the operation.

3. Color

Use clear, yellow, or red raised reflective pavement markers, as required.

If the reflection is off-color, the Department will reject the markers.

4. Specific Intensity

Ensure that the specific intensity of each reflective surface, when tested at 0.2 degree angle of divergence, has at least these values:

Incidence Angle	Clear	Yellow	Red
0°	3.0	1.50	0.75

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20°	1.2	0.60	0.30
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Calculate the intensity as follows:

$$SI = (R_L \times D^2) \div I_L$$

Where:

SI = Specific Intensity

I_L = Incident Light

R_L = Reflected Light

D = Test Distance

B. Fabrication

Omitted

C. Acceptance

The Department will accept markers based on the results of the physical tests and on the manufacturer’s certification showing the physical properties of the markers and their conformance to this Specification.

The Department will conduct the following tests:

- Specific Intensity
- Compressive Strength
- Impact
- Temperature Cycle
- Shore A Hardness (Type 14 and 15 only)

1. Specific Intensity

- a. Place markers so the center of the reflecting face is 5 ft (1.5 m) from a uniformly bright light source. Use a source with an effective diameter of 0.21 in (5 mm).
If using a test distance other than 5 ft (1.5 m), modify the source and receptor in the same proportion as the test distance.
- b. Use a photocell receptor 0.5 in (13 mm) wide. Shield it to eliminate stray light.
- c. Place the center of the light source aperture 0.2 in (5 mm) from the center of the photocell.
- d. Use the following table to determine if the markers pass the tests (except the strength test), unless otherwise specified.

Markers that Pass	Department Action
48 of 50	Accept the lot.
44 or less of 50	Reject whole lot; no retest allowed.
45-47 of 50	Contractor can request a retest on 100 markers. The Department will pass each marker through all tests except the strength test.
96 of 100 retested	Accept the whole shipment
95 or less of 100 retested	Reject the whole shipment

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2. Compressive Strength

Test for compressive strength as follows:

Standard Raised Markers 4 x 4 in (100 x 100 mm)	Low-Profile Markers 4 x 2 in (100 x 50 mm)
1. Select three random markers for the test.	
2. Center the base of the marker over the open end of a hollow, vertically positioned metal cylinder (1 in (25 mm) high, internal diameter of 3 in (75 mm), wall thickness of 0.25 in (6 mm)).	2. Position the marker on its base at the center of a flat, steel plate that has a minimum thickness of 0.5 in (13 mm).
3. Apply a load to the top center of the marker with a 1 in (25 mm) diameter solid steel plug at a rate of	
0.2 in (5 mm) per minute.	0.03 in (0.75 mm) per minute.
4. The marker fails if it breaks or deforms at a load less than	
2,000 lbs (8.9 kN)	4,000 lbs (17.8 kN)
Or if the shell and the filler material significantly delaminate, regardless of the load required to break the marker.	
5. If any of the 3 samples fail, the Department will test 6 additional samples.	
6. If any of the 6 additional samples fail, the Department will reject the entire lot.	

3. Impact Test

- a. Condition all prismatic reflective faces that meet the requirements of ASTM D 4280, designation H, before the impact test.
- b. Choose at random 20 markers for each test.
- c. Condition the markers in an oven at 130 °F (54° C) for one hour.
- d. While at this temperature, drop a 0.42 lb (0.2 kg) dart fitted with a 0.25 in (6 mm) radius spherical head from 18 in (450 mm) above the reflective face.
- e. Drop the dart perpendicularly onto the center of the reflective surface. The cracks in the impact area shall appear generally concentric.
- f. The Department will reject the marker if more than two radial cracks longer than 0.25 in (6 mm) appear, or if radial cracks extend to the edge of the reflective face.
- g. Use the following table to determine if the markers pass the tests.

Markers that Pass	Department Action
18 of 20	Accept the lot.
16 of 20	Reject the lot.
17 of 20	The Contractor may request a retest. The Department will test 20 additional lenses.
19 or less of 20 retested	Reject the lot.

Section 919—Raised Pavement Markers

4. Temperature Cycle
 - a. Subject the same markers used for impact testing to 3 cycles of 140 °F (60 °C) for 4 hours followed by 20 °F (–7 °C) for 4 hours.
 - b. The Department will reject the markers if they crack or delaminate after this test.
 - c. Use the following table to determine if the markers pass the tests.

Markers That Pass	Department Action
18 of 20	Accept the lot.
16 of 20	Reject the lot.
17 of 20	The Contractor may request a retest. The Department will test 20 additional lenses.
19 or less of 20 retested	Reject the lot.

5. Hardness (Type 14 or 15 only)
 - a. Select five random markers.
 - b. Use ASTM D 2240 to determine the Shore A hardness.
 - c. Measure the hardness. The Department will reject markers whose body and clear protective cover hardness is less than 80.

D. Materials Warranty

Omitted

919.2.02 Ceramic Pavement Markers

A. Requirements

Ceramic pavement markers are types 4, 5, 6, 7, and 8.

1. Use ceramic pavement markers made from a heat-fired, white, vitreous, ceramic base and a heat fired, opaque, glazed surface to produce the properties required in these Specifications.
 - a. Do not place glaze on the marker bottom where it connects to the road surface.
 - b. Thoroughly and evenly mature the markers. Ensure that they have no defects that affect appearance and serviceability.
 - c. Use reflective ceramic markers that meet the specific intensity of each reflective surface according to [Subsection 919.2.01.A.4.](#)
 - d. Ensure that the mean thickness of the glazed surface is at least 0.005 in (0.13 mm) when measured at least 0.25 in (6 mm) from the edge of the marker.
 - e. Ensure that the water absorption of the ceramic markers does not exceed 2 percent of the original dry weight when tested according to ASTM C 373.
 - f. Ensure that the glazed surface does not craze, spoil, or peel when passed through one cycle of the Autoclave test at 250 psi (1724 kPa) (ASTM C 424).

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2. Use the designated colors for the white and yellow markers.
 - a. Ensure that the colors are uniform.
 - b. Ensure that black matches Federal Color No. 595-27038.
 - c. Determine the color by visually comparing each marker with calibrated standards having CIE Chromaticity Coordinate limits. Determine the limits with Federal methods of test TT-T-141, Method 4252, using a rectangle with the following corner points:

	1		2		3		4		(90MGO)
White	.290	.316	.310	.296	.330	.320	.310	.344	80 min.
Yellow	.435	.485	.445	.435	.544	.456	.516	.484	50 min.

B. Fabrication

Omitted

C. Acceptance

1. Use a random sample of five markers for each of the required tests in [Subsection 919.2.01.C.3](#) to [Subsection 919.2.01.C.4](#), and [Subsection 919.2.01.C.5](#). Use the Compressive Strength Test in [Subsection 919.2.02.C.3](#).
2. Use the following table to determine if the markers pass the tests.

Markers that Pass	Department Action
5 of 5	Accept the lot.
3 or less of 5	Reject the lot; no resample allowed.
4 of 5	The Contractor may request a retest. The Department will retest an additional 25 random markers in the test or tests where the original sample failed.
20 of 25 retested	Accept the lot.
19 or less of 25 retested	Reject the lot; no resample allowed.

3. Compressive Strength Test
 - a. Center the markers with the base down over the open end of a vertically positioned hollow metal cylinder. Use a cylinder 1 in (25 mm) high with an internal diameter of 3 in (75 mm) and a wall thickness of 0.25 in (6 mm).
 - b. Apply a load at 0.2 in (5 mm) per minute to the top of the markers through a 1 in (25 mm) diameter solid metal cylinder centered on the top of the markers.
 - c. Apply the load until the marker breaks.
 - d. The markers pass if the average compressive load of all five markers is at least 1,500 psi (6.7 kN). No individual marker shall be less than 1,200 psi (5.3 kN).

D. Materials Warranty

Omitted

Section 919—Raised Pavement Markers

919.2.03 Channel Pavement Markers

A. Requirements

Channel pavement markers are type 9 and 10 markers only.

1. Use channel pavement markers made of either a heat-fired, white, vitreous, ceramic base with a heat-fired, opaque, glazed surface, or a 9 gauge (3.9 mm) steel body with a heat-fired porcelain finish.
 - a. Ensure both ceramic and steel channel markers have no defects that affect appearance and serviceability.
 - b. Ensure that the mean thickness of the glazed surface of ceramic channel markers is at least 0.005 in (0.13 mm) when measured at least 0.25 in (6 mm) from the edge of the marker.
 - c. Ensure that mean thickness of the porcelain finish on the steel channel markers is at least 0.030 in (0.76 mm).
 - d. Ensure that the water absorption of the ceramic markers does not exceed 2.0 percent of the original dry weight when tested according to ASTM C 373.
 - e. Ensure that the surface of the markers do not craze, spoil, or peel when passed through one cycle of the Autoclave test at 250 psi (1724 kPa) (ASTM C 424).
2. Use the designated colors for the white and yellow markers.
 - a. Ensure that the colors are uniform.
 - b. Determine the color by visually comparing them with calibrated standards having CIE Chromaticity Coordinate limits. Determine the limits with Federal methods of test TT-T-141, Method 4252, using a rectangle with the following corner points:

	1		2		3		4		(90MGO)
White	.290	.316	.310	.296	.330	.320	.310	.344	80 min.
Yellow	.435	.485	.445	.435	.544	.456	.516	.484	50 min.

B. Fabrication

Omitted

C. Acceptance

1. Ensure that Type 10 markers meet the specific intensity of each reflective surface according to [Subsection 919.2.01.A.4](#)
2. Use a random sample of five markers for each of the required tests in [Subsection 919.2.01.C.2](#), [Subsection 919.2.01.C.3](#), [Subsection 919.2.01.C.4](#), and [Subsection 919.2.01.C.5](#).
3. Select two of the five markers and subject them to all the required tests.
4. Use the following table to determine if the markers pass the tests.

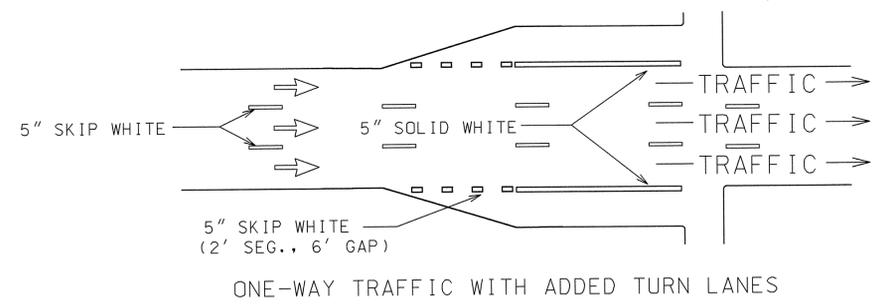
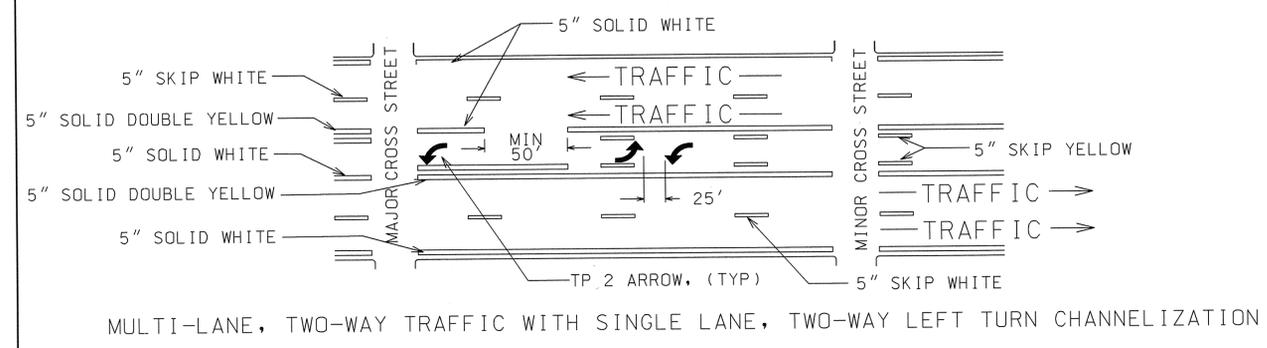
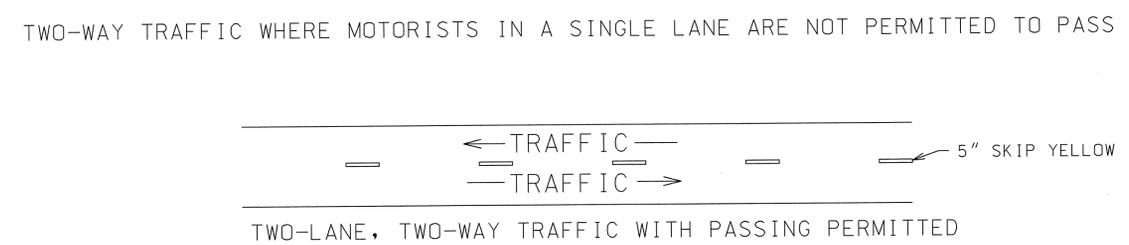
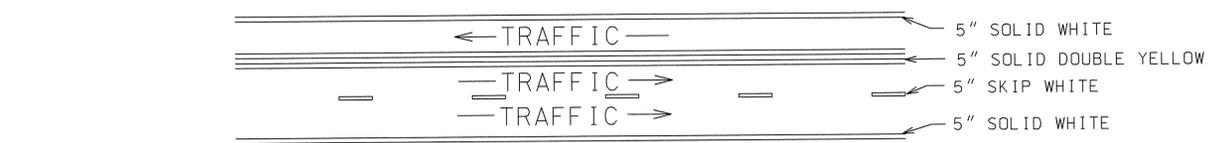
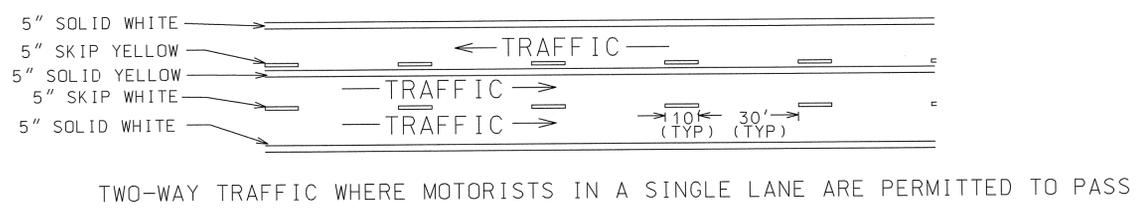
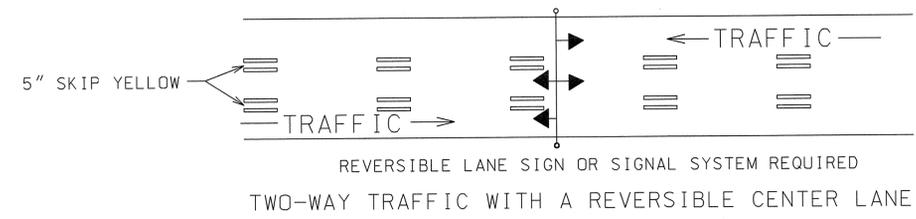
Markers that Pass	Department Action
2 of 2	Accept the lot.
0 of 2	Reject the lot; no resample allowed.

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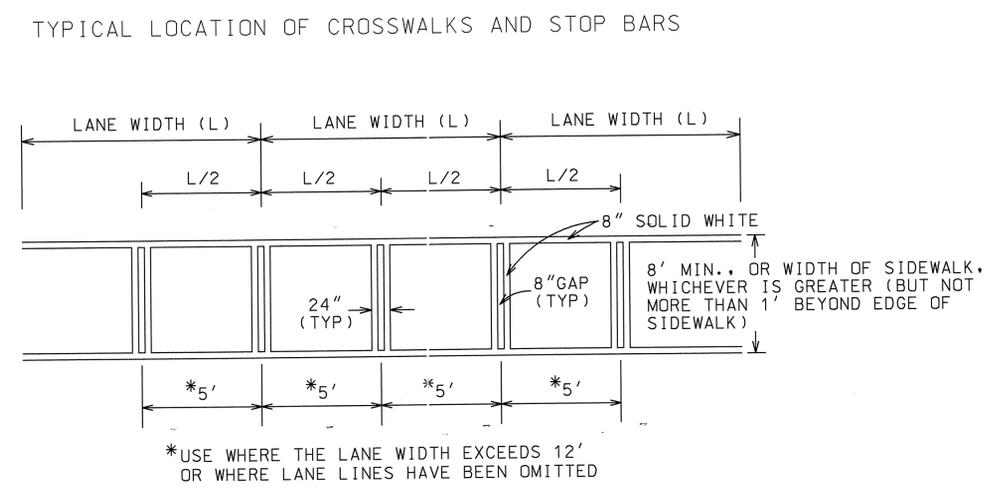
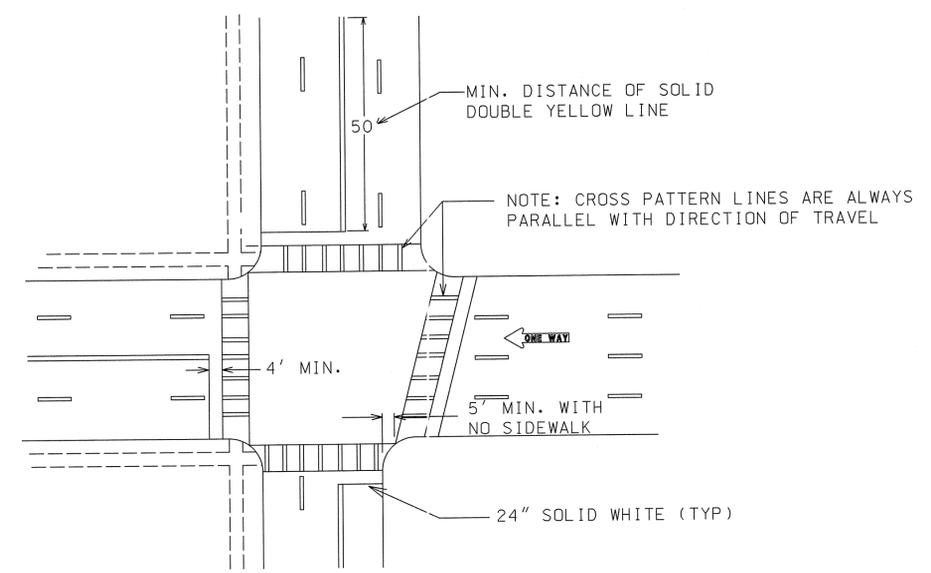
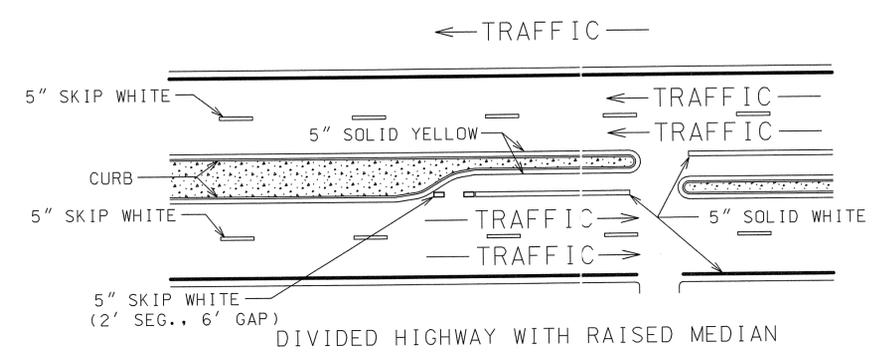
1 of 2	Retest the three remaining markers.
3 of 3 retested	Accept the lot
2 or less of 3 retested	Reject the lot; no resample allowed

D. Materials Warranty

Omitted



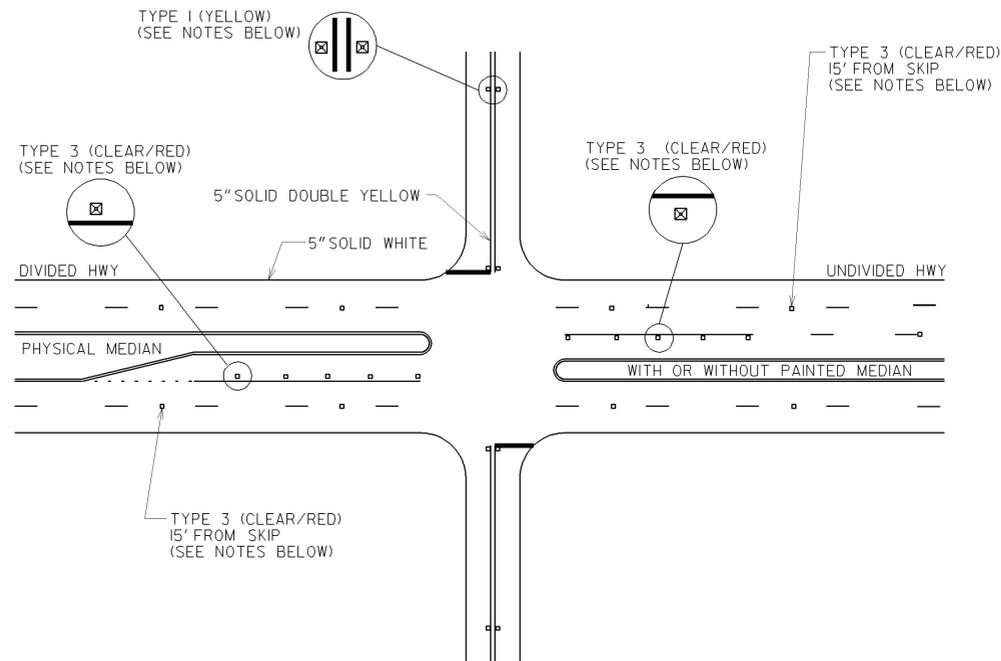
- GENERAL NOTES:
1. SPACING BETWEEN DOUBLE LINES SHALL BE EQUAL TO THE LINE WIDTH.
 2. EDGE LINES SHALL BE PLACED A MINIMUM OF 4 INCHES FROM THE NORMAL EDGE OF PAVEMENT.



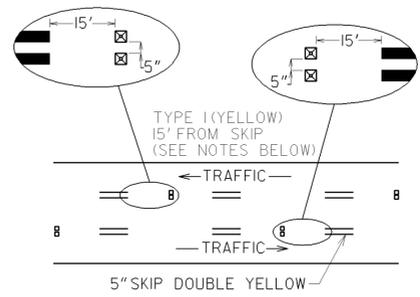
DATE	REVISIONS	GEORGIA DEPARTMENT OF TRANSPORTATION OFFICE OF TRAFFIC SAFETY & DESIGN
		DETAILS OF PAVEMENT MARKING PLACEMENT NON-LIMITED ACCESS ROADWAY
		NO SCALE
		JANUARY 2000

STATE	PROJECT NUMBER	SHEET NO.	TOTAL SHEETS
GA.			

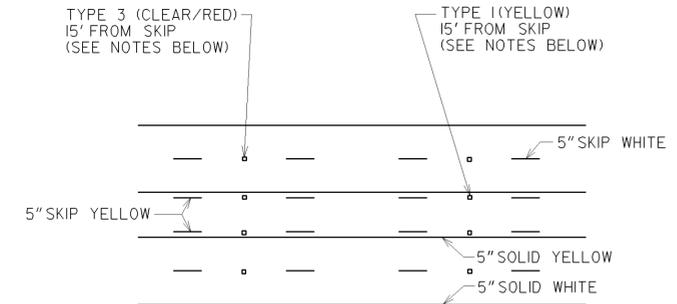
DIVIDED / UNDIVIDED HIGHWAY



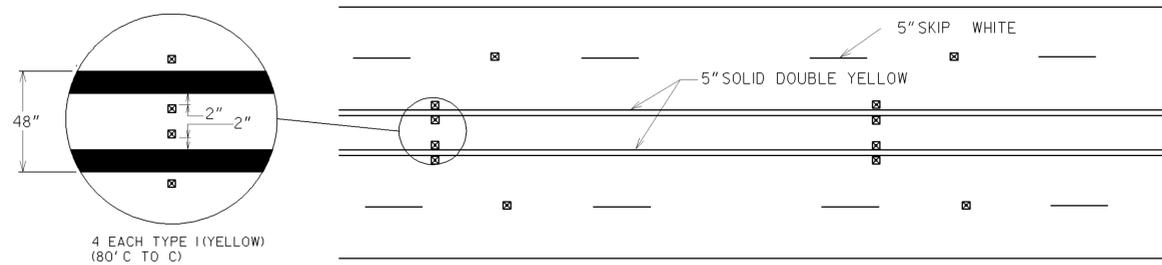
REVERSIBLE LANE



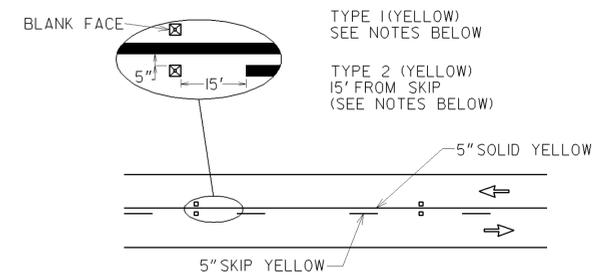
TWO WAY LEFT TURN LANE



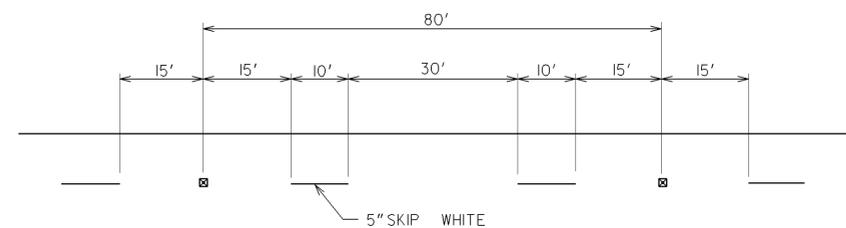
4'-0" STRIPED FLUSH MEDIAN



NO PASSING ZONE



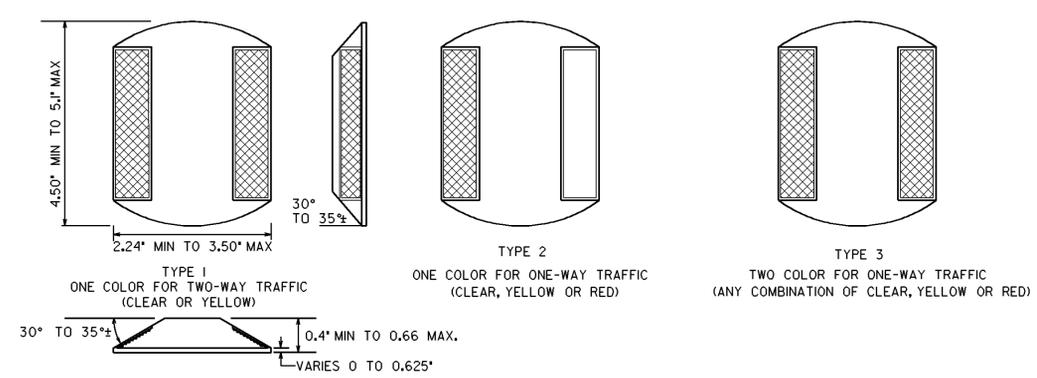
TYPICAL RPM/STRIPE SPACING



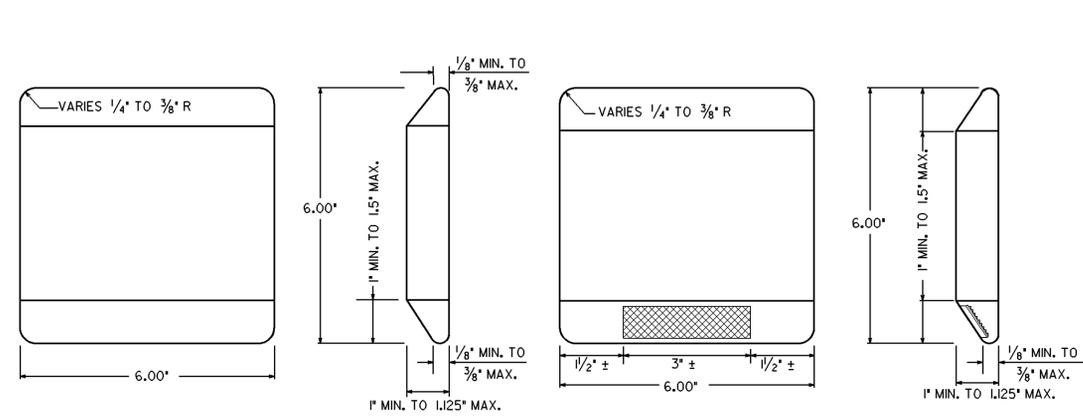
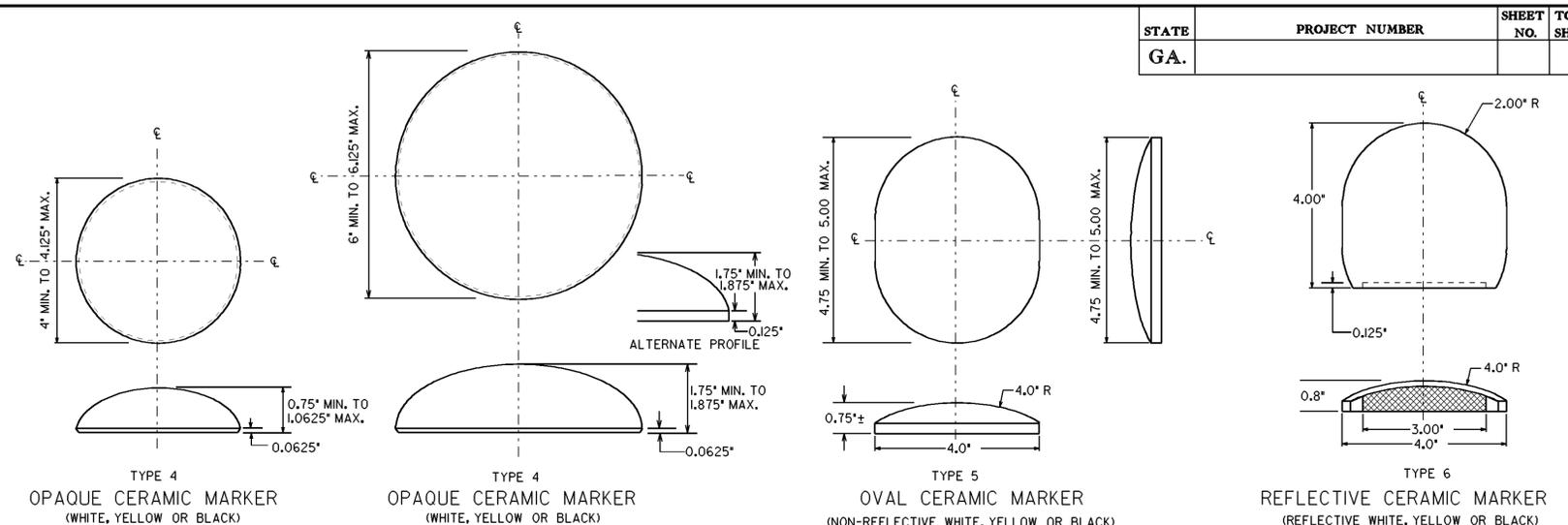
- GENERAL NOTES:
1. RAISED PAVEMENT MARKERS SHALL BE SPACED EVERY 80 FT UNLESS OTHERWISE SPECIFIED.
 2. ON SOLID WHITE TURN BAY LINES, SPACING SHALL BE 20 FT.
 3. RAISED PAVEMENT MARKERS SHALL BE OFFSET 5 INCHES FROM SOLID LANE LINES.
 4. CLEAR FACE OF TYPE 3 RAISED PAVEMENT MARKERS SHALL BE ORIENTED TOWARD ONCOMING TRAFFIC.
 5. ON HORIZONTAL CURVES WHERE AT LEAST 3 MARKERS CANNOT BE SEEN AT ONE TIME USING NORMAL SPACING, MARKERS SHALL BE PLACED 40 FT.

DATE		DEPARTMENT OF TRANSPORTATION STATE OF GEORGIA	
REVISION		CONSTRUCTION DETAILS RAISED PAVEMENT MARKER LOCATION NON-LIMITED ACCESS ROADWAY	
BY		NO SCALE	REV. AND REDRAWN, JUNE 2015
DESIGNED	_____	NUMBER T-15A	
DRAWN	_____		
TRACED	_____		
CHECKED	_____		

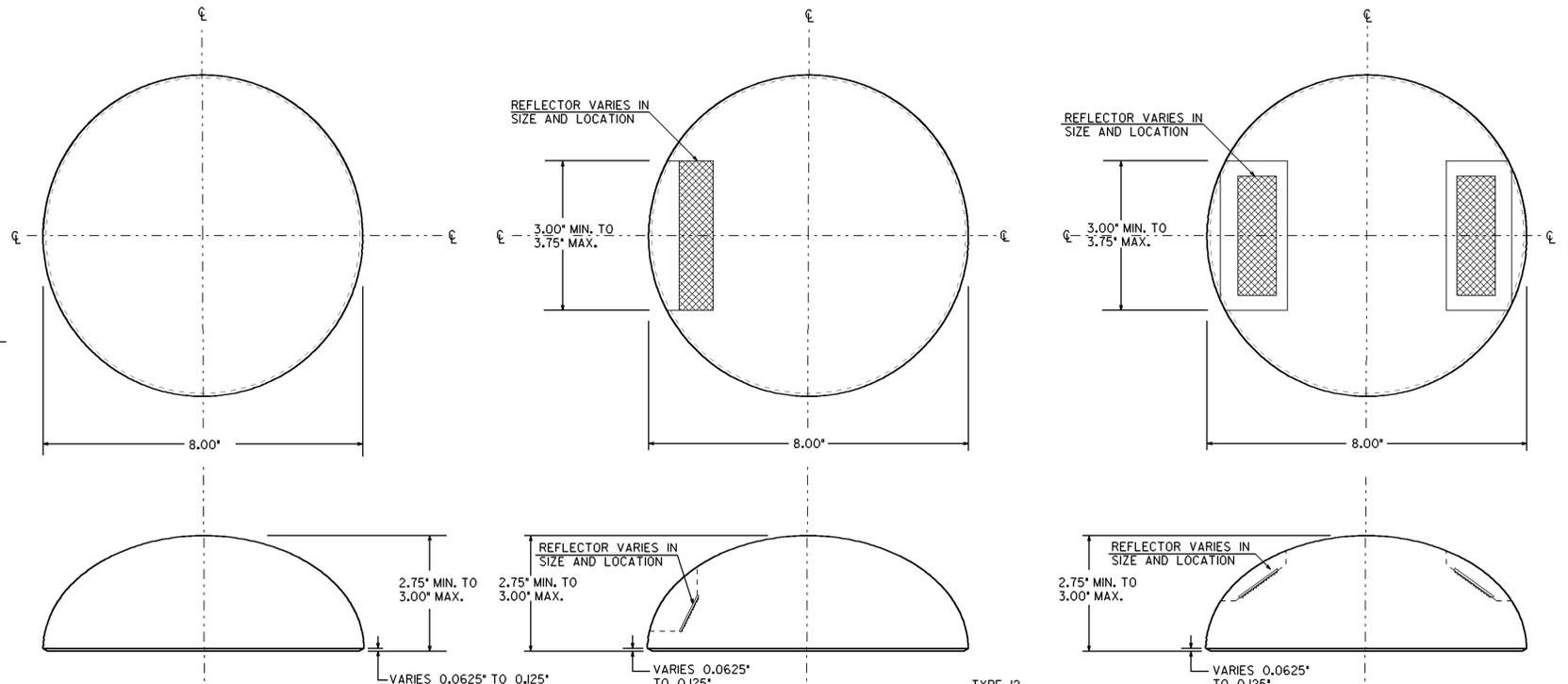
STATE	PROJECT NUMBER	SHEET NO.	TOTAL SHEETS
GA.			



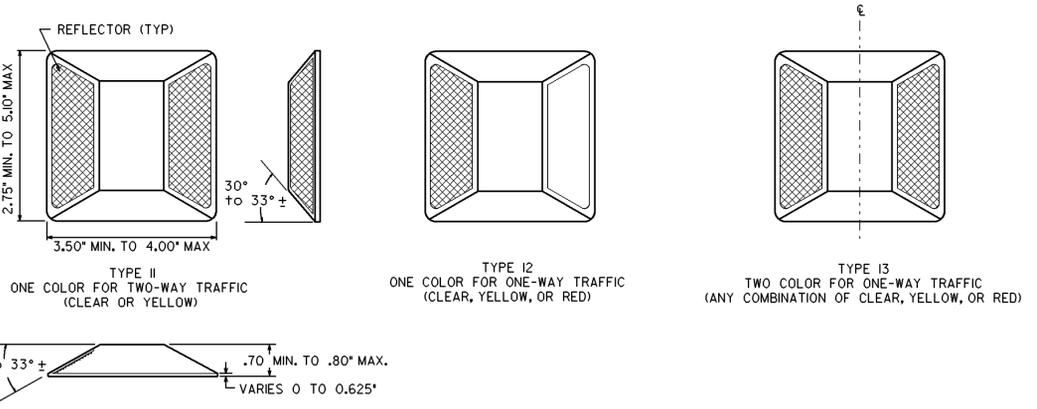
RAISED REFLECTIVE MARKERS



CERAMIC JIGGLE BAR MARKER



CERAMIC CHANNEL MARKER



ALTERNATE RAISED REFLECTIVE MARKERS

GENERAL NOTES:

- SPECIFICATIONS: GEORGIA STANDARD, CURRENT EDITION, AND SUPPLEMENTS THERE TO.
- THE CONTRACTOR SHALL USE RAISED PAVEMENT MAKER SOURCES AS LISTED IN OPL 76.
- COLORS FOR REFLECTIVE ELEMENTS SHALL BE EITHER CLEAR, YELLOW, OR RED AS SPECIFIED.
- THE SHELL OF THE REFLECTIVE MARKERS SHALL BE OF ONE COLOR OR OF A COMBINATION OF TWO COLORS, WHICH SHALL BE THE SAME AS THE REFLECTIVE ELEMENT.
- THE SURFACE OF OPAQUE CERAMIC MARKERS SHALL BE GLAZED AND OF THE COLOR SPECIFIED IN THE PLANS WITH A WHITE, VITREOUS, CERAMIC BASE.
- COLORS FOR ALL RAISED PAVEMENT MARKERS SHALL BE AS SPECIFIED IN THE PLANS.

DATE	REVISIONS	GEORGIA DEPARTMENT OF TRANSPORTATION OFFICE OF TRAFFIC SAFETY & DESIGN
9-22-11	REV. DIMENSIONS, ADDED NOTES TO MARKERS AND REV. GEN. NOTES.	
		DETAILS OF RAISED PAVEMENT MARKERS
		NO SCALE
		JANUARY 2000