

and nuts shall be the hex and heavy types. Washers shall be made and shall be galvanized according to AASHTO M-232. Washers shall meet the dimensional requirements of ANSI B27.2, Type A Plain Washers.

- D. **Certification.** Each box beam and box beam median barrier for a project shall be accompanied by certified test results of actual tests for the heat of base metal used in fabricating all rails, posts, base plates, splice plates, expansion plates, blockouts, and attachment angles in the shipment. Certified test results of actual tests performed to determine compliance with the galvanizing requirements of this Specification, are also required on component parts of the shipment.
- E. **Galvanizing.** The posts, bases, splice plates, expansion plates, blockouts, and attachment angles shall be fabricated and ready for assembly before galvanizing. Slots and round holes may be subsequently drilled, punched, burned or cut after galvanizing, and regalvanized according to Section 854.

SECTION 868 INSULATION BOARD (POLYSTYRENE)

868.01 REQUIREMENTS.

Insulation Board (polystyrene) shall meet AASHTO M-230.

SECTION 880 PAVEMENT MARKINGS

880.01 PAVEMENT MARKING PAINT.

A. General.

1. **Quality.** All paint shall be formulated from first grade materials and shall be suitable in all respects for application at elevated spray temperatures with drop-on glass beads using conventional traffic striping equipment. The finished paint shall be smooth and homogeneous, free of coarse particles, skins or any other foreign materials that are detrimental to its use or appearance.
2. **Manufacturing and Packaging of Preapproved Paint.** When preapproval of pavement marking paint is specified, the paint shall be manufactured in lot sizes no smaller than 1,000 gallons. The paint shall be screened with a 40

mesh or finer screen to remove any coarse particles, skins or foreign materials. Paint shall be packaged in a container coated with a non-corrosive lining. The outside coating, for drums containing water-based paints, shall be a pastel color. The storage temperature shall be kept at 32°F. or higher.

3. **Package Stability of Preapproved Paint.** Within a period of twelve months from the time of delivery, the paint shall not cake, settle, liver, thicken, skin, curdle, gel or show any other objectionable properties which cannot readily be corrected with minimal stirring. Any paint with properties that make it unsuitable for use within the specified twelve months shall be rejected and replaced with paint that meets the specifications. All costs incurred in replacing the paint shall be at the contractor's expense.

B. **Specific Requirements for Solvent Based Traffic Marking Paint.** Solvent based pavement marking paint shall meet the general requirements of AASHTO M-248-86: "Ready Mixed White and Yellow Traffic Paints" except for the following requirements:

AASHTO M-248-86, Section 4.1.2 shall be revised as follows:

ASTM D476 Type I Anatase, or Type II Rutile shall be used.

AASHTO M-248-86, Section 5.2.1, Extracted Pigment Requirements, shall be revised as follows:

The minimum purity requirements for the respective materials shall be as given in Sections 4.1.1 through 4.1.5.

**Composition of Solvent Based Paint
White Traffic Paint**

Pigment Ingredients (% of Pigment)	Low VOC Type F
Titanium Dioxide, Min.(Pure)	17.5
Calcium Carbonate	35.0-40.0
Magnesium Silicate	35.0-43.0
Zinc Oxide, Min.	3.0

**Composition of Solvent Based Paint
Yellow Traffic Paint**

Pigment Ingredients (% of Pigment)	Low VOC Type F
Lead Chromate, Min. (Pure)	16.7
Calcium Carbonate	35.0-40.0
Magnesium Silicate	35.0-43.0

AASHTO M-248-86, Section 5.3 shall be revised as follows:

**Composition of Non-Volatile Vehicle
White and Yellow Traffic Paint**

Vehicle Ingredients (% by Wt. of Vehicle)	Acrylic Copolymer Type F	Chlorinated Rubber Type F
Alkyd Resin Solids (±0.5%)	41.14	37.6
Acrylic Copolymer BR-201 or equivalent (±0.5%)	47.25	—
Chlorinated Rubber (±0.5%)	—	37.0
Chlorinated Paraffin (±0.5%)	11.61	25.4

AASHTO M-248-86, Section 5.4 shall be revised as follows:

Quantitative Requirements of White Solvent Based Paint

Characteristics	Low VOC Type F
Titanium Dioxide (as % of Extr. Pigment) (min) (Pure)	17.5
Pigment (%)	49.0–51.0
Total Solids (%) (min)	69.0
Vehicle Solids (%) (min)	38.0
Weight per Gallon (lbs) (min)	11.1
Viscosity (K.U.)	70-85
Fineness of Grind (Hegman) (min)	2.0
Drying Time (Minutes) (max)	10.0
Directional Reflectance, (%) (min)	80
Uncombined Water (%) (max)	1.0
Particles and Skins Retained on 325 Mesh Sieve (%) (max)	1.0
Volatile Organic Content (^{lb} /gal) (max)	1.25

Quantitative Requirements of Yellow Paint

Characteristics	Low VOC Type F
Lead Chromate (as % of Extr. Pigment) (min) (Pure)	16.7
Pigment (%)	50.0–52.0
Total Solids (%) (min)	69.5
Vehicle Solids (%) (min)	38.0

Weight per Gallon (lbs) (min)	11.3
Viscosity (K.U.)	70–85
Fineness of Grind (Hegman) (min)	2.0
Drying Time (Minutes) (max)	10.0
Color (to pass Fed. Std.) (Chip #33538)	
Directional Reflectance, (%) (min)	50
Uncombined Water (%) (max)	1.0
Particles and Skins Retained on 325 Mesh Sieve (%) (max)	1.0
Volatile Organic Content (lb/gal) (max)	1.25

- C. **Specific Requirements for Water Based Traffic Marking Paint.** The exact composition of the water based traffic paint shall be left to the manufacturer, provided the finished paint meets the following:

Quantitative Requirements of Water Based Paint

Characteristics	White	Yellow
Pigment (%)	58–62	57–61
Titanium Dioxide, (%) (min), Pure TiO ₂ as % of pigment (Rutile II)	12.20	2.50
Acrylic Emulsion Vehicle		
Resin solids (%) (min)	43.0	43.0
Total Solids (%) (min)	76.1	75.1
Weight per Gallon (lbs) (min)	13.0	12.7
Fineness of Grind (Hegman) (min)	3.0	3.0
Viscosity (K.U. @ 77°)	80–100	80–100
pH (min)	9.6	9.6
Color (Fed. Std. Chip #33538)		
CIE Chromaticity Limits		x ₁₀ = 0.470–0.530 y ₁₀ = 0.429–0.483
Drying Time (Minutes) (max) (ASTM D-711) 12 mil wet thickness @ 77°F.:		
@65% R.H.	12.0	12.0
@90% R.H.	75.0	75.0
Contrast Ratio @ 15 mils wet (%) (min)	98.0	96.0
Directional Reflectance, Daylight (%) (min)	83	39.5
Volatile Organic Content, (lb/gal) (max)	1.25	1.25

The vehicle resin solids shall be composed of a 100% acrylic polymer such as Rohm and Haas E-3427, or equivalent.

The yellow paint shall have non-toxic organic yellow pigmentation. The prime organic pigment in the yellow paint shall be color index pigment yellow number 65 or number 75.

The white and organic pigmented yellow paints shall be free of toxic heavy metals.

When applied with glass beads at pavement temperatures above 50°F. and at relative humidities of up to 75%, the paint shall dry to a no-track condition within 3 minutes.

- D. **Sampling, Testing, and Accepting.** When preapproval of pavement marking paint, solvent or water based, is specified, the Contractor shall obtain two, one-pint samples of paint from each lot after the paint has been shipped to some point within the state. Epoxy lined cans shall be used for sampling water based paint. Department personnel are to be notified and shall be present when each sample is obtained. The Department personnel will submit the samples to the Central Laboratory. The samples shall be submitted 30 days before the scheduled use of the marking paint. If the paint sample meets specifications, the lot being represented by the sample will be accepted. If a paint sample fails to meet specifications, the lot being represented by the sample will be rejected and replaced with paint that meets specifications. All costs incurred in replacing nonspecification paint shall be at the Contractor's expense.

If preapproval of the marking paint, solvent or water based, is not specified, the Department will take random samples of the marking paint. If the paint samples meet specifications, the lot being represented by the sample will be accepted. If the paint does not meet the specifications and the paint has not been applied to the road, the paint will be rejected and replaced with paint that meets specifications. If the paint sample does not meet specifications and the paint has been applied to the road, and the work is found unacceptable, the lot being represented by the sample will be rejected and replaced with paint that meets specifications. All costs incurred in replacing nonspecification paint shall be at the Contractor's expense. If the Engineer accepts the paint which does not meet specifications, payment for the lot being represented by the sample will be made at the following adjusted price:

1. **Quantitative Requirements for Paint.**

a. **Pigment (Solvent Based and Water Based Paints).**

Deviation in Units ±	Price Adjustment %
0 to 1.0	0
1.0(+) to 2.0	10
2.0(+) to 3.0	15
3.0(+) to 4.0	20
Over 4.0	25

b. **Viscosity (Solvent Based and Water Based Paints).**

Deviation in Krebs Units ±	Price Adjustment %
0 to 2	0
2(+) to 4	5
4(+) to 6	10
6(+) to 8	15
Over 8	25

c. **Total Solids (Vehicle Solids for Solvent Based and Acrylic Emulsion Vehicle Solids for Water Based Paints).**

Deviation in Units	Price Adjustment %
0 to 1.0	0
1.0(+) to 2.0	10
2.0(+) to 3.0	15
3.0(+) to 4.0	20
Over 4.0	25

d. **Drying Time Requirement.**

(1) **Solvent Based Paint, and Water Based Paint at 65% Relative Humidity.**

Deviation in Minutes	Price Adjustment %
0 to 2	0
2(+) to 4	5
4(+) to 7	10
7(+) to 10	15
Over 10	25

(2) **Water Based Paint at 90% Relative Humidity.**

Deviation in Minutes	Price Adjustment %
0 to 15	0
15(+) to 45	10
Over 45	25

2. **Quantitative Requirements for Pigment.***

a. **White Traffic Paint – Titanium Dioxide (Solvent Based and Water Based Paint).**

Deviation in Units	Price Adjustment %
0 to 1.0	0
1.0(+) to 2.0	10
2.0(+) to 3.0	15
3.0(+) to 4.0	20
Over 4.0	25

b. **Yellow Traffic Paint – Lead Chromate (Solvent Based Paint).**

Deviation in Units	Price Adjustment %
0 to 1.0	0
1.0(+) to 2.0	10
2.0(+) to 3.0	15
3.0(+) to 4.0	20
Over 4.0	25

*If the percent of Titanium Dioxide and Lead Chromate is greater than the specification limits, no deduct will be applied for pigment content. The deduct for pigment content will only be applied if test results are less than the specification range.

c. **Yellow Traffic Paint – CIE Chromaticity Limits for X and Y (Water Based Paint).**

Deviation in Percent from X and Y Centroids	Price Adjustment %
0 to 6.0	0
6.0(+) to 7.0	5
7.0(+) to 8.0	10
10.0(+) 12.0	20
Over 12.0	25

3. **Calculation of Price Adjustment.**

$$\text{Price Adjustment} = [\text{Gallons of Paint}^*] \times [\text{Price/Gal.}^{**}] \times [\text{Price Adj. \%}]$$

* Gallons of paint used on the project represented by the failing test.

** Invoice price per gallon of paint.

880.02 GLASS BEADS.

A. **Specific Requirement.**

1. **Glass Beads for Solvent Based Paint.**

- a. **Physical Properties.** Glass beads for solvent based pavement marking paint shall meet AASHTO M-247, Type I. The flotation properties of AASHTO M-247 shall be modified to allow a maximum of 20% of the beads, by weight, to float when tested according to Section 4.5.
- b. **Sampling and Testing.** The sampling and testing shall be according to AASHTO M-247.

2. **Glass Beads for Water Based Paint.**

- a. **Physical Properties.** Glass beads for pavement marking shall meet AASHTO M-247, Type I, “standard gradation,” except the beads shall have a minimum of 80% true spheres. The beads shall be made from clean colorless transparent glass and shall be smooth, spherically shaped, and free from milkiness, pits, excessive air bubbles, chips, and foreign material. The beads shall have a dual surface treatment consisting of a moisture resistant silicone treatment and a silane adherence surface treatment. The dual treated beads shall pass the Department’s method of testing glass beads for moisture resistance (Spoon Test), and shall pass the Department’s method of testing glass beads for adherence coating (Dansyl Chloride Test).
- b. **Sampling and Testing.** The sampling and testing shall be according to the Department’s sampling and testing methods.

B. **Packaging and Marking.** The beads shall be furnished in moisture proof containers or moisture proof bags. Each container or bag shall be marked with name of contents, manufacturer, net weight, lot number, and ton number.

C. **Certification.** The manufacturer shall furnish one copy of a certificate for each lot of the material furnished, giving the properties of the beads and certifying that

they meet the required specifications. The affidavit shall show designation of the sample, lot number, and date of manufacture.

880.03 PLASTIC PAVEMENT MARKING FILM (RETROREFLECTIVE).

A. **General.** The prefabricated plastic pavement markings shall consist of white or yellow pigmented plastic films, conforming to standard highway colors, with reflective glass spheres incorporated throughout the entire cross-sectional area and a layer of reflective glass spheres bonded to the top surface. The pavement markings shall adhere to bituminous or Portland Cement Concrete pavements by either a pressure-sensitive precoated adhesive or a liquid contact cement. The markings shall be provided in a form that facilitates rapid application and protects the markings in shipment and storage. The manufacturer shall identify proper solvents and adhesives to be applied at the time of application, all equipment necessary for proper application, and recommendations for application that assures an effective performance life. The marking material shall mold itself to pavement contours by the action of traffic. The pavement marking films shall also be capable of application on new bituminous concrete wearing courses during the paving operation according to the manufacturer’s instructions. After application, the markings shall be immediately ready for traffic.

Prefabricated legend and symbols shall meet the applicable shapes and sizes shown in the Contract.

B. **Retroreflective Pliant Polymer.** The pavement marking film shall consist of a mixture of high quality polymeric material, pigments, 1.5 index glass beads uniformly distributed throughout its cross-sectional area, and a reflective layer of beads bonded to the top surface. These materials shall be as follows:

Materials	Minimum Percent by Weight
Resins & Plasticizers	20
Pigments	30
Graded Glass Beads	33

The remaining 17% shall be comprised of the above materials in various proportions.

These materials shall be fabricated into pavement marking film of specified thickness and dimensions.

C. **Requirements.**

1. **Skid Resistance.** The surface of the marking film shall provide a minimum skid resistance value of 45 BPN when tested according to ASTM E-303.
2. **Reflectance.** The white and yellow films shall have the initial minimum values specified in the following table when measured according to ASTM D-4061. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot-candle [(mcd/ft²)/fc]. The metric equivalent shall be expressed as millicandelas per square meter per lux. The sample size shall be a 2 ft. by 2.5 ft. rectangle.

<u>Observation Angle</u> SL [(mcd/ft ²)/fc]	White		Yellow	
	<u>0.2°</u>	<u>0.5°</u>	<u>0.2°</u>	<u>0.5°</u>
	550	380	410	250

3. **Tensile Strength and Elongation.** The film shall have a minimum tensile strength of 150 psi of cross-section when tested according to ASTM D-638. A sample 6 inches by one inch shall be tested at a temperature between 70°F. and 80°F. using a jaw speed of 12 inches per minute. The film shall have a minimum elongation of 75% at break.
4. **Patchability.** The pavement marking film shall be capable of use for patching worn areas of the same type of film according to the manufacturer's instructions.
5. **Pigmentation.** The film, white or yellow, shall meet standard highway colors.
6. **Acid Resistance.** The beads 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 1,000 cc of distilled water. Always add the concentrated acid into the water, not the reverse. The test shall be performed as follows:

A one-inch by 2-inch sample shall be adhered to the bottom of a glass tray and just enough acid solution shall be placed over the sample to completely immerse it. The tray shall be covered with a piece of glass to prevent evaporation and the sample shall remain under those conditions for 24 hours. The acid solution shall be decanted and the sample, while adhering to the glass tray, shall be dried in a 150°F. oven for approximately 15 minutes.

Microscopic examination with 20 power shall show no more than 15% of the beads having a formation of a very distinct opaque white (corroded) layer on their entire surface.

7. **Reflective Retention.** To have effective performance life, the glass beads shall be strongly bonded. One of the following tests shall be employed to measure reflective retention:
 - a. **Taber Abrader Simulation Test.** Using a taber abrader with an H-18 wheel and a 125 gram load, the sample shall be inspected at 200 cycles under a microscope and no more than 15% of the beads shall be lost due to popouts.
 - b. **Qualitative Tests.** Bead bond strengths shall be judged under a microscope with a magnification of at least 5-power. The beads shall be difficult to remove and bead removal shall remove a portion of the polymeric bead bond with the bead rather than popping out clean from their sockets.
8. **Thickness.** The film, without adhesive, shall be supplied in a standard thickness of 0.06 inch.

9. **Effective Performance Life.** The film, when applied according to the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature. Although reflectivity is reduced by wear, the film shall provide a cushioned resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and through normal traffic wear, shall not fade, lift, or shrink throughout the life of the marking and shall show no significant tearing, roll back, or other signs of poor adhesion.

880.04 PREFORMED PLASTIC MARKING FILM.

- A. **General.** The pavement marking material shall consist of white or yellow weather-resistant reflective film meeting the following requirements:

The markings shall be manufactured and packaged to permit storage at the manufacturer's recommended shelf temperature for a period of not less than one year from the date of purchase.

Prefabricated legends and symbols shall meet the shapes and sizes as shown on the Standard Drawings.

- B. **Composition.** The preformed plastic markings shall consist of high quality plastic material, pigments, and 1.5 index glass beads uniformly distributed throughout its cross sectional area and with a reflective layer of beads embedded or bonded in the top surface. The film shall be furnished with the appropriate adhesive system recommended by the manufacturer.
- C. **Skid Resistance.** The surface of the preformed plastic marking film shall provide an initial skid resistance value of 55 BPN and a retained skid resistance value of 35 BPN when tested according to ASTM E-303.
- D. **Color.** The striping material shall be white or yellow in color meeting standard highway colors.
- E. **Thickness.** The thickness of the preformed plastic marking film without adhesive shall be 60 mils.
- F. **Durability and Wear Resistance.** The preformed plastic marking film, when properly applied, shall provide a neat, durable marking. The preformed plastic marking film shall provide a cushioned resilient surface substrate that reduces bead crush and loss. The film shall be weather resistant and through normal traffic wear shall not fade, lift, or shrink throughout the life of the marking, and show no significant tearing, roll back, or other signs of poor adhesion.
- G. **Tensile Strength.** The film shall have a minimum tensile strength of 40 psi of cross section when tested according to ASTM D-638.
- H. **Conformability and Resealing.** The preformed film shall conform to pavement contours, breaks, faults, etc., through the action of traffic at normal pavement temperatures. The film shall have resealing characteristics that will fuse with itself and previously-applied marking film of the same composition under normal conditions of use.
- I. **Elongation.** The film shall have a maximum elongation of 100% when tested according to ASTM D-638.

- J. **Plastic Pull Test.** A test specimen one inch by 3 inches shall support a dead weight of 5 pounds for not less than 5 minutes at a temperature between 70° and 80°F.

880.05 PREFORMED PATTERNED PAVEMENT MARKING FILM.

- A. **General.** The preformed patterned markings shall consist of white or yellow films with ceramic beads incorporated to provide immediate and continuing retroreflection and shall meet the following requirements:

The markings shall be manufactured and packaged to permit storage at manufacturer's recommended shelf temperature for a period of not less than one year from the date of purchase.

Legends and symbols shall conform to the shapes and sizes as shown on the Standard Drawings.

The Contractor shall secure from the manufacturer all warranties and guarantees with respect to materials, workmanship, or performance which the products covered by the proposal bear, and include these warranties and guarantees with the certification.

- B. **Composition.** The retroreflective pliant polymer pavement markings shall consist of a mixture of high quality polymeric materials, pigments and glass beads distributed throughout its base cross-sectional area, with a reflective layer of ceramic beads bonded to a durable polyurethane topcoat surface. The patterned surface shall have approximately 50% + or - 15% of the surface area raised and presenting a near vertical face to traffic from any direction. The channels between the raised areas shall be substantially free of exposed beads or particles.

The preformed markings shall conform to pavement contours by the action of traffic. The pavements markings shall be capable of application on new, dense, and open graded asphalt wearing courses during the paving operation according to the manufacturer's instructions. After application, the marking shall be immediately ready for traffic.

- C. **Skid Resistance.** The surface of the tape shall provide an initial minimum skid resistance value of 45 BPN when tested according to ASTM E-303 except values shall be taken at downweb and at 45 degree angle from downweb. These two values will then be averaged to find the skid resistance of the patterned surface.
- D. **Thickness.** The patterned material without adhesive shall have a minimum caliper of 0.065 inches at the thickest portion of the patterned cross-section and minimum caliper of 0.02 inches at the thinnest portion of the cross-section.
- E. **Beads.** The glass beads on the surface of the material shall have a minimum index of refraction of 1.7 when tested using the liquid oil immersion method. The glass beads mixed into the pliant polymer shall have a minimum index of 1.5 when tested by the oil immersion method.
- F. **Patchability.** The pavement marking material shall be capable of use for patching worn areas of the same type according to the manufacturer's instructions.

- G. **Reflectance.** The white and yellow markings shall have the following initial expected retroreflectance values as measured according to the testing procedures of ASTM D-4061. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per footcandle. The test distance shall be 50 feet and the sample size shall be a 2.0 foot by 2.5 foot rectangle.

	White	Yellow
Entrance Angle	86.5°	86.5°
Observation Angle	1°	1°
SL	700*	500*

*All reflectance measurements shall be made using an "Ecolux" brand retroreflectometer or equivalent.

880.06 SHORT-TERM PAVEMENT MARKING.

Short-term pavement marking, placed on the top lift of asphalt paving projects and after final brooming on seal coat projects, shall meet Section 880.01. Pavement marking paint for short-term pavement marking, on the lower lifts of asphalt paving projects and before final brooming on seal coat projects, may be commercially-available traffic marking paint, and shall be yellow or white in color.

Mixed commercially-available traffic marking paint shall show no signs of thickening, caking, livering, or curdling, and shall be free of water, skins, and any other foreign materials. At the time of application, the mixed paint shall be capable of being easily stirred with a paddle to a smooth, uniform consistency. The paint shall dry to an elastic, adherent finish that will not discolor in sunlight.

Glass beads for short-term pavement marking shall meet Section 880.02.

Pavement marking tape for short-term pavement marking shall be 4 inches wide with a pressure-sensitive adhesive backing and have reflectorizing glass beads embedded in the surface. The tape shall be durable and function effectively for the required period of service and adhere to the pavement surface.

880.07 CONSTRUCTION ZONE MARKING.

The wet retroreflective system shall consist of white or yellow retroreflective tape on a conformable backing with deformable highly retroreflective markers adhered transversely to the top surface with a pressure sensitive adhesive. The tape and the wet retroreflective marker sheeting element, white or yellow, shall meet standard highway colors. Wet retroreflective markers will only be required when specified.

The size, quality, and refractive index of the glass beads shall be such that the performance requirements for the marking shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

The preformed tape shall be precoated with a pressure-sensitive adhesive and shall adhere to asphalt concrete or portland cement concrete, according to manufacturer's instructions, without the use of heat, solvents, or other additional adhesive means, and shall be immediately ready for traffic after application.

The wet retroreflective markers shall be precoated with a pressure sensitive adhesive that adheres to the retroreflective top film of the preformed tape. The retroreflective sheeting element of the wet retroreflective marker shall consist of a retroreflective lens system having a smooth outer surface.

Preformed words and symbols shall meet the applicable shapes and sizes as shown on the Plans.

Preformed marking for construction zones shall be either Type R – Removable Retroreflective Film, or Type NR – Retroreflective Pavement Striping Tape (not easily removed). The Plans will specify which type to use. Requirements for each type are as follows:

A. Type R – Removable Retroreflective Pavement Markings.

The removable striping tape must be designed and constructed in such a manner that it can be readily removed when the markings are no longer applicable. The tape shall be capable of performing for the duration of a normal construction season and shall then be capable of being removed intact or in large pieces manually.

1. **Composition.** The removable preformed retroreflective pavement markings shall consist of glass beads embedded in white or yellow film with a thin flexible conformable backing which is precoated with a pressure sensitive adhesive. A structured interlaced medium shall be incorporated to facilitate removal.
2. **Reflectance.** The white and yellow films shall have the following initial minimum reflectance values at 0.2° and 0.5° observation angles and 86.0° entrance angle as measured in accordance with the testing procedure of ASTM D-4061. The photometric quantity to be measured shall be specific luminance (SL), and shall be expressed as millicandelas per square foot per foot candle. The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample, and the reference axis shall be taken perpendicular to the test sample.

	White			Yellow		
Entrance Angle	86.0°	86.0°	86.5°	86.0°	86.0°	86.5°
Observation Angle	0.2°	0.5°	1.0°	0.2°	0.5°	1.0°
Specific Luminance	1770	1270	750	1310	810	450

3. **Adhesion.** The manufacture shall be required to demonstrate that the properly applied pavement marking adheres to the roadway under climatic and traffic conditions normally encountered in the construction work zone.
4. **Removability.** The marking film shall be removable from asphalt concrete and portland cement intact or in large pieces, either manually or with a roll-up device at temperatures above 40°F without the use of heat, solvents, grinding or blasting.
5. **Skid Resistance.** The surface of the markings provides an initial minimum skid resistance value of 50 BPN when tested according to ASTM E303-74.

B. Type NR – Retroreflective Pavement Striping Tape.

1. **Composition.** The pavement striping tape shall consist of a white or yellow retroreflective film on a conformable metallic backing, precoated with a pressure-sensitive adhesive.
2. **Reflectance.** The white and yellow films shall have the initial minimum values specified in the following table at 86° entrance angle when measured according to ASTM D-4061. The photometric quantity to be measured shall be specific luminance (SL) and shall be expressed as millicandelas per square foot per foot candle [(mcd/ft²)/fc]. The test distance shall be 50 feet, and the sample size shall be a 2.0-foot by 2.5-foot rectangle. The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample, and the reference axis shall be taken perpendicular to the test sample.

<u>Observation Angle</u>	<u>White</u>		<u>Yellow</u>	
	<u>0.2°</u>	<u>0.5°</u>	<u>0.2°</u>	<u>0.5°</u>
SL [(mcd/ft ²)/fc]	1,360	760	820	510

3. **Skid Resistance.** The surface of the marking shall provide an initial minimum skid resistance value of 35 BPN when tested according to ASTM E-303.
4. **Abrasion Resistance.** Samples of the test material shall not wear through to the conformable backing surface in less than 125 cycles, when tested according to Federal Test Method Standards 141, Method 6192, modified by using an H-22 wheel and a 250 gram load.
5. **Adhesion.** The manufacturer shall demonstrate that the properly-applied pavement marking adheres to the roadway pavement under climatic and traffic conditions normally encountered in construction work where proposed for use.

C. Wet Reflective Markers.

1. **Composition.** The marker body shall be an expanded rubber extrusion that is elastically compressed and deflected when impacted by rotating vehicle tires. When tested per ASTM D-1056 for expanded rubber, the marker body shall have the following typical properties:
 - a. Compression deflection less than 16 psi at 25° deflection.
 - b. Oven aged compression deflection (% change) +18.
 - c. Compress set low 10%.
 - d. Water absorption, less than 9%.
 - e. Density 24 lbs./ft. The marker shall have a precoated pressure sensitive adhesive capable of adhering to the retroreflective top film of the performance tape.

The marker shall have a retroreflective enclosed lens sheeting element adhered to the marker body with a pressure sensitive adhesive.

2. **Reflectance.** The white and yellow foam markers shall have the initial minimum reflectance values shown in the following table when measured according to ASTM E-809. The photometric quantity to be measured shall be coefficient of luminous intensity (R) and shall be expressed as candelas per foot candle (cd/ftc). The entrance angle Beta One = 0 (Vertical). The entrance angle, in the table below, is the entrance component, Beta Two, at -4° (Horizontal) as described in ASTM E-808.

Color	Observation Angle			
	0.2°	0.5°	1.0°	1.5°
White	1.0	0.4	.19	.14
Yellow	0.6	.24	.11	.08

For testing purposes, the retroreflective reference axis used to define the entrance angle in the Specification is considered to be the axis emanating from the center of the reflective surface of the marker and directed parallel to the base and perpendicular to the top edge of the marker when viewed from above.

The angle formed by the reflective surface and the base of the marker must be between 75° and 90° before measurement.

Reflective elements of the marker shall be visible to motorists in low beam headlamps at night at the following distances and conditions:

- 1,500 feet – dry
- 1,000 feet – at a rate of 1" of rainfall per hour
- 250 feet – at a rate of 8" of rainfall per hour

880.08 RAISED PAVEMENT MARKERS.

Raised pavement markers shall consist of a plastic shell with one or more prismatic reflective faces with a minimum of 2.45 square centimeters of reflective surface for each direction required to reflect incident light. The marker shall be fitted with pressure-sensitive adhesive for application to a primed surface.

The materials used shall be capable of being easily applied and removed. The Contractor shall demonstrate that the properly-applied pavement marking adheres to the roadway under climatic and traffic conditions normally encountered in the construction work zone.

880.09 EPOXY PAINT PAVEMENT MARKING.

A. **General.** This specification provides for the classification of epoxy resin pavement marking systems by type. Type II shall be used unless Type I is specified on the plans.

1. Type I

A fast cure material suitable for line applications and, under ideal conditions, may not require coning.

2. Type II

A slow cure material suitable for all applications of pavement markings under controlled traffic conditions, i.e., coning is required and flagging may be as directed by the Engineer.

B. Epoxy Resin Material.

1. **General.** The material shall be composed of epoxy resins and pigments only. No solvents are to be given off to the environment upon application to a pavement surface. Type II material shall be completely free of TMPTA (Tri-Methyl Propane Tri-Acrylate) and other multi-functional monomers.
2. **Color.** The color of the white epoxy shall be a pure flat white, free of tints. The color of the yellow epoxy shall closely match Color Number 33538 of Federal Standard 595 and shall conform to the following CIE Chromaticity limits using illuminant "C":

$$\begin{array}{l} x | 0.470 | 0.485 | 0.520 | 0.480 \\ y | 0.440 | 0.460 | 0.450 | 0.420 \end{array}$$

Daylight Directional Reflectance (Y), white, minimum 83

Daylight Directional Reflectance (Y), yellow, minimum 50

Testing will be according to:

Daylight Directional Reflectance	ASTM D 2805
Color	ASTM D 2805

3. **Adhesion Capabilities.** When the adhesion of the material to Portland cement concrete (the concrete shall have a minimum of 300 psi tensile strength) is tested according to American Concrete Institute Committee 403 testing procedure, the failure of the system must take place in the concrete. The concrete shall be 90°F when the material is applied, after which the material shall be allowed to cure for 72 hours at 73 ± 2°F.
4. **Abrasion Resistance.** When the abrasion resistance of the material is tested according to ASTM C 501 with a CS-17 wheel under a load of 1000 grams for 1000 cycles, the wear index shall be no greater than 82. (The wear index is the weight in milligrams that is abraded from the sample under the test conditions).
5. **Hardness.** The Type D durometer hardness of the material shall be not less than 75 nor more than 90 when tested according to ASTM D2240 after the material has cured for 72 hours at 73 ± 2°F.
6. **Tensile Strength.** The tensile strength of the material, when tested according to ASTM D 638, shall not be less than 6,000 psi after 72 hours cure time at 73 ± 2°F.
7. **Compressive Strength.** The compressive strength of the material, when tested according to ASTM D 695, shall not be less than 12,000 psi after 72 hours cure time at 73 ± 2°F.

8. **Shelf Life.** The individual components shall not require mixing prior to use when stored for a period of 12 months.

9. **Yellowness Index.**

ASTM D 1925 Max before QUV 10
Max after QUV 30

10. **Time to No-Track.** Type I material shall be in “no-tracking” condition in 15 minutes or less and within 45 minutes for Type II material. The “no-tracking” condition shall be determined on an application of specified thickness to the pavement and covered with glass beads. The lines for this test shall be applied with striping equipment operated so as to have the material at manufacturer’s recommended application temperature. This maximum “no-tracking” time shall not be exceeded when the pavement temperature varies from 50 to 120°F and under all humidity conditions, providing the pavement is dry. The no-tracking time shall be determined by passing over the line with a passenger car or pickup truck at a speed of 25 to 35 mph in a simulated passing maneuver. A line showing no visual deposition of the material to the pavement surface when viewed from a distance of 50 feet shall be considered as showing “no-tracking” and conforming to this requirement for time to “no-track.”

C. **Glass Beads.** Glass Beads shall meet the requirements of ASSHTO M-247, have a roundness of at least 80%, and be of the type recommended by the manufacturer. The glass beads shall be applied at a rate of at least 25 lb/gal.

D. **Sampling Rate and Procedures.** One pint samples of each manufacturer’s lot or batch furnished for the contract shall be submitted at least 15 days prior to use. All samples must be submitted to the Department’s Materials and Research Laboratory. Samples shall be identified as follows:

1. Manufacturer’s name.
2. Manufacturer’s product number.
3. Lot/Batch number.
4. Color.
5. Intended state project numbers.
6. Date manufactured.

E. **Packaging of Epoxy Components and Glass Beads.** Containers for epoxy components shall be marked with the manufacturer’s name, product identification number, lot or batch number, date of manufacture, color, net weight of contents. Containers for glass beads shall be marked with the name of manufacturer, the wording “Glass Beads,” lot or batch number, coating type, date manufactured, and the net weight.