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DIVISION 2200
REFLECTIVE MATERIALS AND ACCESSORY ITEMS

SECTION 2201

RETROREFLECTIVE SHEETING

2201.1 DESCRIPTION

This specification covers Type I and all Types of High Intensity retroreflective sheeting. This includes both non-exposed glass bead lens and microprismatic sheeting.

2201.2 REQUIREMENTS

a. General. Provide retroreflective sheeting that complies with ASTM D 4956. The type to be provided will be shown in the Contract Documents. Types and classes are as defined in ASTM D 4956.

b. Conformable Retroreflective Sheeting. Provide High Intensity retroreflective sheeting that has a conformable aluminum foil backing with an aggressive pressure sensitive adhesive. This material is designed for application to moderately rough or porous metal, wood or masonry surfaces. Provide material that complies with ASTM D 4956 with the following exceptions and additions:

(1) Conformable aluminum backing thickness – 0.005 inches to 0.010 inches.

(2) Follow all manufacturers' recommendations for application procedures and temperatures.

2201.3 MANUFACTURER WARRANTY

The following warranty conditions apply only to the retroreflective sheeting manufacturer. Provide a product warranty for a minimum period of 10 years on all Types of High Intensity retroreflective sheeting for placement on permanent signing. Failure to comply with this warranty may be cause for removal from the prequalified list.

The High Intensity retroreflective sheeting warranty must comply with the following requirements and obligations:

- Certification: Submit with each lot or shipment, a certification which states that the material supplied is subject to and complies with the requirements. Include in the certification, the manufacturer's office, address, phone number and the contact for potential claims under the provisions of this warranty. Provide documentation as to which signs were fabricated from each lot.
- Field Performance: Field Performance applies to retroreflective sheeting applied to sign blank materials or overlaid on existing signs. The field performance obligation period begins with the date of erection. The sheeting is considered unsatisfactory if it has deteriorated due to natural causes to the extent that the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions or shows any of the following defects:
    - Cracking discernible with the unaided eye from a driver's position at a distance of 50 feet or greater from the sign:
    - Scaling, pitting, orange peel, delamination, edge lifting or curling;
    - Peeling in excess of 3/8 inch;
    - Shrinkage in excess of 3/16 inch total per yard of sheeting width;
    - Fading or loss of color to the extent that retroreflective sheeting color fails to comply with **subsection 2201.2a.**, or;
    - Loss of retroreflectivity reducing the coefficient of retroreflection as measured by a retroreflectometer to less than the minimum specified in Table 12 of **ASTM D 4956** at 0.2° observation and -4° entrance angles. Make all measurements after cleaning the sign.

Defective Material Replacement: When traffic signs with High Intensity sheeting fail to comply with the field performance requirements, re-sheet or replace the signs at no cost to KDOT for materials and labor. Employ a contractor qualified by KDOT to perform signing work. Install highway signs, as shown in the Contract Documents and the MUTCD and provide proper traffic control.

Replace all defective material within 60 days after written notification by KDOT. Signs not corrected within 60 days, will be removed and replaced by KDOT. Signs removed by KDOT will be placed in storage for inspections by the manufacturer, and the manufacturer will be billed for all costs of replacement of the sheeting.

When more than 25% of the signs within a lot fail to comply with the requirements, replace all signs made from that lot.

2201.4 PREQUALIFICATION

Manufacturers desiring to provide material under this specification are to submit prequalification samples of each type, class and color covered by this specification which they wish to prequalify. Each sample consists of 3 pieces 24 inches square.

Forward the prequalification samples to the Engineer of Tests. Samples will be tested for compliance with all requirements of this specification. Each Manufacturer will be notified of the test results.

If the prequalification samples of retroreflective sheeting comply with this specification, the product will be placed on a list of prequalified products maintained by the Bureau of Construction and Materials. No retroreflective sheeting will be used on KDOT projects unless it has been prequalified. Testing and evaluation by KDOT may be waived if complete testing has been performed on the identical product by AASHTO National Transportation Product Evaluation Program (NTPEP) within the last five years. Forward an official copy of the test report along with evidence that the product referenced is identical to that submitted for prequalification, to the Engineer of Tests for evaluation.

2201.5 TEST METHODS

All tests will be conducted in accordance with ASTM D 4956 with the exception of artificial weathering. Artificial weathering will be conducted according to ASTM G 155, Cycle 1, with the following additions and exceptions:

- At the end of each 20 hour cycle, the panels will be placed in a cold cabinet at approximately 0°F for one hour. After removal from the cold cabinet, panels will be returned to the weatherometer to await the start of the next cycle.

2201.6 BASIS OF ACCEPTANCE

a. Permanent Sheeting.

(1) Prequalification as required by **subsection 2201.4**.

(2) Satisfactory results of tests conducted at MRC. Each lot of sheeting will be sampled at destination by a representative of KDOT and will be subjected to a visual examination and tested for physical properties as necessary to verify that the sheeting complies with this specification.

(3) Receipt of the warranty certification as specified in **subsection 2201.3** by the Project Engineer.

b. Temporary Sheeting. Retroreflective sheeting used to manufacture temporary traffic control signs will be accepted on the basis of a certification prepared by the contractor stating that the retroreflective sheeting used to manufacture the signs was prequalified under this specification, and visual inspection by the Engineer for condition and other requirements.

SECTION 2202

IMAGE SYSTEMS FOR RETROFLECTIVE SHEETING

2202.1 DESCRIPTION

This specification covers Process Inks, Electronic Cuttable Films, and Digital Print for use on retroreflective sheeting.

2202.2 REQUIREMENTS

a. General. Provide transparent or opaque process inks with reducers and thinners as required for proper application. Provide durable, transparent or opaque, colored electronic cuttable films with a pressure sensitive adhesive and a removable liner. Provide digital print on Type XI retroreflective sheeting. Provide materials that are suitable for processing legends, borders, and background colors on retroreflective sheeting. Provide process inks or electronic cuttable films in 2 types as follows:

Type I - For use with Type I retroreflective sheeting.
Type High Intensity - For use with all types of High Intensity retroreflective sheeting.

b. Color. Provide transparent inks, films, and digital print that are yellow, red, orange, green, blue, or brown. Opaque ink, film, or digital print is black. Provide colors that comply with the chromaticity limits in **ASTM D 4956**.

c. Performance. Provide process inks, electronic cuttable films, and digital print that, when applied according to the manufacturer's recommendations, comply with the following:

(1) They are compatible with the retroreflective sheeting.

(2) They have good adhesion to the sheeting and do not cause blistering, puckering, shrinkage, expansion or other deterioration of the sheeting.

(3) After artificial weathering, they have a "good" or better colorfastness, and show no evidence of cracking, edge lifting, curling or other surface deterioration.

(4) Process inks dry hard within 16 hours.

2202.3 TEST METHODS

All tests will be conducted in accordance with ASTM D 4956 with the exception of artificial weathering. Artificial weathering will be conducted according to ASTM G 155, Cycle 1, with the following additions and exceptions:

- At the end of each 20-hour cycle, place the panels in a cold cabinet at approximately 0ºF for 1 hour. After removal from the cold cabinet, return the panels to the weatherometer to await the start of the next cycle.

2202.4 PREQUALIFICATION

Manufacturers desiring to provide material under this specification are to submit prequalification samples of each type and color covered by this specification that they wish to prequalify. Each sample of process ink consists of 1 quart of transparent and opaque inks and any necessary reducer or thinner required for proper application. Each sample of electronic cuttable film and digital print consists of 2 pieces 24 inches square.

Supply a sufficient quantity of the correct type of retroreflective sheeting for ink or film applications. Directions for proper application to retroreflective sheeting must accompany all samples of ink or film.

Forward the prequalification samples to the Engineer of Tests. Samples will be tested for compliance with all requirements of this specification. Each manufacturer will be notified of the test results.

If the prequalification samples of ink, film, or digital print comply with this specification, the product will be placed on a list of prequalified products maintained by the Bureau of Materials and Research. No ink, film, or digital print will be used on KDOT projects unless it has been prequalified. Manufacturers will be required to requalify at intervals determined by the Engineer of Tests.

Testing and evaluation by KDOT may be waived if complete testing has been performed on the identical product by AASHTO National Transportation Product Evaluation Program (NTPEP) within the last five years. Forward an official copy of the test report along with evidence that the product referenced is identical to that submitted for prequalification, to the Engineer of Tests for evaluation.

2202.5 BASIS OF ACCEPTANCE

Prequalification as required by **subsection 2202.3**.

Receipt and approval of a Type C certification as specified in **DIVISION 2600**.

Visual observation of performance.

SECTION 2203

ROLL-UP SIGNS

2203.1 DESCRIPTION

This specification covers white, fluorescent orange, and fluorescent pink retroreflective sheeting used for temporary roll-up warning signs.

2203.2 REQUIREMENTS

a. Provide retroreflective sheeting that complies with ASTM D 4956, Type VI, Class 5.

b. Mounting Stands. The type and configuration of stands for mounting and displaying roll-up signs are not specified here, and are at the Contractor's option. However, all stands used must meet the crashworthy criteria for Category 2 devices contained in the testing and acceptance guidelines of the National Cooperative Highway Research Program (NCHRP) Report 350. Retain a copy of the NCHRP Report 350 crashworthy test data and the FHWA acceptance letter to be provided to the Engineer if requested. In addition, the mounted sign and stand must be able to resist normal wind loading without falling over, and be able to maintain a minimum mounting height of 12 inches above the edge of the pavement.

2203.3 TEST METHODS

All tests will be conducted in accordance with ASTM D 4956 with the exception of artificial weathering. Artificial weathering will be conducted according to ASTM G 155, Cycle 1, with the following additions and exceptions:

- At the end of each 20-hour cycle, the panels will be placed in a cold cabinet at approximately 0ºF for 1 hour. After removal from the cold cabinet, panels will be returned to the weatherometer to await the start of the next cycle.

2203.4 PREQUALIFICATION

Only the retroreflective sheeting used to manufacture the signs will be prequalified. Sheeting manufacturers interested in prequalifying material under this specification must submit 3 pieces 24 inches square to the Engineer of Tests. Samples will be tested for compliance with all requirements of this specification. Each manufacturer will be notified of the test results.

If the prequalification samples of retroreflective sheeting comply with this specification, the product will be placed on a list of prequalified products maintained by the Bureau of Construction and Materials. No retroreflective sheeting will be used on KDOT projects unless it has been prequalified. Manufacturers will be required to requalify at intervals determined by the Engineer of Tests.

Testing and evaluation by KDOT may be waived if complete testing has been performed on the identical product by AASHTO National Transportation Product Evaluation Program (NTPEP) within the last five years. Forward an official copy of the test report along with evidence that the product referenced is identical to that submitted for prequalification, to the Engineer of Tests for evaluation.

2203.5 BASIS OF ACCEPTANCE

Prequalification as required by **subsection 2203.4** above.

Receipt and approval of a certification prepared by the manufacturer stating that the sheeting used to manufacture the roll-up signs is essentially the same as that submitted for prequalification.

Visual inspection on delivery.

SECTION 2204

CENTER MOUNT REFLECTORS

2204.1 DESCRIPTION

This specification covers plastic center mount reflectors.

2204.2 REQUIREMENTS

a. General. Provide reflectors that are plastic reflector discs with a mounting hole in the center, and a nominal diameter of 3 inches. Provide the reflectors in 3 colors; white, amber and red. Provide amber and red reflectors that comply with the limits set by the Highway Yellow and Red Color Tolerance Charts of the U. S. Department of Transportation.

b. Construction and Materials.

(1) Plastic Reflector Unit. Provide reflectors that consist of 2 circular pieces of plastic, hermetically sealed together at the edges and at the center mounting hole. Provide units with an air space between the two sealed pieces and permanently sealed against dust, water and vapor.

(a) Front (Lens). Provide reflectors whose front piece of plastic consists of a clear and transparent acrylic plastic of the color shown in the Contract Documents. Provide reflectors whose outer surface of the front piece is smooth and highly polished, free from cracks, checks, projections or indentations. This surface may contain a mounting hole and trademark identification. Legibly mold the manufacturer's name and identification into the face near the edge. Form the inner surface into numerous small reflector elements to affect "cubecorner" retroreflection.

(b) Back. Provide a plastic back that is either transparent or opaque, but sealed to the front to form an airtight seal in order to protect the reflector elements.

(2) Housing and Mounting. Provide reflectors with a center mounting hole with a grommet that uses either of two designs. A Type I grommet is formed as part of the backing and projects through the reflector and beyond the lens by about 1/32 in. The backing, including the grommet, is hermetically sealed to the lens. A Type II grommet is formed from nonferrous metal and applied after the reflector is assembled and sealed. Provide either type of grommet with an inside diameter of 0.19 – 0.24 inches, inclusive.

c. Performance. Provide reflectors with the following minimum Reflective Intensity per reflector at a divergence angle of 0.2º:

TABLE 2204-1: MINIMUM REFLECTIVE INTENSITY

Angle of Incidence	Reflective Intensity (cd/ft-c)		
	White	Amber	Red
-4º	90	54	25
20º	45	27	12

2204.3 TEST METHODS

Center mount reflectors will be sampled by a representative of KDOT and submitted to the Engineer of Tests. A sample consists of 18 reflectors per each 5000 reflectors for each color. For each additional 5000, or fraction thereof, add 4 reflectors to the sample size. Lightly wash the reflectors with a mild detergent and dry with a clean cloth before testing as follows:

a. Coefficient of Luminous Intensity per Reflector. Determine the reflective intensity of center mount reflectors according to ASTM E 809. Measure each reflector individually at a divergence angle of 0.2º and incidence angles of -4º and 20º. Average readings taken at every 45º rotation.

b. Heat Test. After measuring the reflective intensity per reflector, place a minimum of 9 reflectors face up in a horizontal position on the central rack of a forced draft oven maintained between 148º and 150°F for 4 hours.

Remove the reflectors from the oven and place them face up on a table to cool. Allow the reflectors to return to room temperature, wipe the reflectors with a clean chamois and measure the reflective intensity of each reflector as described in **subsection 2204.3a**. The reflective intensity of each reflector must not be less than the minimum values shown in **subsection 2204.2c**.

c. Leakage Test. After measuring the reflective intensity per reflector, immerse a minimum of 9 reflectors face down in water in a vacuum desiccator under a coarse bronze or stainless steel screen to keep them beneath the water. Cover the desiccator and slowly reduce the air pressure in the desiccator until a vacuum of 20 inches of mercury is obtained. Hold this reduced pressure for 5 minutes and then allow air to slowly enter the desiccator until the pressure is equal to atmospheric pressure. Allow the reflectors to remain under water for an additional 5 minutes. Remove the reflectors from the water and wipe off the excess water with a clean cloth. Measure the reflective intensity of each reflector as described in **subsection 2204.3a**. Any reflectors that have filled with any water will be marked as failures and the reflective intensity will not be measured. The reflective intensity of each reflector must not be less than the minimum values shown in **subsection 2204.2c**.

d. Resampling. When only 1 reflector per sample fails **subsection 2204.3a.**, **b.** or **c.**, the entire sample will be accepted for use on KDOT projects. A failure of 2 reflectors per sample will require resampling and testing. A failure of 3 or more will cause the entire sample to be rejected without resampling.

2204.4 PREQUALIFICATION

None required.

2204.5 BASIS OF ACCEPTANCE

Each lot or batch will be sampled by a representative of KDOT and tested as necessary to verify compliance with the specification.

Satisfactory performance in the field.

SECTION 2205

FLEXIBLE DELINEATOR POSTS AND ANCHORING DEVICES

2205.1 DESCRIPTION

This specification covers flexible delineator posts and anchoring devices.

2205.2 REQUIREMENTS

a. General.

(1) Provide delineator posts consisting of a flexible, durable, UV resistant and non-discoloring material that meet all the requirements of the MUTCD. Provide posts to which retroreflective sheeting can be applied, and are capable of recovering from 5 cold weather impacts between 27 and 37°F and 5 hot weather impacts between 80 and 90°F. Upon installation, the delineator must be resistant to overturning, twisting, or displacement from wind and vehicle forces. For 2-piece systems, the post must be compatible with an anchor that holds the post in place by a locking mechanism, or with a bolting arrangement.

(2) When shown in the Contract Documents, apply High Intensity retroreflective sheeting that complies with **SECTION 2201**. Apply white or yellow retroreflective sheeting to 1 or 2 sides as stated in the Contract Documents. The total length and color of the post are shown in the Contract Documents.

(3) Delineators are required to meet the crashworthy criteria for category I devices contained in the testing and acceptance guidelines of the National Cooperative Highway Research Program (NCHRP) Report 350.

2205.3 TEST METHODS

a. Tensile Strength and Elongation. Test flexible delineator posts and anchoring devices is accordance with the procedures referenced in ASTM D 638 and ASTM G 154.

b. Impact Resistance Test. Test flexible delineators for impact resistance as prescribed by the AASHTO National Transportation Product Evaluation Program (NTPEP) test procedures for flexible delineator posts and plastic barrels.

The manufacturer must submit Impact Resistance data for tests that have been performed on the identical product by the AASHTO NTPEP test location that includes both hot and cold weather conditions. Forward an official copy of the test report along with evidence that the product referenced is identical to that submitted for prequalification, to the Engineer of Tests for evaluation.

c. Crashworthy Test. Test delineators as prescribed by the NCHRP Report 350 for category 1 devices. Federal Highway Administration (FHWA) guidance indicates that category 1 devices may be accepted based on a self-certification by the manufacturer. This certification may be a one-page affidavit signed by the manufacturer, with documentation supporting the certification (crash tests and/or engineering analysis) kept on file by the certifying organization. Forward an official copy of the certification with evidence that the product referenced is identical to that submitted for prequalification, to the Engineer of Tests for evaluation.

2205.4 PREQUALIFICATION

The flexible delineator post, complete with appropriate anchor, will be prequalified as a system or unit by KDOT. Manufacturers interested in prequalifying items under this specification must submit 2 complete units (posts with appropriate anchors), the Impact Resistance test data, and the Crashworthy Certification to the Engineer of Tests. The sample will be tested for compliance with all requirements of this specification and the producer will be notified in writing of the test results. A list of qualified materials will be maintained by the Bureau of Construction and Materials.

2205.5 BASIS OF ACCEPTANCE

Prequalification as required by **subsection 2205.4**.

Receipt and approval of a Type C certification in accordance with **DIVISION 2600**.

SECTION 2206

RAISED PAVEMENT MARKERS

2206.1 DESCRIPTION

This specification covers Flexible Raised Pavement Markers and Rigid Raised Pavement Markers (Type I or Type II) for lane marking and delineation on both portland cement concrete and asphalt surfaces.

2206.2 REQUIREMENTS

a. General. Provide temporary raised pavement markers (RPMs) as shown in the Contract Documents. The markers shall be readily visible at night, from a minimum of 300 feet, when viewed with high beam automobile headlamps. Prior to use, markers must be approved by the Engineer.

Provide flexible RPMs which consist of a flexible body with retroreflective sheeting on both sides facing traffic. The markers shall be between 4 and 6 inches wide, be at least 2 inches tall and have a flat base for mounting to the road. The width of the marker will face traffic in each direction. Each marker shall use adhesive to secure the marker to the road surface and, when hit, will not cause damage to an automobile. Attach a cover to the marker to protect the retroreflective material during surfacing operations. Remove the cover after the operations to expose the retroreflective surface.

Provide rigid (Type I) RMPs that are traversable by motor vehicles and constructed of traffic bearing high impact plastic with 1 or 2 retroreflective faces, as shown in the Contract Documents. The markers shall be 2.5 to 4 inches wide and at least 0.4 inches high. The width of the marker will face traffic in each direction. Each marker shall use an adhesive to secure marker to the road surface and, when hit, the marker will not cause damage to an automobile. The adhesive used shall not stain the pavement and will allow the markers to be easily removed without damage to the roadway surface.

Provide rigid (Type II) RPMs constructed of traffic bearing high impact plastic with retroreflective surfaces on the 2 sides facing traffic. The marker shall be at least 2.5 inches high, 12 inches wide and 6 inches long. Each marker shall use adhesive to secure marker to the road surface and the adhesive used will not stain the pavement and will allow the markers to be easily removed without damage to the roadway surface.

b. Visibility. Markers shall be visible a minimum of 300 feet in daytime and nighttime conditions. Retroreflectivity measured under field conditions may be used to determine visibility.

c. Retroreflectivity. Provide the markers in solid white and yellow which comply with the minimum requirements shown in **TABLE 2206-1**:

TABLE 2206-1: RETROREFLECTIVITY REQUIREMENTS

Color	Millicandelas/sq m/lux (min.) (measured at 0.2°observation angle and 0°entrance angle)
White	3.0
Yellow	1.8

d. Color. The marker shall be the same color as the retroreflective elements, which shall match the color of pavement marking they are intended to replace or supplement, or as shown in the Contract Documents. Marking color should be consistent throughout the body of the device.

2206.3 TEST METHODS

Test for retroreflectivity in accordance with ASTM E 809.

2206.4 PREQUALIFICATION

None required.

2206.5 BASIS OF ACCEPTANCE

Receipt and approval of a Type D certification as specified in **DIVISION 2600**.

Visual inspection for condition and dimensional requirements.

SECTION 2207

COLD PLASTIC PAVEMENT MARKING MATERIAL

2207.1 DESCRIPTION

This specification covers cold plastic pavement marking materials for use on both concrete and asphalt surfaces.

2207.2 REQUIREMENTS

Provide cold plastic pavement marking material that complies with ASTM D 4505 Reflectivity Level II.

2207.3 TEST METHODS

ASTM D 4505

2207.4 PREQUALIFICATION

Submit a sample of at least 100 linear feet of each color of material to the Engineer of Tests.

If the material complies with all laboratory requirements, the manufacturer will be contacted to arrange for the field evaluation. The field evaluation will consist of 2 or 3 test projects at times and locations as determined by the Bureau of Transportation Safety and Technology. Manufacturers must specify if the material may be used on both asphalt and concrete surfaces or only on asphalt or concrete surfaces.

Duration of the test project will be dependent on the submittal of test data from the AASHTO National Transportation Product Evaluation Program (NTPEP). Forward an official copy of the test data along with evidence that the material referenced is identical to that submitted for prequalification to the Engineer of Tests for evaluation. Materials with no test data will have a test project duration of 18 months; materials with test data will have a test project duration of 12 months. Materials will be evaluated initially and every 3 to 6 months throughout the duration of the test project for retroreflectivity, color and durability.

The material will be evaluated for compliance with this specification, and the manufacturer will be notified of the results. The Bureau of Construction and Materials will maintain a list of qualified materials and installation instructions. Products will remain on the prequalified list as long as field performance is satisfactory and the results of verification testing are consistently acceptable. Report any changes in formulation to the Engineer of Tests for review and evaluation to determine if requalification is necessary.

2207.5 BASIS OF ACCEPTANCE

a. Long Line Markings.

(1) Prequalification as stated in **subsection 2207.4**.

(2) Satisfactory results of Verification Testing. Except for symbols, the Engineer will sample each lot or batch. Collect samples of each lot in accordance with KT-81.

b. Preformed Symbols.

(1) Prequalification as stated in **subsection 2207.4**.

(2) Receipt and approval of a Type C certification as specified in **DIVISION 2600.** Include all lot numbers from the material used to fabricate the symbols.

SECTION 2208

PATTERNED COLD PLASTIC PAVEMENT MARKING MATERIAL

2208.1 DESCRIPTION

This specification covers patterned cold plastic pavement marking material for use on both concrete and asphalt surfaces.

2208.2 REQUIREMENTS

Provide patterned cold plastic pavement marking material that complies with ASTM D 4505 Reflectivity Level I with the following additions:

a. Dimensions. Provide material with a thickness of not less than 0.02 in. at the thinnest portion of the cross section. Provide material whose thickest portion of the cross section is 0.07 – 0.09 in. All measurements are exclusive of the adhesive.

2208.3 TEST METHODS

ASTM D 4505

2208. 4 PREQUALIFICATION

Submit at least 100 linear feet of each color of material to be prequalified to the Engineer of Tests.

If the material complies with all laboratory requirements, the manufacturer will be contacted to arrange for the field evaluation. The field evaluation will consist of 2 or 3 test projects at times and locations as determined by the Bureau of Transportation Safety and Technology. Manufacturers must specify if the material may be used on both asphalt and concrete surfaces or only on asphalt or concrete surfaces.

Duration of the test project will be dependent on the submittal of test data from the AASHTO National Transportation Product Evaluation Program (NTPEP). Forward an official copy of the test data along with evidence that the material referenced is identical to that submitted for prequalification to the Engineer of Tests for evaluation. Materials with no test data will have a test project duration of 18 months; materials with test data will have a test project duration of 12 months. Materials will be evaluated initially and every 3 to 6 months throughout the duration of the test project for retroreflectivity, color and durability.

The material will be evaluated for compliance with this specification, and the manufacturer will be notified of the results. The Bureau of Construction and Materials will maintain a list of qualified materials and installation instructions. Products will remain on the prequalified list as long as field performance is satisfactory and the results of verification testing are consistently acceptable. Report any changes in formulation to the Engineer of Tests for review and evaluation to determine if requalification is necessary.

2208.5 BASIS OF ACCEPTANCE

a. Long Line Markings.

(1) Prequalification as stated in **subsection 2208.4**.

(2) Satisfactory results of Verification Testing. Except for symbols, the Engineer will sample each lot or batch. Collect samples of each lot in accordance with KT-81.

b. Preformed Symbols.

(1) Prequalification as stated in **subsection 2208.4**.

(2) Receipt and approval of a Type C certification as specified in **DIVISION 2600.** Include all lot numbers from the material used to fabricate the symbols.

SECTION 2209

HIGH DURABILITY PAVEMENT MARKING MATERIAL

2209.1 DESCRIPTION

This specification covers white or yellow high durability pavement markings designed to be used in severe wear conditions such as repeated shear actions from crossover or encroachment traffic and turning, stopping or starting traffic. This includes material for use on both portland cement concrete and asphalt surfaces.

2209.2 REQUIREMENTS

Provide high durability pavement marking material that complies with ASTM D 4505 Reflectivity Level II with the following exceptions and additions:

a. The material must have a strong topcoat with glass beads distributed to provide immediate and continuing retroreflection. Bond ceramic particles to the top layer to provide a skid resistant surface.

b. Delete all references to application temperatures.

c. Tensile Strength. The material must have a minimum tensile strength of 500 psi when measured in the direction of the roll.

d. Adhesion. 8 lbf, minimum.

e. Dimensions. With the exception of patterned, provide material with a 0.05 inch minimum thickness. Provide patterned material with a thickness of not less than 0.02 inch at the thinnest portion of the cross section and 0.07 – 0.09 inch at the thickest portion of the cross section. All measurements are exclusive of the adhesive.

2209.3 TEST METHODS

ASTM D 638 with the following exception:

- Test a 1 by 6 inch sample at a temperature between 70 and 80ºF using a jaw speed of 10 - 12 inches per minute.

ASTM D 4505.

2209.4 PREQUALIFICATION

Submit at least 100 linear feet of each color, and a complete set of installation recommendations and instructions to Engineer of Tests.

If the material complies with all laboratory requirements, the manufacturer will be contacted to arrange for the field evaluation. The field evaluation will consist of 2 or 3 test projects at times and locations as determined by the Bureau of Transportation Safety and Technology. Manufacturers must specify if the material may be used on both asphalt and concrete surfaces or only on asphalt or concrete surfaces.

Duration of the test project will be dependent on the submittal of test data from the AASHTO National Transportation Product Evaluation Program (NTPEP). Forward an official copy of the test data along with evidence that the material referenced is identical to that submitted for prequalification to the Engineer of Tests for evaluation. Materials with no test data will have a test project duration of 18 months; materials with test data will have a test project duration of 12 months. Materials will be evaluated initially and every 3 to 6 months throughout the duration of the test project for retroreflectivity, color and durability.

The material will be evaluated for compliance with this specification, and the manufacturer will be notified of the results. The Bureau of Construction and Materials will maintain a list of qualified materials and installation instructions. Products will remain on the prequalified list as long as field performance is satisfactory and the results of verification testing are consistently acceptable. Report any changes in formulation to the Engineer of Tests for review and evaluation to determine if requalification is necessary.

2209.5 BASIS OF ACCEPTANCE

a. Long Line Markings.

(1) Prequalification as required by **subsection 2209.4** above.

(2) Satisfactory results of Verification Testing. Except for symbols, the Engineer will sample each lot or batch. Collect samples of each lot in accordance with KT-81.

b. Preformed Symbols.

(1) Prequalification as required by **subsection 2209.4** above.

(2) Receipt and approval of a Type C certification as specified in **DIVISION 2600**, which also includes all lot numbers of material used to fabricate the symbols.

SECTION 2210

TEMPORARY PAVEMENT MARKING TAPE

2210.1 DESCRIPTION

This specification covers preformed plastic pavement markings designed for limited service life. This includes both Removable (Type I) and Non-removable (Type II) materials for use on both portland cement concrete and asphalt surfaces. Type I tape can be removed without damage to or discoloration of the pavement surface. Type II is not required to have the removal characteristics of Type I, though removal that leaves damage to or discoloration of the pavement surface may be required, as shown in the Contract Documents.

This specification also covers Removable Line Masking Tape. This is a highly durable, skid resistant, non-reflective, black or dark gray, pliant polymer tape designed for temporary obliteration of existing pavement markings. The tape must be able to be removed without residue or damage to the existing marking.

2210.2 REQUIREMENTS

Provide pavement markings that comply with ASTM D 4592 with the following exceptions and additions:

- Delete all references to application temperatures. Apply all markings according to the manufacturer's recommendations for proper surface conditions and preparation, air and surface temperatures, and other weather conditions.
- Store all material in accordance with the manufacturer's directions, including temperature and exposure to the elements.
- If recommended by the manufacturer, use a primer to precondition the pavement surface.
- Visibility. Pavement Marking Tape shall be visible a minimum of 300 feet in daytime and nighttime conditions. Retroreflectivity measured under field conditions may be used to determine visibility.
- Retroreflectivity. Retroreflectivity requirements are not applicable for Removable Line Masking Tape. Provide tape in white or yellow which complies with the minimum requirements shown in **TABLE 2210-1**:

TABLE 2210-1: RETROREFLECTIVITY

Color	**Millicandelas/sq m/lux** (min.)
White	250
Yellow	175

2210.3 TEST METHODS

ASTM D 4592

2210.4 PREQUALIFICATION

None Required.

2210.5 BASIS OF ACCEPTANCE

Receipt and approval of a Type D certification as specified in **DIVISION 2600**.

Visual observation of performance on the project.

SECTION 2211

THERMOPLASTIC PAVEMENT MARKING MATERIAL

2211.1 DESCRIPTION

This specification covers thermoplastic materials suitable for use as retroreflective pavement markings on asphalt and portland cement concrete pavements. Material will be prequalified for use on both asphalt and portland cement concrete surfaces or for use only on asphalt surfaces. The material is applied to the pavement in molten form. Glass beads are pre-mixed into the material furnished, and also dropped on the surface of the molten material immediately after it is applied to the pavement surface, at a rate specified. Upon cooling to normal pavement temperature, it produces an adherent retroreflectorized stripe of specified thickness and width, capable of resisting deformation by traffic.

2211.2 REQUIREMENTS

a. General.

(1) Provide the material in white and/or yellow as specified.

(2) A binder-sealer is required for applications involving asphalt over 2 years old, or for asphalt surfaces that are worn or oxidized to a condition where 50% or more of the wearing surface is exposed aggregate.

(3) Do not commingle materials from different manufacturers.

b. Thermoplastic Material and Premix Beads. Provide thermoplastic material that complies with AASHTO M 249 with the following restrictions:

(1) Only maleic modified glycerol ester alkyd based resins will be allowed for the binder system.

(2) Yellow pigments must comply with the latest OSHA standards for toxic heavy metals.

c. Glass Beads for Drop-on Application. Provide glass beads according to the thermoplastic manufacturer's recommendations.

d. Binder-Sealer. When a binder-sealer is specified, provide one that is recommended by the manufacturer of the thermoplastic material, and apply it according to the manufacturer's instructions. The binder-sealer must be compatible with the pavement material, and form a tight bond between the pavement and the thermoplastic material.

e. Color. Provide thermoplastic that complies with the requirements of ASTM D 6628. The yellow lines must also display a nighttime presence of yellow when viewed under automobile headlights.

f. Retroreflectivity. Provide thermoplastic that complies with the minimum retroreflectivity requirements in **TABLE 2211-2** using an acceptable 30-meter retroreflectometer:

TABLE 2211-2: THERMOPLASTIC RETROREFLECTIVITY REQUIREMENTS

Color	millicandelas/sq m/lux (min.)
White	300
Yellow	225

2211.3 TEST METHODS

a. Thermoplastic Material.

(1) AASHTO T 250, plus,

(2) Verify the material is alkyd using KTMR-6, Determination of Alkyd Base in Thermoplastic Material.

(3) Glass Bead Content. ASTM D 4797.

(4) Titanium Dioxide. ASTM D 1394, Aluminum Reduction Method.

(5) Specific Gravity. AASHTO T 228.

2211.4 PREQUALIFICATION

a. Manufacturers interested in prequalifying material under this specification must provide a 10-lb sample of each color to the Engineer of Tests. Also include a copy of the quality control test report for each lot of material, material safety data sheets, and a complete set of installation recommendations and instructions.

b. If the material complies with all laboratory requirements, the manufacturer will be contacted to arrange for the field evaluation. The field evaluation will consist of 2 or 3 test projects at times and locations as determined by the Bureau of Transportation Safety and Technology. Manufacturers must specify if the material may be used on both asphalt and concrete surfaces or only on asphalt or concrete surfaces.

Duration of the test project will be dependent on the submittal of test data from the AASHTO National Transportation Product Evaluation Program (NTPEP). Forward an official copy of the test data along with evidence that the material referenced is identical to that submitted for prequalification to the Engineer of Tests for evaluation. Materials with no test data will have a test project duration of 18 months; materials with test data will have a test project duration of 12 months. Materials will be evaluated initially and every 3 to 6 months throughout the duration of the test project for retroreflectivity, color and durability.

c. The material will be evaluated for compliance with all requirements of this specification, and the manufacturer will be notified of the results. The Bureau of Construction and Materials will maintain a list of qualified materials and installation instructions. The list will differentiate between products prequalified for use on asphalt and concrete surfaces, or for use on asphalt surfaces only. Products will remain on the prequalified list as long as the results of verification testing and field performance are satisfactory. Any changes in formulation should be reported to the Engineer of Tests for review and evaluation to determine if requalification is necessary.

2211.5 BASIS OF ACCEPTANCE

a. Thermoplastic Material.

(1) Prequalification as required by **subsection 2211.4**.

(2) Receipt and approval of a Type C certification as specified in **DIVISION 2600** for each lot of material used.

b. Glass Beads for Drop-on Application.

(1) Receipt and approval of a Type D certification as specified in **DIVISION 2600**.

(2) Copies of testing results for each lot of beads used on the project.

c. Binder-Sealer. If binder-sealer is required, it will be accepted on the basis of brand name as recommended by the thermoplastic material manufacturer, and visual observation of performance in the field.

SECTION 2212

PREFORMED THERMOPLASTIC PAVEMENT MARKING MATERIAL

2212.1 DESCRIPTION

This specification covers preformed thermoplastic materials suitable for use as reflecting pavement markings on either asphalt or concrete pavements. A manufacturer recommended heat source fuses the markings to the asphalt or concrete pavements. Glass beads are pre-mixed into the material furnished, and also must be applied to the surface either before or after fusion to the pavement. Upon cooling, the material produces an adherent reflectorized marking of specified thickness and width, capable of resisting deformation by traffic.

2212.2 REQUIREMENTS

a. General.

(1) Provide the material in white and/or yellow as specified.

(2) Provide material with a minimum thickness of 0.1 inch as supplied by the manufacturer.

(3) Provide material that is resistant to deterioration due to exposure to sunlight, water, oil, gasoline, salt, or adverse weather conditions.

(4) After application, the material must exhibit no appreciable deformation or discoloration, remain tack free, and not lift from the pavement under normal traffic conditions within a road temperature range of 20 to 150ºF.

(5) Provide material that is capable of conforming to pavement contours, breaks, and faults through the action of traffic at normal pavement temperatures.

b. Color. Provide thermoplastic that meets the requirements of ASTM D 6628.

c. Retroreflectivity. Provide preformed thermoplastic that meets the minimum retroreflectivity requirements in **TABLE 2212-1**, using an acceptable 30-meter retroreflectometer.

TABLE 2212-1: PREFORMED THERMOPLASTIC RETROREFLECTIVITY REQUIREMENTS

COLOR	millicandelas/sq m/lux (min.)
White	300
Yellow	225

d. Thermoplastic Material and Premix Beads.

(1) Provide thermoplastic material that complies with AASHTO M 249 with exception of the relevant differences due to the material being supplied in a preformed state.

(2) All pigments must be heavy metal free, including, but not restricted to lead, cadmium, and mercury.

e. Glass Beads for Drop-on Application. Provide glass beads according to the thermoplastic manufacturer's recommendations.

2212.3 TEST METHODS

a. Thermoplastic Material and Premix Beads. AASHTO T 250

2212.4 PREQUALIFICATION

a. Manufacturers interested in prequalifying material under this specification must provide at least 100 linear feet of each color to the Engineer of Tests. Also, include a copy of the quality control test report for each lot of material, material safety data sheets, and a complete set of installation recommendations and instructions.

b. If the material complies with all laboratory requirements, the manufacturer will be contacted to arrange for the field evaluation. The field evaluation will consist of 2 or 3 test projects at times and locations as determined by the Bureau of Transportation Safety and Technology. Manufacturers must specify if the material may be used on both asphalt and concrete surfaces or only on asphalt or concrete surfaces.

Duration of the test project will be dependent on the submittal of test data from the AASHTO National Transportation Product Evaluation Program (NTPEP). Forward an official copy of the test data along with evidence that the material referenced is identical to that submitted for prequalification to the Engineer of Tests for evaluation. Materials with no test data will have a test project duration of 18 months; materials with test data will have a test project duration of 12 months. Materials will be evaluated initially and every 3 to 6 months throughout the duration of the test project for retroreflectivity, color and durability.

c. The material will be evaluated for compliance with all requirements of this specification, and the manufacturer will be notified of the results. The Bureau of Construction and Materials will maintain a list of qualified materials and installation instructions. Products will remain on the prequalified list as long as field performance is satisfactory and the results of verification testing are consistently acceptable. Report any changes in formulation to the Engineer of Tests for review and evaluation to determine if requalification is necessary.

2212.5 BASIS OF ACCEPTANCE

a. Thermoplastic Material.

(1) Prequalification as required by **subsection 2212.4**.

(2) Receipt and approval of a Type C certification as specified in **DIVISION 2600** for each lot of material used.

b. Glass Beads for Drop-on Application.

(1) Receipt and approval of a Type D certification as specified in **DIVISION 2600.**

(2) Copies of testing results for each lot of beads used on the project.

SECTION 2213

SPRAYED THERMOPLASTIC PAVEMENT MARKING MATERIAL

2213.1 DESCRIPTION

This specification covers thermoplastic materials suitable for use as retroreflecting pavement markings on asphalt pavement. The material is applied to the pavement in molten form by spray means. Glass beads are pre-mixed into the material furnished, and also dropped on the surface of the molten material immediately after it is applied to the pavement surface, at a rate specified. Upon cooling to normal pavement temperature, the material produces an adherent retroreflective marking of specified thickness and width, capable of resisting deformation by traffic.

2213.2 REQUIREMENTS

a. General.

(1) Provide the material in white and/or yellow as specified.

(2) Provide 100% solids thermoplastic material that is homogeneously composed of pigment, filler, resins and glass beads. The material must have a minimum binder content of 25% by mass composition and be free of foreign objects that would cause bleeding, staining, or discoloration. Upon heating to application temperature, the material will not exude fumes that are toxic, or injurious to persons or property.

b. Pigment.

(1) Use high-grade titanium dioxide as the pigment for the white material. The material must contain a minimum of 10% titanium dioxide by mass.

(2) Use heat resistant and colorfast yellows, golds, or oranges to produce a material to comply with color requirements.

(3) Yellow pigments must comply with the latest OSHA standards for toxic heavy metals.

(4) Use a filler consisting of white calcium carbonate, silica, or an approved substitute.

c. Glass Beads. Provide glass beads according to the thermoplastic manufacturer's recommendations.

d. Thermoplastic Material. Provide thermoplastic material that complies with the following:

(1) Specific Gravity--2.0 maximum

(2) Daylight Reflectance (Y)

(a) White—75% minimum

(b) Yellow—45% minimum

(3) Color—meets the requirements of ASTM D 6628. Yellow lines must display a nighttime presence of yellow when viewed under automobile headlights.

(4) Retroreflectivity—Provide sprayed thermoplastic that meets the following minimum retroreflectivity requirements using an acceptable 30-meter retroreflectometer:

TABLE 2213-2: SPRAYED THERMOPLASTIC RETROREFLECTIVITY REQUIREMENTS

Color	Millicandelas/sq m/lux (min.)
White	300
Yellow	225

(5) Softening Point--180°F minimum

(6) Cracking Resistance at Low Temperature--No visible cracks when observed from a distance of one foot.

e. Binder-Sealer. When a binder-sealer is specified, provide one that is recommended by the manufacturer of the thermoplastic material, and apply it according to the manufacturer's instructions. The binder-sealer must be compatible with the pavement material, and form a tight bond between the pavement and the thermoplastic material.

2213.3 TEST METHODS

a. Thermoplastic Material. Use AASHTO T 250 except for:

(1) Softening Point-Heat the material for 4 hours ± 5 minutes at 375 ± 2ºF.

(2) Cracking Resistance at Low Temperature-Heat the material for 4 hours ± 5 minutes at 375 ± 2ºF.

(3) Glass Beads content. ASTM D 4797 and AASHTO T 247.

(4) Titanium Dioxide. ASTM D 1394, Aluminum Reduction Method.

2213.4 PREQUALIFICATION

a. Manufacturers interested in prequalifying material under this specification must provide a 10-lb sample of each color to the Engineer of Tests. Also include a copy of the quality control test report for each lot of material, material safety data sheets, and a complete set of installation recommendations and instructions.

b. If the material complies with all laboratory requirements, the manufacturer will be contacted to arrange for the field evaluation. The field evaluation will consist of 2 or 3 test projects at times and locations as determined by the Bureau of Transportation Safety and Technology. Manufacturers must specify if the material may be used on both asphalt and concrete surfaces or only on asphalt or concrete surfaces.

Duration of the test project will be dependent on the submittal of test data from the AASHTO National Transportation Product Evaluation Program (NTPEP). Forward an official copy of the test data along with evidence that the material referenced is identical to that submitted for prequalification to the Engineer of Tests for evaluation. Materials with no test data will have a test project duration of 18 months; materials with test data will have a test project duration of 12 months. Materials will be evaluated initially and every 3 to 6 months throughout the duration of the test project for retroreflectivity, color and durability.

c. The material will be evaluated for compliance with all requirements of this specification, and the manufacturer will be notified of the results. The Bureau of Construction and Materials will maintain a list of qualified materials and installation instructions. Products will remain on the prequalified list as long as the results of verification testing and field performance are satisfactory. Any changes in formulation should be reported to the Engineer of Tests for review and evaluation to determine if requalification is necessary.

2213.5 BASIS OF ACCEPTANCE

a. Thermoplastic Material.

(1) Prequalification as required by **subsection 2213.4**.

(2) Receipt and approval of a Type C certification as specified in **DIVISION 2600** for each lot of material used.

b. Glass Beads for Drop-on Application.

(1) Receipt and approval of a Type D certification as specified in **DIVISION 2600**.

(2) Copies of testing results for each lot of beads used on the project.

c. Binder-Sealer. If binder-sealer is required, it will be accepted based on brand name as recommended by the thermoplastic material manufacturer, and visual observation of performance in the field.

SECTION 2214

EPOXY PAVEMENT MARKING MATERIAL

2214.1 DESCRIPTION

This specification covers epoxy resin and glass beads suitable for use as reflective pavement markings on portland cement concrete or asphalt pavement.

2214.2 REQUIREMENTS

a. Epoxy Pavement Marking Material.

(1) General. Provide an epoxy resin material that is toxic heavy metal free, 2-component, 100% solids, and is formulated and tested to perform as a pavement marking material with glass beads applied to the surface. The 2 components are an epoxy resin and an amine curing agent. Provide complete manufacturer's specifications and material safety data sheets to the Engineer for all material provided.

Provide a material that does not exude toxic fumes when heated to application temperature.

Provide a material that, when mixed in the proper ratio and applied at 0.02 inch wet film thickness at 75ºF with the proper saturation of glass beads, has a no tracking time of less than 40 minutes for slow curing material and less than 10 minutes for rapid curing material. Provide a material that is capable of fully curing under a constant surface temperature of 32ºF or above.

(2) Properties of Cured Material.

(a) Color. Provide material that complies with the requirements of ASTM D 6628. Provide white and yellow material that complies with the following Daylight Reflectance values:

TABLE 2214-1 DAYLIGHT REFLECTANCE	
Color	**45 Degrees-0 Degrees, % Min.**
White	75
Yellow	45

(b) Retroreflectivity. Provide epoxy pavement marking material that meets the following minimum retroreflectivity requirements using an acceptable 30-meter retroreflectometer:

TABLE 2214-3: EPOXY RETROREFLECTIVITY REQUIREMENTS	
Color	**millicandelas/sq m/lux (min.)**
White	325
Yellow	250

(c) Hardness. Provide material with Shore D hardness of 75 minimum.

(d) Bond Strength to Concrete. Provide material that when catalyzed, has such a high degree of adhesion to the specified concrete surface that there is a 100% concrete failure. Apply the material at a film thickness of 0.01 ± 0.001 inch to concrete with a minimum compressive strength of 4000 psi. Allow the material to cure for 72 hours at 77ºF before the test is performed.

(e) Yellowness Index. White only. Value after 72 hours in QUV – 30 maximum when tested at 0.01 ± 0.001 inch and a 72-hour cure.

b. Glass Beads For Drop-On Application (double drop system). Provide glass beads according to the epoxy manufacturer's recommendations.

2214.3 TEST METHODS

a. Bond Strength to Concrete. AASHTO T 237

b. Hardness. ASTM D 2240

c. Yellowness Index. ASTM E 313

2214.4 PREQUALIFICATION

a. Manufacturers interested in prequalifying material under this specification must provide a 1-quart sample of each color plus 1 quart of hardener to the Engineer of Tests. Also include a copy of the quality control test report for each lot of material, an infrared spectroscopy analysis for each component, material safety data sheets and a complete set of installation recommendations and instructions. .

b. The material will be evaluated for compliance with all requirements of this specification, and the manufacturer will be notified of the results. Each color and the hardener will be analyzed and "fingerprinted" using infrared spectroscopy for use in screening future verification samples to verify that materials submitted for use are of an identical formulation as originally approved.

c. If the material complies with all laboratory requirements, the manufacturer will be contacted to arrange for the field evaluation. The field evaluation will consist of 2 or 3 test projects at times and locations as determined by the Bureau of Transportation Safety and Technology. Manufacturers must specify if the material may be used on both asphalt and concrete surfaces or only on asphalt or concrete surfaces.

Duration of the test project will be dependent on the submittal of test data from the AASHTO National Transportation Product Evaluation Program (NTPEP). Forward an official copy of the test data along with evidence that the material referenced is identical to that submitted for prequalification to the Engineer of Tests for evaluation. Materials with no test data will have a test project duration of 18 months; materials with test data will have a test project duration of 12 months. Materials will be evaluated initially and every 3 to 6 months throughout the duration of the test project for retroreflectivity, color and durability.

d. The Bureau of Construction and Materials will maintain a list of qualified materials and installation instructions. Products will remain on the prequalified list as long as the results of verification testing and field performance are satisfactory. Any changes in formulation should be reported to the Engineer of Tests for review and evaluation to determine if requalification is necessary.

2214.5 BASIS OF ACCEPTANCE

a. Epoxy Material.

(1) Prequalification as required by **subsection 2214.4**.

(2) Receipt and approval of a Type C certification as specified in **DIVISION 2600**.

b. Glass Beads for Drop-on Application.

(1) Receipt and approval of a Type D certification as specified in **DIVISION 2600**.

(2) Copies of testing results for each lot of beads used on the project.

SECTION 2215

PAVEMENT MARKING PAINT

2215.1 DESCRIPTION

This specification covers water-borne pavement marking paint and glass beads suitable for use as retroreflective pavement markings on portland cement concrete or asphalt pavement.

2215.2 REQUIREMENTS

a. Paint. Use white or yellow paint that is specifically manufactured for use as pavement markings. Formulate the paint to consist of acrylic resin, lead free pigments and water as the solvent. The paint must comply with volatile organic compound (VOC) requirements, be lead and other toxic heavy metal free, and exhibit the following qualities:

(1) Formulation:

Yellow paint- The pigment of the Yellow paint shall consist of the following for each 100 gallons of paint:

A. 30 lbs. of approved Hansa Yellow
B. 17 lbs. of Rutile Titanium Dioxide
C. Other such extender pigments as necessary to produce a close match to the yellow color requirement.

White and yellow paint shall be composed of 100% acrylic polymer, which shall be Rohm and Haas HD-21 acrylic resin or Dow Chemical's DT400.

(2) Dry-Opacity: A contrast ratio of not less than 0.96 when the paint is applied with a 0.012 inch film applicator.

(3) Daylight Reflectance: Daylight Reflectance of the white paint not less than 80% relative to magnesium oxide.

(4) Color: Provide paint that meets the requirements of ASTM D 6628.

(5) Bead Embedment: At least 90% of the glass beads must be embedded between 50 and 70%.

(6) Dry to No Pick-Up Time: Maximum 5 minutes when tested according to KT-MR1

b. Glass Beads for Pavement Marking Paint (Double Drop System). Provide glass beads according to the paint manufacturer's recommendations.

2215.3 TEST METHODS

a. Paint.

(1) Dry Opacity. ASTM D 2805.

(2) Daylight Reflectance. ASTM E 1347.

(3) Bead Embedment. Apply paint to a Leneta plain white paper chart at a wet film thickness of 0.025 inch followed immediately by an application of glass beads (AASHTO M 247, Type 3) dropped onto the surface of the paint. After drying for at least 24 hours observe the amount of bead embedment with a 30-power microscope.

(4) No Pick-Up Time. ASTM D 711.

2215.4 PREQUALIFICATION

None Required.

2215.5 BASIS OF ACCEPTANCE

Acceptance of pavement marking paint and glass beads will be made on the basis of Type D certifications as specified in **DIVISION 2600**, copies of testing results for each lot of beads used on the project, and visual inspection of performance and consistency on the job site.

SECTION 2216

MULTI-COMPONENT LIQUID PAVEMENT MARKING MATERIAL

2216.1 DESCRIPTION

This specification covers multi-component, liquid materials* suitable for use as retroreflecting pavement markings on portland cement concrete or asphalt pavements. Glass beads or other reflective elements are dropped at a specified rate on the surface of the liquid material immediately after it is applied to the pavement surface. Upon curing, it produces an adherent retroreflective marking of specified thickness and width, capable of resisting deformation by traffic.

***These can be modified urethanes, polyureas, methylmethacrylates, special epoxies or other applicable materials.

2216.2 REQUIREMENTS

a. Color. Provide material that complies with the requirements of ASTM D 6628. Provide white and yellow material that complies with the following Daylight Reflectance values:

TABLE 2216-1: DAYLIGHT REFLECTANCE	
Color	**45 Degrees-0 Degrees, % Min.**
White	75
Yellow	45

b. Provide material that is a homogeneous blend of liquid resins, pigments, and fillers and is also free of lead and other toxic heavy metals.

c. Provide one of the above-mentioned liquid marking materials or a material as approved by KDOT. The burden of proof of a product rests with the producer. Provide all supporting technical data, including test reports, field test data, etc. for consideration of the product.

d. Retroreflectivity. Provide multi-component pavement marking material that meets the following minimum retroreflectivity requirements using an acceptable 30-meter retroreflectometer:

TABLE 2216-2: MULTI-COMPONENT RETROREFLECTIVITY REQUIREMENTS	
Color	**millicandelas/sq m/lux (min.)**
White	325
Yellow	250

e. Glass Beads For Drop-On Application (double drop system). Provide glass beads according to the multi-component manufacturer's recommendations.

2216.3 TEST METHODS

a. Bond Strength to Concrete. AASHTO T 237

b. Hardness. ASTM D 2240

c. Yellowness Index. ASTM E 313

2216.4 PREQUALIFICATION

a. Manufacturers interested in prequalifying material under this specification must provide a 1-quart sample of each color plus 1 quart of hardener to the Engineer of Tests. Also include a copy of the quality control test report for

each lot of material, an infrared spectroscopy analysis for each component, material safety data sheets and a complete set of installation recommendations and instructions. .

b. The material will be evaluated for compliance with all requirements of this specification, and the manufacturer will be notified of the results. Each color and the hardener will be analyzed and "fingerprinted" using infrared spectroscopy for use in screening future verification samples to verify that materials submitted for use are of an identical formulation as originally approved.

c. If the material complies with all laboratory requirements, the manufacturer will be contacted to arrange for the field evaluation. The field evaluation will consist of 2 or 3 test projects at times and locations as determined by the Bureau of Transportation Safety and Technology. Manufacturers must specify if the material may be used on both asphalt and concrete surfaces or only on asphalt or concrete surfaces.

Duration of the test project will be dependent on the submittal of test data from the AASHTO National Transportation Product Evaluation Program (NTPEP). Forward an official copy of the test data along with evidence that the material referenced is identical to that submitted for prequalification to the Engineer of Tests for evaluation. Materials with no test data will have a test project duration of 18 months; materials with test data will have a test project duration of 12 months. Materials will be evaluated initially and every 3 to 6 months throughout the duration of the test project for retroreflectivity, color and durability.

d. The Bureau of Construction and Materials will maintain a list of qualified materials and installation instructions. Products will remain on the prequalified list as long as the results of verification testing and field performance are satisfactory. Any changes in formulation should be reported to the Engineer of Tests for review and evaluation to determine if requalification is necessary.

2216.5 BASIS OF ACCEPTANCE

a. Multi-Component Liquid Material

(1) Prequalification as required by **subsection 2216.4**.

(2) Receipt and approval of a Type C certification as specified in **DIVISION 2600**.

b. Glass Beads/Reflective Elements for Drop-on Application.

(1) Receipt and approval of a Type D certification as specified in **DIVISION 2600**.

(2) Copies of testing results for each lot of beads used on the project.