

**SECTION 48 - TRAFFIC STRIPES AND PAVEMENT MARKINGS  
TABLE OF CONTENTS**

<u>Section</u>	<u>Page</u>
48-1 GENERAL .....	48.1
48-2 THERMOPLASTIC TRAFFIC STRIPES AND PAVEMENT MARKINGS .....	48.1
48-3 PAINTED TRAFFIC STRIPES AND PAVEMENT MARKINGS .....	48.4
48-4 PREFORMED TRAFFIC STRIPES AND PAVEMENT MARKINGS .....	48.4
48-4.01 General .....	48.4
48-4.02 High Reflective Preformed Traffic Striping .....	48.5
48-4.03 Preformed Traffic Stripes .....	48.6
48-4.04 Twelve-Inch Preformed Traffic Striping (White and Yellow) and Markings .....	48.6
48-5 PLACEMENT .....	48.6
48-6 DELINEATORS, PAVEMENT MARKERS, AND OBJECT MARKERS .....	48.7
48-7 MEASUREMENT AND PAYMENT .....	48.7

## **SECTION 48 - TRAFFIC STRIPES AND PAVEMENT MARKINGS**

### **48-1 GENERAL**

Traffic stripes and pavement markings must be as shown on the Plans and must conform to these Specifications.

The traffic stripes and pavement markings must conform to the standards, dimensions, and details as specified in the latest edition of the California Manual on Uniform Traffic Control Devices for Streets and Highways (FHWA's MUTCD as amended for use in California). In addition, the traffic stripes and pavement markings must conform to County Standard Drawing 4-77.

### **48-2 THERMOPLASTIC TRAFFIC STRIPES AND PAVEMENT MARKINGS**

All thermoplastic traffic stripes and pavement markings shall be enhanced wet-night visibility and shall conform to these Specifications. Thermoplastic must be Alkyd type for extrusion application and must produce an adherent reflectorized strip capable of resisting deformation by traffic.

The thermoplastic material must be 100 percent solids. The binder must consist of synthetic alkyd resins, and must be homogeneously incorporated with all the necessary prime pigments, fillers and glass beads to produce a coating that meets the requirements specified in the following table:

<b>REQUIRED THERMOPLASTIC CHARACTERISTICS</b>		
<b>Requirement</b>	<b>Color</b>	
	<u>White</u>	<u>Yellow</u>
• Glass Beads, AASHTO M-247, Type I, percent by weight, min. (California Test Method 423)	30	30
• Titanium Dioxide (TiO <sub>2</sub> ), percent by weight, min. (AASHTO T250)	10	
• Lead Chromate, Medium Heat Stability, percent by weight, min.		2.5
• Specific Gravity, max. (California Test Method 423)	2.15	2.15
• Binder, percent by weight, min. (California Test Method)	18	18
• Ring & Ball Softening Point, °F (ASTM E28)	200 - 240	200 - 240
<i>Tests on Material after 4 hours heat with stirring at 425°F+ 2°F, which includes 1 hour for meltdown and temperature stabilization:</i>		
• Bond Strength to Concrete, 0.125-inch thick film drawdown at 425°F test at 75°+ 2°F, psi, min. (California Test Method 423)	180	180
• Brookfield Thermosel Viscosity, Spindle SC4-27, 20 RPM at 425°F, Poise (California Test Method 423)	30 - 45	30 - 45
• Impact Resistance, Falling Ball Method, 0.125 inch thick film drawdown at 425°F on concrete. Test at 75+2°F, inch-lbs., (ASTM D2794)	10	10
• Daylight Luminous Reflectance, min. (ASTM E97)	75	40
• Yellowness Index, max., (ASTM E313)	0.15	
• Hardness, Shore A-2 Durometer with 2 kilogram weight at 115°F. (California Test Method 423)	60 - 80	60 - 80
• Low Temperature Stress Cracking, Resistance at 25°F, (AASHTO T250)	No Crack	No Crack
• Color Match, Federal Std. No. 595a, Color No. 33538		Passes

The thermoplastic material must be applied in a single, uniform layer by extrusion methods.

Stencils must be used when applying thermoplastic pavement markings. Stencils may be new or used if in good condition. If stencils are bent or damaged, they must be replaced.

The pavement surface to which thermoplastic material is applied must be completely coated by the material and the voids of the pavement surface must be filled.

Unless otherwise specified in the Special Provisions, thermoplastic material for traffic stripes and pavement markings shall be applied at a minimum thickness of 0.100 inch. Glass beads must be applied immediately to the surface of the molten thermoplastic material at rate of not less than 8 pounds per 100 square feet. The amount of glass beads applied must be measured by stabbing the glass beads tank with a calibrated rod.

Thermoplastic traffic stripes and pavement markings with enhanced wet-night visibility shall consist of a single uniform layer of thermoplastic and a layer of bonded core elements and a layer of glass beads as follows:

The 1st layer of bonded core elements shall be 3M Bonded Core All Weather Reflective Elements for use in thermoplastic traffic stripes and pavement markings. The color of the bonded core elements shall match the color of the stripe or marking to which they are being applied

The 2nd layer of glass beads shall comply with AASHTO M247 Type 2.

Both bonded core elements and glass beads must be surface treated for use with thermoplastic under the manufacturer’s instructions.

The bonded core elements (surface-drop) shall contain either clear or yellow tinted microcrystalline ceramic beads bonded to the opacified core. These elements shall not be manufactured using lead, chromate or arsenic. All “dry performing” microcrystalline ceramic beads bonded to the core shall have a minimum index of refraction of 1.8 when tested using the liquid oil immersion method. All “wet performing” microcrystalline ceramic beads bonded to the core shall have a minimum index of refraction of 2.30 when tested using the oil immersion method.

Gradations for the bonded core elements are shown below.

Element Gradations Mass Percent Passing (ASTM D1214)		
US Mesh	Micron	“S” series
12	1700	85-100
14	1410	70-96
16	1180	50-90
18	1000	5-60
20	850	0-25
30	600	0-7

A sample of bonded core reflective elements supplied by the manufacturer shall show resistance to corrosion of their surface after exposure to a 1 % solution (by weight) of sulfuric acid. The 1 % acid solution shall be made by adding 5.7 cc of concentrated acid into 1000 cc of distilled water.

The bonded core elements shall be surface treated to optimize embedment and adhesion to the thermoplastic binder.

Minimum retroreflectivity values [mcd(ft<sup>2</sup>)(fc)] metric equivalent [mcd(m<sup>2</sup>)(lux) ] are shown below:

**Minimum Initial Retroreflectivity Values**

	White	Yellow
Dry (ASTM E1710)	700	500
Wet recovery (ASTM E2177)	280	250
Wet continuous (ASTM E2176)	90	75

Note: Increased element drop may be necessary to compensate for increased surface area characteristic of rough pavement surfaces.

Mobile truck mounted applicators shall be capable of traveling at a uniform, predetermined speed over variable road grades to produce uniform application of striping material, following straight lines and making normal curves in a true arc. The equipment shall be capable of air blasting the pavement, applying the stripe and immediately dropping the bonded core elements and glass beads in a single pass at speeds of up to 8 MPH.

Walk-behind cart applicators shall be capable of uniform application of striping material at walking speeds, following straight lines and making tight turns symbols and legends. Mobile equipment must be available to air blast the areas immediately prior to hand cart application. The walk-behind cart shall be capable of applying the molten binder and immediately dropping the bonded core elements and glass beads in a single pass at walking speeds.

The equipment shall be capable of application of bonded core elements and glass beads to the surface of the pavement marking by double drop application. The element dispenser for the first drop shall be attached to the striping machine in such a manner that the elements are dispensed closely behind the binder application device. The bead dispenser for the second drop shall be attached to the

striping machine in such a manner that the beads are dispensed immediately after the first drop (bonded core elements).

The applicator for the bonded core elements and glass beads shall be capable of delivering a uniform drop rate at required application speeds.

The bonded core elements and glass beads are applied such that they appear uniform on the entire traffic marking.

The specified reflective media shall be dropped immediately after binder application. Reflective media consists of retroreflective elements followed by glass beads commonly called “Double-Drop” and shall be applied to achieve the application rates shown below.

**Bonded Core Element Application Rates for Thermoplastic Binders**

Units	Minimum for smooth pavement surfaces
Pounds per 4-inch Linear foot	0.022
Pounds per 100 sq ft	6.6
Grams per 4-inch Linear foot	10

Note: Increased element drop may be necessary to compensate for increased surface area characteristic of rough pavement surfaces.

**Application Rates for Glass Bead**

Units	AASHTO M247 Type 2
Pounds per 4-inch Linear Foot	0.048
Grams per 4-inch Linear Foot	22
Pounds per 100 sq ft	14.4

Note: Increased glass bead may be necessary to compensate for increased surface area characteristic of rough pavement surfaces

Within 3-7 days of applying a thermoplastic traffic stripe or pavement marking with enhanced wet-night visibility, the Contractor shall test the retroreflectivity using a reflectometer in the presence of the Engineer under ASTM E1710. For continuous lines, reflectance measurements must be made at approximately 20 feet intervals. For skip lines, measurements must be taken at two random locations on each skip. The Contractor shall provide all equipment necessary to conduct field tests.

**48-3 PAINTED TRAFFIC STRIPES AND PAVEMENT MARKINGS**

Painted traffic stripes and pavement markings must conform to the State Specifications, and these Specifications.

Self-sticking traffic marking tape, vinyl or otherwise, developed for such use must be used for temporary striping as required, unless otherwise shown or specified in the Contract.

**48-4 PREFORMED TRAFFIC STRIPES AND PAVEMENT MARKINGS**

**48-4.01 General**

Prefomed traffic stripes and pavement markings must be furnished and placed in accordance with these Specifications and as directed by the Agency. Pavement markings must be in conformance with the State of California Manual on Uniform Traffic Control Devices.

The preformed stripes and pavement markings must consist of white or yellow film with pigments blended to conform to standard highway marking colors. The pigments must be thoroughly blended to

produce long lasting colors resistant to the effects of weather exposure and to last through the expected life of the film.

The preformed tapes must consist of a pressure sensitive adhesive that is capable of adhering to clean and dry bituminous or portland cement surfaces. All surfaces must be prepared and tape applied as indicated by the manufacturer's specifications.

The Contractor must post-inlay all traffic stripes and markings on new asphalt surfaces in accordance with the manufacturer's recommendations and these Specifications. The Contractor must post-inlay within 24 hours of the placement of an asphalt overlay.

The Contractor must not apply tape without assistance of a manufacturer's factory service representative, who must be present during tape application.

The Contractor must provide manual or automatic application equipment as required. The application equipment must be capable of simultaneously applying 2 parallel 4-inch lines spaced 3 inches apart. The application equipment must also be capable of applying unlined, pre-coated, pressure-sensitive, adhesive pavement marking tape.

The manual unit must have a manually actuated product feed advance system and a foot operated product cutting mechanism.

The automatic unit must have the capability of advancing, applying, and cutting the pavement marking tape at specific pre-programmed lengths, at speeds up to 6.5 miles per hour when towed by an appropriate vehicle.

Additional supplemental equipment for manual application of required primer, or for manual tamping of the applied markings must also be provided.

Prior to installation, the Contractor must submit to the Agency for approval the method the Contractor proposes to use to install traffic stripes and markings, including a list of equipment to be used in the installation.

The completed traffic stripes and markings must have clean, well-defined edges, without deformations, and be free of tears or other disfigurements. Improperly placed, defective, or disfigured traffic stripes and markings must, at the Contractor's expense, be immediately removed from the pavement surface by methods approved by the Agency.

Completed traffic stripes must be uniform, straight on tangent alignment, and on a true arc on curved alignment. On tangent alignment, when a one-hundred-foot (100') string line is stretched taut and placed directly on the outer edge of the completed traffic stripe, the distance between the string and the edge of the traffic stripe must not exceed 3/4 inch, measured anywhere along any 100-foot interval of the tangent alignment. On curved alignment, the outer edge of the traffic stripe must not deviate more than 3/4 inch from the true arc. The lengths of the gaps and individual stripes that form broken traffic stripes must not deviate more than 2 inches from the lengths required to produce a uniformly repeating, broken-stripe pattern.

#### **48-4.02 High Reflective Preformed Traffic Striping**

Preformed striping material must be durable retroreflective preformed patterned pavement tape (#380) with ceramic beads as manufactured by the 3M Company or equivalent if approved in writing by the Agency.

The preformed tape must have the following minimum retroreflective values measured in accordance with ASTM D4061:

	Requirement	Color	
		White	Yellow
Entrance Angle		86.0° - 86.5°	86.0° - 86.5°
Observation Angle		0.2° - 1.0°	0.2° - 1.0°
Specific Luminance [(mcd·ft)·fc]		1,100 - 700	800 - 500

**48-4.03 Preformed Traffic Stripes**

Preformed striping material must be durable retroreflective preformed pavement tape (#5730) with glass beads as manufactured by the 3M Company or equivalent if approved in writing by the Agency.

The preformed tape must have the following minimum reflective values measured in accordance with ASTM Designation: D 4061:

	Requirement	Color	
		White	Yellow
Observation Angle		0.2° - 0.5°	0.2° - 0.5°
Specific Luminance [(mcd·ft)·fc]		550 - 380	410 - 250

**48-4.04 Twelve-Inch Preformed Traffic Striping (White and Yellow) and Markings**

Twelve-inch (12”) preformed traffic striping (white and yellow) and markings must be furnished and placed in accordance with these Specifications and as directed by the Agency.

Preformed traffic stripes must be installed on all newly resurfaced streets.

Preformed striping material must be durable retroreflective preformed pavement tape (#420) with glass beads as manufactured by the 3M Company or equivalent product as approved by the Agency.

The preformed tape must have the following minimum reflective values as measured in accordance with ASTM D4061:

	Requirement	White		
Entrance Angle		86.0°	86.0°	86.5°
Observation Angle		0.2°	0.5°	1.0°
Specific Luminance [(mcd·ft)·fc]		700	500	400

**48-5 PLACEMENT**

New traffic striping of the roadway centerline must be installed on each segment of roadway construction on the same day that the final lift of asphalt concrete pavement is placed on that roadway segment.

New traffic striping of lane lines, crosswalks, and stop bars (skip white and solid white) must be installed on each segment of roadway construction within one Calendar Day of the final lift of asphalt concrete pavement placed on that roadway segment.

If application of lane line striping, crosswalks, and/or stop bars is not completed on the required day, the Contractor must supply and install temporary pavement markings as detailed below:

Temporary pavement markings must be flush mounted reflectorized tape squares, four inch by four inch (4” x 4”) 3M “Staymark” with backing liners, detour grade, #6350 yellow and #6351 white, or approved equal. Right turn barrier lines, edge lines, and shoulder lane lines must not be delineated with temporary pavement markings. The spacing of the temporary pavement markings must be as follows:

<u>Line Type</u>	<u>Color</u>	<u>Spacing</u>
Centerline (straight roadway portions)	Yellow	48’ O.C.
Centerline (tapered or curving portions)	Yellow	24’ O.C.
Stop Lines	White	6’ O.C.
Channelizing Line	White	24’ O.C.

The Contractor must remove the temporary pavement markings prior to the installation of new striping.

All other required new striping (e.g. bicycle lane stripes, edge lines, pavement markings, etc., not listed above) must be installed on each roadway segment within 2 Working Days of the day the final lift of asphalt concrete pavement is placed on that roadway segment.

**48-6 DELINEATORS, PAVEMENT MARKERS, AND OBJECT MARKERS**

The Contractor's attention is directed to the provisions in Section 81-2, "Delineators," Section 81-3, "Pavement Markers," and Section 82-5, "Markers," of the State Specifications.

Retroreflective pavement markers shall be marked as abrasion resistant on the body of the markers.

**48-7 MEASUREMENT AND PAYMENT**

Thermoplastic traffic stripes will be measured by the linear foot along the line of the traffic stripes, without deductions for gaps in broken traffic stripes.

If the Contract includes a separate pay item for two-direction, no passing zone striping, as depicted in Details 15, 16, 18, 19, 21 or 22 of State Standard Plan A20A, both stripes of the double traffic stripe are measured together by the linear foot such that one foot of measurement for payment includes two stripes each one foot long. If the Contract does not have a separate pay item for two-direction, no passing zone striping, each stripe of a double traffic stripe will be measured separately.

If the Contract includes a separate pay item for median island and/or two-way left turn striping as depicted in Details 28, 29, 31 or 32 of State Plan A20B, all four stripes of the quadruple traffic striping will be measured together by the linear foot such that one foot of measurement for payment includes four stripes each one foot long. If the Contract does not have a separate pay item for median island and/or two-way left turn striping, each stripe of a quadruple traffic stripe will be measured separately.

If the Contract includes a separate pay item for channelizing striping, as depicted in Details 38 or 38A of State Standard Plan A20D an 8-inch wide stripe will be measured by the linear foot. If the Contract does not include a separate pay item for channelizing striping, each linear foot of 8-inch wide striping installed will be measured as 2 feet of traffic striping.

If the Contract includes a separate pay item for bicycle lane striping, as depicted in Detail 39 or 39A of State Plan A20D, a 6-inch wide stripe will be measured by the linear foot. If the Contract does not include a separate pay item for bicycle lane striping, each linear foot of 6-inch wide striping installed will be measured as 1-1/2 feet of traffic striping.

Thermoplastic pavement markings, including crosswalk lines and stop bars, will be measured by the square foot for the actual area covered. The prices paid per linear foot for thermoplastic traffic stripes of the widths and patterns designated in the Contract and per square foot for thermoplastic pavement markings include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in applying thermoplastic traffic stripes and pavement markings, complete in place, including establishing alignment for stripes, and layout work, as shown or specified in the Contract, these Specifications, and directed by the Agency.

Painted traffic stripes will be measured by the linear foot along the line of the traffic stripes, without deductions for gaps in broken traffic stripes. A double traffic stripe, consisting of two 4-inch wide yellow stripes separated by a 3-inch wide black stripe, will be measured as one traffic stripe. Painted pavement markings will be measured by the square foot for the actual area painted. The prices paid per linear foot for painted traffic stripes and per square foot for painted pavement markings include full compensation for furnishing all labor, materials, tools, equipment, and incidentals involved in painting traffic stripes. Compensation includes establishing alignment for stripes and layout work as shown or specified in the Contract, these Specifications, and directed by the Agency. All exposed surfaces of asphalt concrete dike used around corner returns at intersections must be painted with two coats of traffic white paint. The supply and painting of the asphalt concrete dikes is considered incidental and included in the unit prices of the various bid items and no additional compensation will be allowed.

Preformed traffic stripes will be measured by the linear foot along the line of the traffic stripes, without deductions for gaps in broken traffic stripes. A double traffic stripe, consisting of two 4-inch wide yellow stripes, will be measured as two traffic stripes. Undulation striping will be paid for under this item. Preformed pavement markings will be measured by the square foot for the actual area



covered. Parking stall brackets are considered markings for payment purposes. The prices paid per linear foot for preformed traffic stripes of the widths and patterns designated in the Contract and per square foot for preformed pavement markings include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in applying preformed traffic stripes and pavement markings, complete in place, including establishing alignment for stripes, and layout work, as shown or specified in the Contract, these Specifications, and directed by the Agency.

Delineators, Pavement Markers, Concrete Barrier Markers, and Object Markers of the types specified in the Contract, shall be measured per each of the actual number placed.

Unless otherwise specified in the Contract, pavement markers as a part of traffic striping shall be included in the linear foot price paid per linear foot of the various types of traffic stripes and no additional compensation will be allowed therefor.

The contract unit price per EACH Delineator, Concrete Barrier Marker, and Object Marker of the various types listed in the bid proposal shall include full compensation for furnishing all labor, materials, tools, equipment, incidentals, and for doing all work involved in placing markers as shown on the plans, as specified in the State Specifications, these Specifications, and as directed by the Engineer and no additional compensation will be allowed therefor.