

**DIVISION 12****PAVEMENT MARKINGS, MARKERS AND DELINEATION****SECTION 1205****PAVEMENT MARKING GENERAL REQUIREMENTS****1205-1 DESCRIPTION**

Furnish, install and remove pavement markings in accordance with the contract.

**1205-2 MATERIALS****(A) General**

Refer to Division 10.

<b>Item</b>	<b>Section</b>
Pavement Markings	1087

**(B) Material Qualifications**

Use pavement markings, which are on the Department's Approved Products List or are traffic qualified by the Traffic Control Unit.

**(C) Historical Performance**

Historical performance of the pavement marking material will be used in determining future use of the material by the Department, even if the material has been traffic qualified. Poor past or poor current performance of pavement marking materials at any site, whether or not related to a specific contract may be grounds for nonacceptance of a product on any project under contract.

**1205-3 CONSTRUCTION METHODS**

Do not use handliners or any other non-truck mounted pavement marking machine to install pavement markings for long line applications of any one line longer than 305 m.

**(A) Testing Procedures**

All pavement marking materials and placement will be tested according to Materials and Test Unit Testing Procedure PM 1.0 as shown in the *NCDOT Construction Manual*. Install pavement markings in order to meet the retroreflectivity requirements as measured by an LTL 2000, LTL-X or Department approved mobile retroreflectometer.

**(B) Application Equipment****(1) General for all Application Equipment**

Use pavement marking application equipment such that all parts that come in contact with pavement marking material are constructed for easy accessibility during cleaning and maintenance.

Keep the marking guns of the application device in full view of the operators at all times. Use applicators that are mobile and maneuverable to the extent that straight lines can be followed and all standard curves can be made in true arcs.

**(2) Glass Bead/Element Dispensing Equipment**

Apply drop-on beads/elements to the surface of pavement long line markings using an automatic high pressurized bead dispenser or a pressurized mechanical feed, attached to the marking equipment. Hand liner type equipment is exempt from this requirement. Locate the bead/element applicator at the proper distance behind the application of pavement marking material to provide the proper amount of retroreflectivity. Equip the bead applicator with an automatic cut-off control synchronized with the cut-off control of the marking material.

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Spread the beads/elements uniformly over the entire surface of the pavement marking material such that they are partially embedded in the pavement marking. A 60% bead/element embedment depth provides optimum retroreflectivity.

**(C) Weather Limitations and Seasonal Limitations for all markings**

Do not place pavement markings when moisture tests conducted on the pavement show signs of moisture presence on the pavement, or it is anticipated that damage causing moisture may occur during the installation and drying periods. See Section 12 of the *Construction Manual* for details.

**(D) Time Limitations for Replacement**

Facility Type	Marking Type	Replacement Deadline
Full-control-of-access multi-lane roadway (4 or more total lanes) and ramps, including Interstates	All markings including symbols	By the end of each workday's operation if the lane is opened to traffic
Multi-lane roadways (3 or more lanes) and ramps	Center Line, Lane Line, Railroad symbols, & school symbols	By the end of each workday's operation if the lane is opened to traffic (temporary paint may be used)
	Edge Lines, gore lines & all other symbols	By the end of the 3rd calendar after obliteration
Two-lane, two-way roadways	All centerline markings, railroad, & school symbols	By the end of the 5th calendar day after obliteration
	Edge Lines & all other symbols	By the end of the 15th calendar day after obliteration

A multilane facility is defined as any roadway having more than two lanes to include a two-lane / two-way roadway with a center two-way left turn lane.

**(E) Premarking**

Premark each installation of pavement marking materials prior to application on new pavement and when required to replace pavement marking, except when existing markings are visible. Use premarking to guide in the placement of pavement markings. Get the premarking inspected and approved before placing the pavement marking materials.

Review and record the existing pavement markings prior to resurfacing and reestablish the new pavement markings using the record of existing markings in conjunction with the Standard Drawings, unless otherwise directed. In order to assure compliance with this specification, submit a pavement marking plan 7 calendar days before any pavement marking is placed.

**(F) Surface Preparation and Curing Compound Removal**

Prepare the pavement to accept pavement markings to insure maximum possible adhesion. Clean, seal and remove curing compound as necessary to insure that the markings adhere to the pavement. Obtain approval for all surface preparation methods prior to implementing.

Pavements shall be free of grease, oil, mud, dust, dirt, grass, loose gravel and other deleterious material, prior to applying pavement markings.

Prepare the pavement surface, including removal of curing compound, a minimum of 51 mm wider than the pavement markings to be placed, such that, an additional 25 mm of prepared area is on all sides of the pavement markings after they are applied.

Remove all curing compound and surface laitance on Portland cement concrete pavements where long-life pavement markings will be placed. Perform curing compound removal by high-pressure water or shot blasting methods. Ensure that the surface is free of all residue, laitance and debris prior to applying the pavement marking.

When surface preparation and curing compound removal operations are completed, blow the pavement surface clean by compressed air to remove residue or debris.

Curing compound removal will be paid for at the applicable contract unit price. All other surface preparation will be considered incidental to the work covered by this specification.

If required, apply a primer sealer to pavement surfaces before applying pavement marking material as recommended by the manufacturer. Apply primer sealer in a continuous film in such a way as to not cause any noticeable change in the appearance of the pavement markings. Submit a sample of the primer sealer to the Engineer, prior to application.

Conduct all pavement surface preparation including curing compound removal in such a manner that the pavement or joint material is not damaged or left in a condition that will mislead or misdirect the motorist. Repair any damage caused to the pavement, or joint materials caused by surface preparation or the removal of curing compound by acceptable methods and at no additional cost to the Department.

Where pavement surface preparation results in obscuring existing pavement markings of a lane occupied by traffic, immediately remove the residue, including dust, by approved methods.

**(G) Application of Pavement Markings**

**(1) General for all types of Pavement Markings**

Install pavement marking material that has a uniform thickness, a smooth surfaced cross section throughout its entire length, width and length not less than the dimensions specified in the plans and that does not exceed the dimension by more than 13 mm.

Do not apply pavement marking materials over a longitudinal joint. See Standard Drawing No. 1205.01 sheet 2 of 2 for details.

Install pavement marking lines that are straight or have uniform curvature and conform with the tangents, curves, and transitions as specified in the plans.

Produce finished lines that have well defined edges and are free of horizontal fluctuations. Do not exceed 13 mm in lateral deviation from the proposed location alignment at any point. Any greater deviations may be cause for requiring the material to be removed and replaced at no additional cost.

Apply all longitudinal pavement marking lines 203 mm or less in width with one pass of the pavement marking equipment. Pavement marking lines greater than 203 mm in width and pavement marking symbols may be applied with multiple passes of the pavement marking equipment

The stem portion of straight arrows shall be applied in a single pass and the stem portion of turn arrows is to be applied in a maximum of 2 passes of

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the application equipment. Arrowheads may be applied by multiple passes of the application equipment, not to exceed three passes.

Install all pavement marking lines, characters, and symbols that require multiple passes of the application equipment such that there are no gaps separating the application passes.

Install characters and symbols so that they conform to the sizes and shapes shown in the plans.

Use pavement marking material that is capable of accepting an overlay of compatible material.

Protect the pavement markings until they are track free. Remove any markings tracked by a vehicle by acceptable methods and at no additional expense to the Department.

Reapply any molten pavement marking that is crossed by a vehicle. Payment will only be made for 1 application of molten pavement marking.

Remove all pavement marking materials spilled on the road surface by acceptable methods at no additional expense to the Department.

Use yellow, white, and black pavement markings, without drop-on glass beads, that visually match the color chips that correspond to the Federal Test Standard Number 595a for the following colors. Use markings that when subjected to accelerated weathering as described in U.S. Federal Specification No. (TT-P-115F) are within the tolerance limits of the color chips listed below:

WHITE:	Color 17886
YELLOW:	Color 13538
BLACK:	Color 37038

### (2) Glass Bead/Element Application

Drop-On: Method where glass beads are dispensed by a pressurized mechanical feed or high pressure means onto the pavement marking as it is applied to the pavement. Drop-On bead dispensing for symbols and characters may be accomplished by gravitational methods such as hand scattering.

### (3) Maintenance

See *Construction Manual*, Section 12, for details.

## (H) Observation Period

Maintain responsibility for the pavement markings for a 180 day observation period beginning upon the satisfactory completion of all work required in the plans. Guarantee the markings under the payment and performance bond in accordance with Article 105-17.

Have traffic operating on the facility during the entire 180 day observation period unless otherwise directed.

During the 180 day observation period provide pavement marking material that shows no signs of failure due to blistering, excessive cracking, chipping, bleeding, staining, discoloration, oil content of the pavement materials, smearing or spreading under heat, deterioration due to contact with grease deposits, oil, diesel fuel, gasoline drippings, spilling, poor adhesion to the pavement materials, loss of reflectivity, vehicular damage, or normal wear.

Replace, at no additional expense to the Department, any pavement markings that do not perform satisfactorily under traffic during the 180 day observation.

**(I) Removal of Pavement Markings**

This work includes the removal of all types of pavement marking lines, symbols, and characters including removal for long life marking preparation. This work does not include removal of removable tape pavement markings.

Remove pavement marking lines, characters, and symbols by acceptable methods to the Engineer that will not materially or structurally damage the surface or the texture of the pavement. Leave the pavement surface in a condition that will not mislead or misdirect the motorist.

Where existing pavement markings are to be removed and replaced by other pavement markings, do not begin removal until adequate provisions have been made to complete the installation of the replacement markings. Remove pavement markings such that the surface is in proper condition for adequate bonding of the new markings. Promptly remove any material deposited on the pavement as a result of removing pavement markings as the work progresses by acceptable methods. Provide the equipment necessary to control dust and the accumulation of debris resulting from the removal process. The removal equipment shall provide dust control and the capture of the removed material shall be done utilizing a separate vacuum equipped vehicle or other approved system. Perform the recovery process within the same operation as the removal. Do not let traffic use the lane where the removal is taking place until the recovery system is finished. Should the recovery system fail, cease removal operations until the recovery system is properly operating. The Contractor is responsible for all cleanup and proper disposal of all removed debris from the project site.

When using a grinding method for pavement removal, the equipment shall have multiple heads working in tandem to provide adequate preparation of the surface to accept the new marking material.

Do not apply polyurea pavement markings over existing pavement marking materials having less adherence than the polyurea. Application over existing pavement marking materials other than polyurea will require the existing pavement marking material to be removed, so that a minimum of 85 percent of the existing pavement marking is removed. However, if pavement is less than 6 months old and one 0.38 mm application of paint was placed on the pavement initially, do not remove the existing paint pavement markings.

Do not apply thermoplastic pavement markings over existing pavement marking materials having less adherence than the thermoplastic. Application over existing pavement marking materials other than thermoplastic will require the existing pavement marking material to be removed so that a minimum of 85 percent of the existing pavement marking surface is removed. Before applying thermoplastic pavement markings over the existing thermoplastic pavement markings, remove a minimum of 25 percent of the oxidized existing thermoplastic. However, if pavement is less than 6 month old and one 0.38 mm application of paint was placed on the pavement initially, do not remove the existing paint pavement markings.

Use black color #37038 in paint or tape, as determined by Contractor, to cover any remaining conflicting pavement marking after removal from asphalt pavement surfaces. Do not use black paint or tape on concrete pavement surfaces. The black paint will not have a defined shape or edges with a width not exceeding double of the existing lines. No direct payment will be made for black paint or tape.

**(J) Pavement Marking Installer Qualifications**

Have at least one member of every pavement marking crew certified through the NCDOT Pavement Marking Technician Certification Process. Keep the certification current throughout the life of the project. The certified crewmember is not required to be the same person throughout the life of the contract.

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### 1205-4 THERMOPLASTIC (Alkyd/Maleic)

#### (A) Application Equipment

Use equipment to install hot thermoplastic pavement marking material that includes the following features:

Premelting Kettle: oil-jacketed or air-jacketed utilized for uniform heating and melting of the thermoplastic material. Use a kettle that is equipped with an automatic thermostat control device to provide positive temperature control and continuous mixing and agitation of the thermoplastic material. Do not premelt thermoplastic material in handliner type equipment.

Applicator Storage Kettle: Equip long line pavement marking vehicles with an automatic thermostat control device to maintain the thermoplastic material at the application temperature and provide continuous mixing and agitation of the thermoplastic material during installation. Construct the equipment so that all mixing and conveying parts, up to and including the application apparatus, maintains the thermoplastic pavement marking material at the specified installation temperature and which has a capacity of a minimum of 680 kg. of molten thermoplastic pavement marking material. Hand transfer is not allowed.

Hand Liner type application vehicles may contain the premelting and applicator storage functions in the same kettle. Agitation and mixing can be done manually. Drag box type and bucket type application is not allowed.

Use premelting and applicator storage kettles that meet the requirements of the National Board of Fire Underwriters, the National Fire Protection Association, and State and local authorities.

Use application equipment that is constructed to assure continuous uniformity in the thickness and width of the thermoplastic pavement marking.

Use application equipment that provides multiple width settings ranging from 102 mm to 305 mm and multiple thickness settings to achieve the pavement marking thickness ranging from 2.3 mm to 3.05 mm. Special thickness equipment may be required for in lane or shoulder transverse rumble strip pavement markings.

Do not use spray thermoplastic unless approved by the Work Zone Traffic Control Unit.

#### (B) Weather Limitations and Seasonal Limitations

Do not apply thermoplastic pavement markings on existing or new pavements unless the ambient air temperature and the temperature of the pavement is 10°C or higher.

Do not apply thermoplastic pavement markings between the dates specified below:

East of I-95	December 15 and the following March 16
East of I-77 to and including I-95	November 30 and the following April 1
West of and including I-77	November 15 and the following April 16

Exception to the above: When traffic is maintained on a portion of roadway and thermoplastic pavement marking will not be placed within 30 calendar days due to seasonal limitations, place pavement marking paint and beads in accordance with Subarticle 1205-8(C).

#### (C) Application

Use only thermoplastic markings that are of the hot, machine applied type. Apply Alkyd/Maleic thermoplastic pavement markings by extrusion methods only. Extrusion may be accomplished using either conventional extrusion equipment or ribbon gun extrusion devices.

Apply Drop-on Beads uniformly to the surface of the molten thermoplastic material so that the beads are partially embedded and at a rate to immediately obtain the minimum reflectance values. At the time of installation, produce in place markings with the minimum retroreflective values shown below, as obtained with a LTL 2000 Retroreflectometer or Department approved mobile retroreflectometer. Maintain the retroreflective values shown below for a minimum of 30 days from the time of placement of the marking material.

**White:**        **375 mcd/lux/m<sup>2</sup>**  
**Yellow:**       **250 mcd/lux/m<sup>2</sup>**

Ensure that the marking is uniformly retroreflective upon cooling and has the ability to resist deformation caused by traffic throughout its entire length.

A thin layer of pavement marking paint at the proper width may be placed prior to applying the thermoplastic markings. If this option is chosen, when not specified in the plans or by the Engineer, direct payment for the paint will not be made. Cover any such thin layer of pavement marking paint with thermoplastic pavement marking within 30 calendar days of placement. Apply the thin layer of pavement marking paint and beads at the rate necessary to produce a dry film thickness of 0.13 - 0.20 mils. Apply drop-on glass beads at a rate of 0.12 - 0.36 kg per liter of paint.

Provide drainage openings at intervals of 76.2 m in edge lines placed on the inside of curves and in edge lines on the low side of tangents. Provide openings that are a maximum of 305 mm and a minimum of 152 mm in length.

Produce a cross sectional thickness of the thermoplastic markings above the surface of the pavement as follows:

- 6.1 mm        In-lane and shoulder-transverse pavement markings (rumble strips) may be placed in 2 passes.
- 3.05 mm       Center lines, skip lines, transverse bands, mini-skip lines, characters, and crosswalk lines.
- 2.3 mm        Edge lines, gore lines, diagonals, and arrow symbols.

**(D) Observation Period:**

Retroreflective measurements will be taken within 30 days prior to the end of the 180 day observation period. Maintain minimum retroreflective values as shown below throughout the 180 day observation period.

**White:**        **325 mcd/lux/m<sup>2</sup>**  
**Yellow:**       **200 mcd/lux/m<sup>2</sup>**

At the end of the Observation Period, the thermoplastic pavement marking material shall be within 0.25 mm of the initial pavement marking thickness as required in the plan. Take the thickness measurements as specified by Materials and Tests Unit Procedure PM-1.0. See the *Construction Manual* for details.

**1205-5        POLYUREA**

**(A) Weather Limitations**

Do not apply polyurea pavement markings on existing or new pavements unless the ambient air temperature of the pavement is 4°C or higher.

**(B) Application**

Produce polyurea pavement marking lines that have a minimum dry thickness of 0.51 mm when placed on concrete and asphalt pavements.

Using the polyurea application equipment, apply the pavement marking materials simultaneously. Apply the polyurea resin, mixed at the proper ratio according to the manufacturer's recommendations, to the pavement surfaces within the proper application temperatures as determined by the material manufacturer. Inject

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reflective glass beads/elements into the molten (liquid) polyurea pavement markings.

Wait a minimum of 15 days before applying polyurea on new asphalt. Place a thin layer of pavement marking paint at the proper width prior to applying the polyurea markings during the 15 day waiting period. Apply the thin layer of pavement marking paint and beads at the rate necessary to produce a dry film thickness of 0.13 - 0.20 mm. Apply drop on beads at a rate of 0.12 – 0.36 kg/liter of paint. Direct payment for the pavement marking paint will not be made. Cover any such thin layer of paint with polyurea pavement marking within 30 calendar days of placement.

Apply glass beads/highly reflective elements according to manufacturer's recommendations. At the time of installation, maintain the retroreflective values shown below for a minimum of 30 days from the time of placement of marking material.

### **Standard Glass Beads**

White	375 mcd/lux/m <sup>2</sup>
Yellow	250 mcd/lux/m <sup>2</sup>

### **Highly Reflective Elements**

White:	800 mcd/lux/m <sup>2</sup>
Yellow:	500 mcd/lux/m <sup>2</sup>

Produce marking that, upon curing, is uniformly reflectorized and has the ability to resist deformation caused by traffic throughout its entire length.

The Contractor shall be certified by the manufacturer of the polyurea pavement marking material to install the manufacturer's material. Provide at least one member of each crew that completed this training. Furnish the Engineer written confirmation of the training from the material manufacturer prior to beginning work. Have the manufacturer's technical representative, or a manufacturer's certified representative, onsite during the entire installation of the product.

Provide a manufacturer's technical representative that is knowledgeable and familiar with the Contractor's application equipment prior to the installation of the polyurea pavement markings.

### **(C) Observation Period**

Retroreflective measurements will be taken within 30 days prior to the end of the 180 day observation period. Maintain minimum retroreflective values shown below throughout the 180 day observation period from the time of placement of the marking material.

### **Standard Glass Beads**

White:	325 mcd/lux/m <sup>2</sup>
Yellow:	200 mcd/lux/m <sup>2</sup>

### **Highly Reflective Elements**

White:	700 mcd/lux/m <sup>2</sup>
Yellow:	400 mcd/lux/m <sup>2</sup>

If polyurea with highly reflective elements is snowplowed during the 180 day observation period, the polyurea pavement marking materials shall meet the following minimum retroreflective values:

White:	375 mcd/lux/m <sup>2</sup>
Yellow:	250 mcd/lux/m <sup>2</sup>

## **1205-6 COLD APPLIED PLASTIC**

### **(A) Application Equipment**

Use mechanical application equipment, defined as a mobile pavement marking machine specifically designed for use in applying pressure sensitive pavement

marking tape of varying widths up to 305 mm. Use an applicator equipped with rollers to provide initial adhesion of the preformed, pressure sensitive marking tape with the pavement surface. Symbols and legends may be tamped by hand but shall be rolled with a weighted roller as per the manufacturer's recommendations. Tamp the Cold Applied Plastic pavement marking material with a 90.7 kg weighted roller as per the manufacturer recommendations.

Surface preparation adhesive may be required depending on the type of Cold Applied Plastic. Refer to the manufacturers' specifications before applying Cold Applied Plastic.

Most overlay tape installations should be conducted at an ambient air temperature of 16°C and rising and a surface temperature of 21°C with an overnight temperature a minimum of 4°C the night before application. Check the manufacturer's specifications for actual requirements. Install Cold Applied Plastic pavement markings at ambient air temperature and pavement surface temperature per manufacturer's specifications. Wait at least 24 hours after a rain before applying cold applied plastic pavement marking.

Cold Applied Plastic pavement markings shall be between 0.38 - 2.3 mm thick.

**(B) Types of Cold Applied Plastic**

At the time of installation, Cold Applied Plastic pavement markings shall meet the following:

**Type 1 – Permanent Standard Tape**

White	400 mcd/lux/m <sup>2</sup>
Yellow	300 mcd/lux/m <sup>2</sup>

Typically a 2 year life cycle permanent tape used on roadways with an ADT of 5000 or less.

**Type 2 – Permanent High Performance Tape**

White	500 mcd/lux/m <sup>2</sup>
Yellow	300 mcd/lux/m <sup>2</sup>

Material may come as one piece with a black border with yellow or white in the center. Typically a 5 year permanent tape used on roadways with an ADT greater than 5000.

**Type 3 – Permanent Wet Reflective High Performance Tape**

White:	500 mcd/lux/m <sup>2</sup> – Dry
	250 mcd/lux/m <sup>2</sup> – Wet
Yellow:	300 mcd/lux/m <sup>2</sup> – Dry
	250 mcd/lux/m <sup>2</sup> – Wet

Wet reflective tape shall meet the above retroreflective values both wet and dry. The value measured under wet conditions shall be measured in accordance with ASTM E1710 when using a portable retroreflectometer and in accordance with ASTM E2176 Condition of Continuous Wetting.

**Type 4 – Removable Tape**

White	700 mcd/lux/m <sup>2</sup>
Yellow	400 mcd/lux/m <sup>2</sup>

**1205-7 HEATED-IN-PLACE THERMOPLASTIC**

**(A) Application Equipment**

Apply Heated-In-Place Thermoplastic using a propane blow torch and other material as recommended by the manufacturer.

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### (B) Weather Limitations

Apply Heated-In-Place Thermoplastic only when ambient air temperature and pavement surface temperature is 0°C and rising.

### (C) Applications

Apply Heated-In-Place Thermoplastic per manufacturer's specifications. The manufacturer shall certify the Installer of Heated-In-Place Thermoplastic. See the *Construction Manual* for details.

The Contractor may choose to use Heated-In-Place Thermoplastic symbols, characters, and transverse lines in lieu of molten thermoplastics pavement markings at no additional cost to the Department.

Produce a cross sectional thickness of installed Heated-In-Place thermoplastic markings above the surface of the pavement after installation and upon cooling as follows:

6.1 mm In lane and shoulder transverse pavement markings rumble strips may be placed in 2 passes.

3.05 mm Center-lines, skip lines, transverse bands, mini-skip lines, characters, and crosswalk lines.

2.3 mm edge lines, gore lines, diagonals, and arrow symbols.

For initial minimum retroreflective value requirements, see Subarticle 1205-4(C).

### (D) Observation Period

See Subarticle 1205-4(D).

## 1205-8 PAINT

### (A) Application Equipment

The equipment to apply paint to pavements shall be a truck mounted pneumatic spray machine with suitable arrangements of atomizing nozzles and controls to obtain the specified markings. Paint pavement markings application equipment shall be capable of placing double solid lines, single solid lines, intermittent skip lines, or a combination of solid and intermittent skip lines in a single pass. This equipment shall also have an internal timing mechanism for measurement and controlled output of required line lengths.

The paint applicator equipment shall have at least two paint tanks with a minimum 227 liter capacity and one tank for glass beads with a minimum of 227 kg. capacity. The pneumatic spray guns used for hand held paint pavement marking application shall be operable from the application truck. All metal parts that hold or transfer paint pavement marking material shall be stainless steel. The paint trucks shall be equipped with quick action valves. The required gauges and pressure regulators shall be conveniently located and in full view and reach of the operator. Paint strainers are required in paint supply lines.

The paint applicator shall be equipped with a dispenser for the glass beads as described in Subarticle 1205-3(B)(2). Provide a glass bead dispenser that operates automatically and simultaneously with the paint applicator through the same mechanism and that is capable of adjustment and designed to provide uniform flow over the full length and width of the stripe as specified in Subarticle 1205-3(G)(2).

Provide pneumatic spray guns for hand application of detail markings, symbols, and legends. A hand operated push type applicator with a glass bead dispenser may be used of radii and/or parking spaces.

### (B) Weather Limitations

Apply paint only when the ambient air temperature and pavement surface temperatures are a minimum of 4°C and rising and a maximum of 71°C.

**(C) Application**

Final pavement marking applications of paint shall be placed in two applications of 0.38 mm wet each. Apply the second application of paint upon sufficient drying time of the first. Each application of paint shall consist of drop-on beads applied at a rate to immediately obtain the minimum retroreflective values. Take the thickness measurements as specified by Materials and Tests unit Procedure 1.0. See the *Construction Manual* for details.

When paint is required by the Engineer or Traffic Control Plan for temporary pavement markings during temporary traffic patterns, apply one application of paint at 0.38 mm wet. If the temporary traffic pattern will last longer than six months, apply a second application of paint six months after the initial application. Additional applications of paint at 0.38 mm wet may be applied every six months as directed by the Engineer or Traffic Control Plan.

For each 0.38 mm application of paint, apply drop-on beads uniformly to the surface of the paint material at a rate to immediately obtain the minimum retroreflective values. At the time of installation, produce in-place markings with the minimum retroreflective values shown below, as obtained with a LTL 2000 Retroreflectometer or Department approved 30 m mobile retroreflectometer. Maintain the retroreflective values shown below for a minimum of 30 days from the time of placement of the marking material.

White	225 mcd/lux/m <sup>2</sup>
Yellow	200 mcd/lux/m <sup>2</sup>

Make sure that the marking is uniformly retroreflectorized upon drying.

**(D) Observation Period**

Measurements will be taken within 30 days prior to the end of the 180 day Observation Period. Maintain minimum retroreflective values shown below for a minimum of 180 days from the time of placement of the marking material.

White:	200 mcd/lux/m <sup>2</sup>
Yellow:	180 mcd/lux/m <sup>2</sup>

**1205-9 MAINTENANCE**

Replace pavement markings that prematurely deteriorate, fail to adhere to the pavement, lack reflectorization, or are otherwise unsatisfactory, during the life of the project or during the 180 day observation period as determined by the Engineer at no cost to the Department.

Upon notification from the Engineer, winterize the existing pavement markings on the project by placing an additional application of markings. The markings shall be suitable for use in winter periods whether in a temporary or final pattern. Payment will be made under the pay item for the type of marking placed.

**1205-10 MEASUREMENT AND PAYMENT**

*Pavement Marking Lines* will be measured and paid for as the actual number of linear meters of pavement marking lines that have been satisfactorily placed and accepted by the Engineer. The quantity of solid lines will be the summation of the linear meters of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear meters derived by multiplying the nominal length of a line by the number of marking lines satisfactorily placed.

*Pavement Marking Symbols* will be measured and paid for as the actual number of pavement marking symbols that have been satisfactorily placed and accepted by the Engineer.

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*Pavement Marking Characters* will be measured and paid for as the actual number of characters satisfactorily placed and accepted by the Engineer. A character is considered to be one letter or one number of a word message.

*Removal of Pavement Marking Lines* will be measured and paid for as the actual number of linear meters of pavement marking lines that have been satisfactorily removed and accepted by the Engineer. The quantity of solid lines will be the summation of the linear meters of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear meters derived by multiplying the nominal length of a line by the number of marking lines satisfactorily removed. No payment will be made for the removal of removable pavement marking tape.

*Removal of Pavement Marking Symbols & Characters* will be measured and paid for as the actual number of pavement marking symbols and characters that have been satisfactorily removed and accepted by the Engineer.

*Curing Compound Removal, Lines* will be measured and paid for as the actual number of linear meters of pavement surface from which the curing compounds are satisfactorily removed. Measurement will be made along the surface of the pavement.

*Curing Compound Removal, Symbols & Characters* will be measured and paid for as the actual number of symbols and characters for which the curing compound has been satisfactorily removed.

Payment at the contract unit price for the various items in the contract will be full compensation for all the items covered by this section. No direct payment will be made for: the work involved in applying the lines, including surface preparation; reapplication of molten pavement marking crossed by a vehicle; and removal of all pavement marking materials spilled on the roadway surface.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Paint Pavement Marking Lines, __mm	Linear Meter
Thermoplastic Pavement Marking Lines, __mm, __mils	Linear Meter
Polyurea Pavement Marking Lines; __mm	Linear Meter
Cold Applied Plastic Pavement Marking Lines, Type __ ( __mm):	Linear Meter
Heated-In-Place Thermoplastic Pavement Marking Lines, __mm, __mils	Linear Meter
Paint Pavement Marking Symbols	Each
Thermoplastic Pavement Marking Symbols, __mils:	Each
Polyurea Pavement Marking Symbols	Each
Cold Applied Plastic Pavement Marking Symbols, Type ____	Each
Heated-In-Place Thermoplastic Pavement Marking Symbols, __mils	Each
Paint Pavement Marking Characters	Each
Thermoplastic Pavement Marking Characters, __mils	Each
Polyurea Pavement Marking Characters	Each
Cold Applied Plastic Pavement Marking Characters, Type ____	Each
Heated-In-Place Pavement Marking Characters __mils	Each
Removal of Pavement Marking Lines, __mm	Linear Meter
Removal of Pavement Marking Symbols & Characters	Each
Curing Compound Removal, Lines	Linear Meter
Curing Compound Removal, Symbols & Characters	Each

**SECTION 1250  
GENERAL REQUIREMENTS FOR PAVEMENT MARKERS**

**1250-1 DESCRIPTION**

Furnish and place pavement markers in accordance with the contract.

**1250-2 MATERIALS****(A) General**

Refer to Division 10.

<b>Item</b>	<b>Section</b>
Pavement Markers	1086

**(B) Material Qualifications**

Use pavement markers that are on the Department's Approved Products List, are traffic qualified by the Traffic Control Unit and have been evaluated by NTPEP.

**(C) Historical Performance**

Historical performance of the pavement markers will be used in determining future use of the pavement markers by the Department, even if the pavement markers have been traffic qualified. Poor past or poor current performance of pavement markers at any site, whether or not related to a specific contract may be grounds for nonacceptance of a product on any project under contract.

**1250-3 CONSTRUCTION METHODS****(A) Weather Limitations**

Do not install pavement markers or replacement reflectors if moisture tests performed on the pavement indicate the presence of moisture on the pavement surface or on the pavement marker. Install all pavement marker adhesives as required by the manufacturer's specifications for weather and temperature limitations.

**(B) Preparing for installation**

Ensure that the pavement, pavement markers, and replacement lens are free of dirt, dust, oil, grease, moisture, curing compound, loose or unsound layers, or any other material that would interfere with proper bonding of the marker to the pavement or the lens to the marker. Use methods approved by the Engineer for this preparation.

**(C) Removal of Existing Pavement Markers**

Remove existing pavement markers prior to overlaying an existing roadway with pavement. Repair the pavement by filling holes as directed. When traffic patterns are changed, remove pavement markers that conflict with the new traffic pattern prior to switching traffic to the new traffic pattern.

Properly dispose of the removed pavement markers. No direct payment will be made for removal of existing pavement markers or repair of pavement, as such work will be considered incidental to other items in the contract.

**(D) Installation****(1) General**

Install all pavement markers and adhesives per manufacturer's specifications.

**(2) Color**

Ensure that the color of the reflector corresponds to the pavement marking that the marker supplements. Red reflectors may be required in combination with crystal or yellow reflectors to indicate wrong way movement when viewed in the direction opposing the flow of traffic.

**Section 1250**

(3) Appearance

Remove any adhesive from the reflective lens of the marker; otherwise, replace the reflector lenses of a snowplowable pavement marker or the entire raised pavement marker.

(4) Spacing

Space pavement markers as shown in the plans. Position pavement marker lenses perpendicular to the flow of traffic as shown in the Standard Drawings. Adjust marker longitudinal spacing up to 305 mm in either direction and/or adjust marker lateral spacing up to 76 mm to avoid installation of the marker at a pavement construction joint or surface defect. If a marker can not be relocated as described above, do not install the affected marker.

**(E) Pavement Marker Installer Qualifications**

Have at least one member of every pavement marker crew certified through the NCDOT Pavement Marking Technician Certification Process. Keep the certification current throughout the life of the project. The certified crewmember is not required to be the same person throughout the life of the contract.

**SECTION 1251  
RAISED PAVEMENT MARKERS**

**1251-1 DESCRIPTION**

Furnish, install, maintain and remove temporary and permanent raised pavement markers in accordance with the contract.

**1251-2 MATERIALS**

Refer to Division 10.

<b>Item</b>	<b>Section</b>
Temporary Raised Pavement Markers	1086-1
Permanent Raised Pavement Markers	1086-2

**1251-3 CONSTRUCTION METHODS**

Install temporary raised pavement markers on the nonfinal pavement surfaces with epoxy, pressure sensitive adhesives or hot bitumen adhesives.

Install permanent raised pavement markers using a hot bitumen adhesive in accordance with Article 1081-7.

On final pavement surfaces, install temporary raised pavement markers using a pressure sensitive adhesive or hot bitumen adhesive. When using a pressure sensitive adhesive, install a primer/sealer when required by the manufacturer's specifications.

**1251-4 MAINTENANCE**

Maintain all installed temporary raised pavement markers. Replace all damaged or missing temporary raised pavement markers if any of the following occurs:

Three segment failures occur in any roadway section. Three consecutive damaged or missing markers in any group of seven represents a segment failure.

Twenty percent of the markers in any roadway section are damaged or missing.

Engineer determines replacement is necessary.

Replace markers from the time of the initial installation up to 180 days at no cost to the Department. After 180 days, any marker replacement not caused by the Contractor's negligence or material failure will be paid for in accordance with Article 1251-5.

Maintain all installed permanent raised pavement markers prior to acceptance.

**1251-5 MEASUREMENT AND PAYMENT**

*Temporary Raised Pavement Markers* will be measured and paid for as the actual number of temporary raised pavement markers that have been satisfactorily placed and accepted by the Engineer.

*Permanent Raised Pavement Markers* will be measured and paid for as the actual number of permanent raised pavement markers that have been satisfactorily placed and accepted by the Engineer.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Temporary Raised Pavement Markers	Each
Permanent Raised Pavement Markers	Each

**SECTION 1253  
SNOWPLOWABLE PAVEMENT MARKERS**

**1253-1 DESCRIPTION**

Furnish, install and maintain snowplowable pavement markers in accordance with the contract.

**1253-2 MATERIALS.**

Refer to Division 10.

<b>Item</b>	<b>Section</b>
Snowplowable Pavement Markers	1086-3

**1253-3 CONSTRUCTION METHODS****(A) General**

Bond marker castings to the pavement with epoxy adhesive. Mechanically mix and dispense epoxy adhesives as required by the manufacturer's specifications. Place the markers immediately after the adhesive has been mixed and dispensed.

Install snowplowable pavement marker castings into slots sawcut into the pavement. Make slots in the pavement to exactly duplicate the shape of the casting of the snowplowable pavement markers.

Promptly remove all debris resulting from the saw cutting operation from the pavement surface. Install the marker castings within 7 calendar days after sawcutting slots in the pavement. Remove and dispose of loose material from the slots by brushing, blow cleaning, or vacuuming. Dry the slots prior to applying the epoxy adhesive. Fill the cleaned slots totally with epoxy adhesive flush with the surface of the existing pavement. Install snowplowable pavement markers according to the manufacturer's recommendations.

Protect the snowplowable pavement markers until the epoxy has initially cured and is track free.

**(B) Reflector Replacement**

In the event that a reflector is damaged, replace the damaged reflector by using adhesives and methods recommended by the manufacturer of the markers and approved by the Engineer. This work is considered incidental to the installation and maintenance of snowplowable markers specified in this section.

**Recycled Snowplowable Pavement Marker Castings**

Use properly refurbished snowplowable pavement marker castings as approved by the Engineer such that approved new reflectors can be installed inside the castings.

**1253-4 MAINTENANCE**

Maintain all installed snowplowable raised pavement markers prior to acceptance.

**Section 1253**

**1253-5 MEASUREMENT AND PAYMENT**

*Snowplowable Pavement Markers* will be measured and paid for as the actual number of snowplowable pavement markers satisfactorily placed and accepted by the Engineer.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Snowplowable Pavement Marker	Each

**SECTION 1264  
OBJECT MARKERS**

**1264-1 DESCRIPTION**

Furnish and install object markers in accordance with the contract.

**1264-2 MATERIALS**

Refer to Division 10.

<b>Item</b>	<b>Section</b>
Object markers	1088-5
U-channel posts	1094-1(B) & (C)
Joint Sealer	1028-2

**1264-3 CONSTRUCTION METHODS**

Use Type 1 object markers to mark obstructions within the roadway. Mount on sign supports to supplement a sign, or mount individually on 7' U-channel posts, or mount on the actual obstruction.

Use Type 2 object markers to mark obstructions that are not in the roadway. Mount Type 2 Object Markers on the back of sign supports located in the median of divided roadways, and the outside of two-lane, two-way roadways where the sign is facing the opposing traffic direction. Place Type 2 object markers on the side nearest the traffic approaching the back of the sign supports. If guardrail is used to protect the sign supports, or where two signs are mounted back to back, Type 2 object markers are not required.

Use Type 3 object markers to mark larger obstructions within or outside the roadway, such as bridge piers, abutments and rails, culvert headwalls, or narrow shoulder drop-offs. Have the stripes slope downward toward the side of the obstruction on which traffic is to pass. They may be required to be mounted on the actual obstruction or individually on 2.1 m U- channel posts.

Mount End of Road object markers on 2.1 m U-channel posts at the end of a roadway where there is no alternate vehicular path.

**1264-4 MEASUREMENT AND PAYMENT**

*Object Markers (Type\_\_ )* will be measured and paid for as the actual number of object markers satisfactorily placed and accepted by the Engineer

*2.1 m U-Channel Posts* will be measured and paid for as the actual number of 2.1 m U-Channel posts satisfactorily placed and accepted by the Engineer.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Object Markers (Type 1)	Each
Object Markers (Type 2)	Each
Object Markers (Type 3)	Each
Object Markers (End of Road)	Each
2.1 m U-Channel Posts	Each

**SECTION 1266  
TUBULAR MARKERS (FIXED)**

**1266-1 DESCRIPTION**

Furnish, install, relocate, maintain and remove tubular markers in accordance with the contract.

**1266-2 MATERIALS**

Refer to Division 10.

<b>Item</b>	<b>Section</b>
Tubular Markers	1088-7

**1266-3 CONSTRUCTION METHODS**

Secure tubular markers to the pavement surfaces using epoxy or other approved types of adhesives.

Use tubular markers affixed to pavement surfaces as a supplement to pavement markings to channelize traffic. Use tubular marker such that the color of the tubular marker and retroreflective sheeting would match the color of the pavement markings they supplement, except as noted below:

- Use orange tubular markers with white and crystal retroreflective sheeting on top of asphalt islands as shown in the plans.
- Use orange tubular markers affixed to pavement surfaces with white and crystal retroreflective sheeting to separate opposing traffic placed on one side of a 4 lane divided highway.
- Gray tubular markers with white/crystal retroreflective sheeting may be used to supplement white pavement markings.

**1266-4 MAINTENANCE**

Inspect and replace any worn out tubular markers at no cost to the Department.

Inspect and replace all damaged or missing tubular markers if any of the following occurs in accordance with Article 1266-5:

Three segment failures occur in any roadway section. Two consecutive damaged or missing tubular markers in any group of seven represents a segment failure

Twenty percent of the total numbers of tubular markers in any roadway section are damaged or missing.

Engineer determines replacement is necessary.

**1266-5 MEASUREMENT AND PAYMENT**

*Tubular Markers (Fixed)* will be measured and paid for as the maximum number of tubular markers satisfactorily placed and accepted by the Engineer at any one time during the life of the project.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Tubular Markers (Fixed)	Each

**SECTION 1267  
FLEXIBLE DELINEATORS**

**1267-1 DESCRIPTION**

Furnish and install flexible delineators in accordance with the contract.

**1267-2 MATERIALS**

Refer to Division 10.

<b>Item</b>	<b>Section</b>
Flexible Delineators	1088-8

**1267-3 CONSTRUCTION METHODS**

Use yellow, red, or crystal retroreflective sheeting as shown in the plans. Place the retroreflective sheeting on the front and back of the delineator post as required by the plans.

Install the delineator post so that the entire width of the retroreflective sheeting is visible to approaching traffic.

Install the delineator post so the top of the reflective sheeting is 1.2 m above the near edge of roadway surface.

Install the delineator post and base support according to the manufacturer's specifications.

Install the flexible delineators plumb on all sides.

Provide a post such that both sides of the top of the post accepts, and holds securely, retroreflectorized sheeting. The color of the post shall be gray.

Install the post such that the post length provides for adequate ground penetration for proper performance.

Attach the flexible delineator post to the base support using 2 hex head bolts, flat washers, lock washers and deformed thread hex nuts. Tighten the bolts to a minimum 2.77 kg-m torque.

Position delineators perpendicular to the centerline of the road. Use yellow delineators in median and on the left side of one-way ramps, loops, or other one-way facilities. Use crystal delineators on the right side of divided highways, ramps, loops and all other one-way or two-way facilities. In all cases, use delineators whose colored retroreflective sheeting supplements the color of the adjacent edgeline

Design the delineator post for a permanent installation to resist overturning, twisting, and displacement from wind and impact forces.

**1267-4 MAINTENANCE**

Maintain all installed flexible delineators prior to acceptance.

**1267-5 MEASUREMENT AND PAYMENT**

*Flexible Delineators (color)* will be measured and paid for as the actual number of flexible delineators that have been satisfactorily installed and accepted by the Engineer.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
Flexible Delineator (Crystal)	Each
Flexible Delineator (Yellow)	Each
Flexible Delineator (Crystal & Red)	Each
Flexible Delineator (Yellow & Red)	Each