

**NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH**

**STANDARD SPECIFICATIONS
FOR
ROADS AND STRUCTURES**



JANUARY 2012

FOREWORD

This publication has been prepared to provide a compilation of standard requirements used by the North Carolina Department of Transportation for construction contracts.

When this publication, entitled *Standard Specifications for Roads and Structures*, dated January 2012, is incorporated by reference into the Department's construction bid proposals or contracts; it is made a part of that document and shall be known as the *Standard Specifications*. The requirements stated herein may be revised or amended from time to time by Supplemental Specifications, by Standard Special Provisions which are unique to a select group of projects or by Project Special Provisions which are unique to the specific bid proposal or contract.

Working titles have a masculine gender, such as workman, workmen and foreman. Pronouns such as he, his, and him are used in the *Standard Specifications* for the sake of brevity and are intended to refer to persons of either sex and corporate entities.

Reference by title and date will be made to the governing provisions on plans and contract documents.

GENERAL INFORMATION

For general questions about this publication, please contact the Contract Standards and Development Unit at specs@ncdot.gov or (919) 707-6900.

ORDERING INFORMATION

Copies of the *Standard Specifications* and the *Roadway Standard Drawings* may be purchased through the Contract Standards and Development Unit:

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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.

| Item | Section |
|-------------------|----------------|
| Pavement Markings | 1087 |

(B) Material Qualifications

Use pavement markings that are on the NCDOT Approved Products List.

(C) Performance

Poor 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 1,000 ft.

(A) Testing Procedures

All pavement marking materials and placement will be tested by the Department. Install pavement markings in order to meet the retroreflectivity requirements as measured by a Department approved 30 m mobile or handheld 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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- 1 Spread the beads/elements uniformly over the entire surface of the pavement
2 marking material such that they are partially embedded in the pavement marking.
3 A 60% bead embedment depth provides optimum retroreflectivity.

4 (C) Weather Limitations and Seasonal Limitations for All Markings

- 5 Do not place pavement markings when moisture tests conducted on the pavement show
6 signs of moisture presence on the pavement or when it is anticipated that damage caused
7 by moisture may occur during the installation and drying periods.

8 (D) Time Limitations for Replacement

| TABLE 1205-1 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 | 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, Stop bars, and school symbols | By the end of each workday's operation if the lane is opened to traffic (temporary paint with beads may be used) |
| | Edge Lines, gore lines and all other symbols | By the end of the 3rd calendar day after obliteration |
| Two-lane, two-way roadways | All centerline markings, railroad, Stop bars and school symbols | By the end of the 5th calendar day after obliteration |
| | Edge Lines and all other symbols | By the end of the 15th calendar day after obliteration |

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

11 (E) Premarking/Interim/Temporary Markings

- 12 Premarking (or layout markings) are small paint spots used by striping contractors to
13 establish locations of pavement markings. Premark each installation of the final
14 pavement marking materials before application on new pavement and when required to
15 replace existing pavement marking, except when existing markings are visible. Get the
16 premarking inspected and approved by the Engineer before placing the pavement
17 marking materials.

- 18 Interim paint is a thin layer of pavement marking paint applied at the striping contractor's
19 option to maintain traffic, instead of durable pavement markings. Apply interim paint to
20 comply with time limitations for placement if final pavement markings cannot be placed.
21 Interim markings shall be no more than 1/4" less than the specified line width of the
22 existing markings.

- 23 Place temporary paint markings for detours, lane shifts, milled surfaces and lifts of
24 asphalt other than the final pavement surface.

- 25 Review and record the existing pavement markings before resurfacing and reestablish the
26 new pavement markings using the record of existing markings in conjunction with the
27 *Roadway Standard Drawings*, unless otherwise directed. Submit the record of the
28 existing pavement markings 7 calendar days before the obliteration of any pavement
29 markings.

(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 before implementing.

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

Prepare the pavement surface, including removal of curing compound, at least 2" wider than the pavement markings to be placed, such that, an additional 1" 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 blasting or grinding methods. Ensure that the surface is free of all residue, laitance and debris before applying the pavement marking. When surface preparation and curing compound removal operations are completed, blow the pavement surface clean by compressed air immediately before installing the pavement markings.

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 at least 2" wider than the pavement markings in such a way as not to cause any noticeable change in the appearance of the pavement markings.

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, 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 1/2".

Do not apply pavement marking materials over a longitudinal joint. See *Roadway Standard Drawings* No. 1205.01, Sheet 2 of 2 for details.

Install pavement marking lines that are straight or have uniform curvature and conform to 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 1/2" 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 8" or less in width with one pass of the pavement marking equipment. Pavement marking lines greater than 8" in width and pavement marking symbols may be applied with multiple passes of the pavement marking equipment.

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

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

6 Protect the pavement markings until they are track free. Repair any markings
7 tracked by a vehicle by acceptable methods.

8 Remove all pavement marking materials spilled on the road surface by acceptable
9 methods.

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

White: Color No. 17886

Yellow: Color No. 13538

Black: Color No. 37038

15 (2) Glass Bead/Element Application

16 "Drop-on" is the method where glass beads are dispensed by a pressurized
17 mechanical feed or high pressure means onto the pavement marking as it is applied
18 to the pavement. Drop-on bead dispensing for symbols stop bars and characters may
19 be accomplished by gravitational methods.

20 **(H) Observation Period**

21 Maintain responsibility for debonding and color of the pavement markings during
22 a 12 month observation period beginning upon final acceptance of the project as defined
23 under Article 105-17. Guarantee the markings under the payment and performance bond
24 in accordance with Article 105-17.

25 During the 12 month observation period, provide pavement marking material that shows
26 no signs of failure due to blistering, chipping, bleeding, discoloration, smearing or
27 spreading under heat or poor adhesion to the pavement materials. Pavement markings
28 that bonded during application and were approved, but debond due to snowplowing will
29 not be considered a failed marking. Replace, at no additional expense to the Department,
30 any pavement markings that do not perform satisfactorily under traffic during the
31 12 month observation period.

32 **(I) Removal of Pavement Markings**

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

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

40 Where existing pavement markings are to be removed and replaced by other pavement
41 markings, do not begin removal until adequate provisions have been made to complete
42 the installation of the replacement markings. Remove pavement markings such that the
43 surface is in proper condition for adequate bonding of the new markings.
44 Promptly remove any material deposited on the pavement as a result of
45 removing pavement markings as the work progresses by acceptable methods.

1 Provide the equipment necessary to control dust and the accumulation of debris resulting
 2 from the removal process. The removal equipment shall provide dust control and the
 3 capture of the removed material shall be done using a separate vacuum equipped vehicle
 4 or other approved system. Perform the recovery process within the same operation as the
 5 removal. Do not let traffic use the lane where the removal is taking place until the
 6 recovery system is finished. Should the recovery system fail, cease removal operations
 7 until the recovery system is properly operating. The Contractor is responsible for all
 8 cleanup and proper disposal of all removed debris from the project site.

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

12 Do not apply polyurea pavement markings over existing pavement marking materials.
 13 Polyurea may be installed over existing polyurea only on asphalt as long as the existing
 14 polyurea is bonded. Application over all other existing pavement marking materials will
 15 require at least 95% of the existing pavement marking material to be removed. However,
 16 if one 15 mil application of paint was placed on asphalt pavement less than 6 month old,
 17 do not remove the existing paint pavement markings.

18 Do not apply thermoplastic pavement markings over existing pavement marking
 19 materials. Thermoplastic may be installed over existing thermoplastic on asphalt.
 20 Application over existing pavement marking materials other than thermoplastic will
 21 require the existing pavement marking material to be removed so that at least 85% of the
 22 existing pavement marking surface is removed. Before applying thermoplastic pavement
 23 markings over the existing thermoplastic pavement markings, remove at least 25% of the
 24 oxidized existing thermoplastic. However, if one 15 mil application of paint was placed
 25 on asphalt pavement less than 6 month old, do not remove the existing paint pavement
 26 markings.

27 Use black color #37038 in paint or tape, as determined by Contractor, to cover any
 28 remaining conflicting pavement marking after removal from asphalt pavement surfaces.
 29 Do not use black paint or tape on concrete pavement surfaces. The black paint will not
 30 have a defined shape or edges with a width not exceeding double of the existing lines.

31 **(J) Pavement Marking Installer Qualifications**

32 Ensure at least one member of every pavement marking crew is certified through the
 33 NCDOT Pavement Marking Technician Certification Process. Keep the certification
 34 current throughout the life of the project. A certified crewmember shall be present
 35 anytime this work is being performed. The certified crewmember is not required to be
 36 the same person throughout the life of the contract.

37 **1205-4 THERMOPLASTIC (ALKYD/MALEIC)**

38 **(A) Application Equipment**

39 **(1) General**

40 Use application equipment constructed to assure continuous uniformity in the
 41 thickness and width of the thermoplastic pavement marking. Use application
 42 equipment that provides multiple width settings ranging from 4" to 12" and multiple
 43 thickness settings to achieve the pavement marking thickness ranging from 0.090" to
 44 0.120". Special thickness equipment may be required for in lane or shoulder
 45 transverse rumble strip pavement markings.

46 Do not use spray thermoplastic unless approved by the Signing and Delineation Unit.

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1 (2) Premelting Kettle

2 Use equipment to install hot thermoplastic pavement marking material that includes
3 an oil-jacketed or air-jacketed premelt kettle for uniform heating and melting of the
4 thermoplastic material. Use a kettle that is equipped with an automatic thermostat
5 control device to provide positive temperature control and continuous mixing and
6 agitation of the thermoplastic material. Do not premelt thermoplastic material in
7 handliner type equipment.

8 (3) Applicator Storage Kettle

9 Equip long line pavement marking vehicles with an automatic thermostat control
10 device to maintain the thermoplastic material at the application temperature and
11 provide continuous mixing and agitation of the thermoplastic material during
12 installation. Construct the equipment so that all mixing and conveying parts, up to
13 and including the application apparatus, maintains the thermoplastic pavement
14 marking material at the specified installation temperature and which has a capacity
15 of at least 1,500 lb of molten thermoplastic pavement marking material. Hand
16 transfer is not allowed.

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

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

23 (B) Weather Limitations and Seasonal Limitations

24 Do not apply thermoplastic pavement markings on existing or new pavements unless the
25 ambient air temperature and the temperature of the pavement is 50°F or higher.

26 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 |

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

31 (C) Application

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

36 The stem portion of straight arrows shall be applied in a single pass and the stem portion
37 of turn arrows is to be applied in no more than 2 passes of the application equipment.
38 Arrowheads may be applied by multiple passes of the application equipment, not to
39 exceed 3 passes.

40 Apply drop-on beads uniformly to the surface of the molten thermoplastic material so the
41 beads are partially embedded and at a rate to immediately obtain the minimum
42 reflectance values. Produce in place markings with minimum retroreflective values
43 shown in Table 1205-2, as obtained with a Department approved 30 m mobile or
44 handheld retroreflectometer. Retroreflective measurements will be taken within 30 days
45 after final placement of the pavement marking.

**TABLE 1205-2
REFLECTOMETER REQUIREMENTS
FOR THERMOPLASTIC**

| Item | Color | Reflectivity |
|----------------------|--------|----------------------------|
| Standard Glass Beads | White | 375 mcd/lux/m ² |
| | Yellow | 250 mcd/lux/m ² |

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

3 A thin layer of interim pavement marking paint at the proper width may be placed before
4 installing the thermoplastic markings. If this option is chosen, when not specified in the
5 plans or by the Engineer, direct payment for the paint will not be made. Cover any such
6 thin layer of pavement marking paint with thermoplastic pavement marking within
7 30 calendar days of placement. Apply the thin layer of pavement marking paint and
8 beads at the rate necessary to produce a dry film thickness of 5 to 8 mils. Apply drop-on
9 glass beads at a rate of 1 to 3 lb/gal of paint.

10 Provide drainage openings at intervals of 250 ft in edge lines placed on the inside of
11 curves and in edge lines on the low side of tangents. Provide openings that are no more
12 than 12" and at least 6" in length.

13 Produce a cross-sectional thickness of the thermoplastic markings above the surface of
14 the pavement in accordance with Table 1205-3.

**TABLE 1205-3
THICKNESS REQUIREMENTS**

| Thickness | Location |
|-----------|--|
| 240 mils | In-lane and shoulder-transverse pavement markings (rumble strips) may be placed in 2 passes. |
| 120 mils | Center lines, skip lines, transverse bands, mini-skip lines, characters and crosswalk lines. |
| 90 mils | Edge lines, gore lines, diagonals and arrow symbols. |

15 **(D) Observation Period**

16 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
17 minimum retroreflective values for a 30-day period beginning upon the Engineer's
18 acceptance of all markings on the project. Guarantee retroreflective values of the
19 markings during the 30-day period under the payment and performance bond in
20 accordance with Article 105-17.

21 **1205-5 POLYUREA**

22 **(A) Weather Limitations**

23 Do not apply polyurea pavement markings on existing or new pavements unless the
24 ambient air temperature and the temperature of the pavement is 40°F or higher.

25 **(B) Application**

26 Produce polyurea pavement marking lines that have a minimum dry thickness of 20 mils
27 when placed on concrete and asphalt pavements.

28 Using the polyurea application equipment, apply the pavement marking materials
29 simultaneously. Apply the polyurea resin, mixed at the proper ratio according to the
30 manufacturer's recommendations, to the pavement surfaces within the proper application
31 temperatures as determined by the material manufacturer. Inject reflective glass
32 beads/elements into the molten (liquid) polyurea pavement markings.

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1 Wait at least 15 days before applying polyurea on new asphalt. Place a thin layer of
 2 pavement marking paint at the proper width before applying the polyurea markings
 3 during the 15 day waiting period. Apply the thin layer of pavement marking paint and
 4 beads at the rate necessary to produce a dry film thickness of 5 to 8 mils. Apply drop-on
 5 beads at a rate of 1 to 3 lb/gal of paint. Direct payment for the pavement marking paint
 6 will not be made. Cover any such thin layer of paint with polyurea pavement marking
 7 within 30 calendar days of placement. If paint is placed on concrete before applying
 8 polyurea, remove 100% of the paint before installing polyurea. Payment for the paint and
 9 removal shall be made under Article 1205-10.

10 Apply drop-on beads and/or highly reflective elements uniformly to the surface of the
 11 polyurea material so that the beads are partially embedded and at a rate to immediately
 12 obtain the minimum reflectance values. Produce in place markings with minimum
 13 retroreflective values shown in Table 1205-2, as obtained with a Department approved
 14 30 m mobile or handheld retroreflectometer. Retroreflective measurements will be taken
 15 within 30 days after final placement of the pavement marking.

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

18 The Contractor shall be certified by the manufacturer of the polyurea pavement marking
 19 material to install the manufacturer’s material. Provide at least one member of each crew
 20 that completed this training. Furnish the Engineer written confirmation of the training
 21 from the material manufacturer before beginning work. Ensure the manufacturer’s
 22 technical representative, or the manufacturer’s certified representative, is onsite during
 23 the entire installation of the product.

24 **(C) Observation Period**

25 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
 26 minimum retroreflective values for a 30-day period beginning upon the Engineer’s
 27 acceptance of all markings on the project. Guarantee retroreflective values of the
 28 markings during the 30-day period under the payment and performance bond in
 29 accordance with Article 105-17.

| TABLE 1205-4 REFLECTOMETER REQUIREMENTS FOR THERMOPLASTIC | | |
|--|--------------|----------------------------|
| Item | Color | Reflectivity |
| Standard Glass Beads | White | 375 mcd/lux/m ² |
| | Yellow | 250 mcd/lux/m ² |
| Highly Reflective Elements | White | 800 mcd/lux/m ² |
| | Yellow | 500 mcd/lux/m ² |

30 If polyurea with highly reflective elements is snowplowed during the 30 day period, the
 31 polyurea pavement marking materials shall meet the minimum retroreflective values in
 32 Table 1205-5.

| TABLE 1205-5 REFLECTOMETER REQUIREMENTS FOR THERMOPLASTIC | | |
|--|--------------|----------------------------|
| Item | Color | Reflectivity |
| Highly Reflective Elements | White | 375 mcd/lux/m ² |
| | Yellow | 250 mcd/lux/m ² |

1 **1205-6 COLD APPLIED PLASTIC**

2 **(A) Application Equipment**

3 Use mechanical application equipment, defined as a mobile pavement marking machine
4 specifically designed for use in applying pressure sensitive pavement marking tape of
5 varying widths up to 12". Use an applicator equipped with rollers to provide initial
6 adhesion of the preformed, pressure sensitive marking tape with the pavement surface.
7 Symbols and legends may be tamped by hand but shall be rolled with a weighted roller as
8 per the manufacturer's recommendations. Tamp the cold applied plastic pavement
9 marking material with a 200 lb weighted roller as per the manufacturer recommendations.

10 Surface preparation adhesive may be required depending on the type of cold applied
11 plastic. Refer to the manufacturers' specifications before applying cold applied plastic.

12 Most overlay tape installations should be conducted at an ambient air temperature of
13 60°F and rising and a surface temperature of 70° F with an overnight temperature at
14 least 40°F the night before application. Check the manufacturer's specifications for
15 actual requirements. Install cold applied plastic pavement markings at ambient air
16 temperature and pavement surface temperature per manufacturer's specifications. Wait
17 at least 24 hours after a rain before applying cold applied plastic pavement marking.

18 Cold applied plastic pavement markings shall be between 15 to 90 mils thick.

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

20 At the time of installation, cold applied plastic pavement markings shall meet
21 Table 1205-4.

| Type | Color | Reflectivity |
|--|--------|----------------------------|
| Type 1 - Permanent Standard Tape | White | 400 mcd/lux/m ² |
| | Yellow | 300 mcd/lux/m ² |
| Type 2 - Permanent High Performance Tape | White | 500 mcd/lux/m ² |
| | Yellow | 300 mcd/lux/m ² |
| Type 3 - Permanent Wet Reflective High Performance Tape (Wet) | White | 250 mcd/lux/m ² |
| | Yellow | 250 mcd/lux/m ² |
| Type 3 - Permanent Wet Reflective High Performance Tape (Dry) | White | 500 mcd/lux/m ² |
| | Yellow | 300 mcd/lux/m ² |
| Type 4 - Removable Tape | White | 700 mcd/lux/m ² |
| | Yellow | 400 mcd/lux/m ² |

22 Type 1 is typically a 2 year life cycle permanent tape used on roadways with an ADT
23 of 5,000 or less.

24 Type 2 material may come as one piece with a black border with yellow or white in the
25 center. Type 2 is typically a 5 year permanent tape used on roadways with an ADT
26 greater than 5,000.

27 Type 3 wet reflective tape shall meet Table 1205-4 retroreflective values, both wet and
28 dry. The value measured under wet conditions shall be measured in accordance with
29 ASTM E1710 when using a portable retroreflectometer and in accordance with
30 ASTM E2176.

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1 (C) Observation Period

2 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
3 minimum retroreflective values for a 30-day period beginning upon the Engineer's
4 acceptance of all markings on the project. Guarantee retroreflective values of the
5 markings during the 30-day period under the payment and performance bond in
6 accordance with Article 105-17.

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

8 (A) Application Equipment

9 Apply heated-in-place thermoplastic using a propane blow torch and other material as
10 recommended by the manufacturer.

11 (B) Weather Limitations

12 Apply heated-in-place thermoplastic only when ambient air temperature and pavement
13 surface temperature is 32°F and rising.

14 (C) Applications

15 Apply heated-in-place thermoplastic per manufacturer's specifications. The
16 manufacturer shall certify the installer of heated-in-place thermoplastic.

17 The Contractor may choose to use heated-in-place thermoplastic symbols, characters and
18 transverse lines instead of molten thermoplastics pavement markings.

19 Produce a cross sectional thickness of installed heated-in-place thermoplastic markings
20 above the surface of the pavement after installation and upon cooling in accordance with
21 Table 1205-3.

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

23 (D) Observation Period

24 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
25 minimum retroreflective values for a 30-day period beginning upon the Engineer's
26 acceptance of all markings on the project. Guarantee retroreflective values of the
27 markings during the 30-day period under the payment and performance bond in
28 accordance with Article 105-17.

29 **1205-8 PAINT**

30 (A) Application Equipment

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

38 The paint applicator equipment shall have at least two paint tanks with a minimum
39 60 gallon capacity and one tank for glass beads with at least 500 lb capacity. The spray
40 guns used for hand held paint pavement marking application shall be operable from the
41 application truck. All metal parts that hold or transfer paint pavement marking material
42 shall be stainless steel. The paint trucks shall be equipped with quick action valves. The
43 required gauges and pressure regulators shall be conveniently located and in full view
44 and reach of the operator. Paint strainers are required in paint supply lines.

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

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

9 **(B) Weather Limitations**

10 Apply paint only when the ambient air temperature and pavement surface temperatures
 11 are at least 40°F and rising and no more than 160°F.

12 **(C) Application**

13 Final pavement marking applications of paint shall be placed in 2 applications of 15 mils
 14 wet each. Apply the second application of paint upon sufficient drying time of the first.
 15 Each application of paint shall consist of drop-on beads applied at a rate to immediately
 16 obtain the minimum retroreflective values.

17 When paint is required by the Engineer or Traffic Control Plan for temporary pavement
 18 markings during temporary traffic patterns, apply one application of paint at 15 mils wet.
 19 If the temporary traffic pattern will last longer than 6 months, apply a second application
 20 of paint 6 months after the initial application. Additional applications of paint at 15 mils
 21 wet may be applied every 6 months as directed by the Engineer or Traffic Control Plan.

22 For each 15 mil application of paint, apply drop-on beads uniformly to the surface of the
 23 paint material at a rate to immediately obtain the minimum retroreflective values. At the
 24 time of installation, produce in-place markings with the minimum retroreflective values
 25 shown in Table 1205-5, as obtained with a Department approved 30 m mobile or
 26 handheld retroreflectometer. Maintain the retroreflective values shown in Table 1205-5
 27 for at least 30 days from the time of placement of the marking material.

| TABLE 1205-7 REFLECTOMETER REQUIREMENTS FOR PAINT | | |
|--|--------------|----------------------------|
| Item | Color | Reflectivity |
| Standard Glass Beads | White | 225 mcd/lux/m ² |
| | Yellow | 200 mcd/lux/m ² |

28 Make sure that the marking is uniformly retroreflectorized upon drying.

29 **(D) Observation Period**

30 In addition to the requirements of Subarticle 1205-3(H), maintain responsibility for
 31 minimum retroreflective values for a 30-day period beginning upon the Engineer's
 32 acceptance of all markings on the project. Guarantee retroreflective values of the
 33 markings during the 30-day period under the payment and performance bond in
 34 accordance with Article 105-17.

35 **1205-9 MAINTENANCE**

36 Replace pavement markings that prematurely deteriorate, fail to adhere to the pavement, lack
 37 reflectorization or are otherwise unsatisfactory during the life of the project or during the
 38 12 month observation period as determined by the Engineer.

39 Upon notification from the Engineer, winterize the project by placing an initial or additional
 40 application of paint pavement marking lines in accordance with Article 1205-8.

Section 1205

1205-10 MEASUREMENT AND PAYMENT

____ *Pavement Marking Lines* will be measured and paid as the actual number of linear feet of pavement marking lines satisfactorily placed and accepted by the Engineer. In addition, *Paint Pavement Marking Lines* will be paid per linear foot for each 15 mil application placed in accordance with Subarticle 1205-8(C). The quantity of solid lines will be the summation of the linear feet of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear feet 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 as the actual number of pavement marking symbols satisfactorily placed and accepted by the Engineer. In addition, *Paint Pavement Marking Symbols* will be paid for each 15 mil application placed in accordance with Subarticle 1205-8(C).

____ *Pavement Marking Characters* will be measured and paid 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. In addition, *Paint Pavement Marking Characters* will be paid for each 15 mil application placed in accordance with Subarticle 1205-8(C).

Removal of Pavement Marking Lines will be measured and paid as the actual number of linear feet of pavement marking lines satisfactorily removed and accepted by the Engineer. The quantity of solid lines will be the summation of the linear feet of solid line measured end-to-end of the line. The quantity of skip or broken lines will be the summation of the linear feet 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 as the actual number of pavement marking symbols and characters satisfactorily removed and accepted by the Engineer.

Curing Compound Removal, Lines will be measured and paid as the actual number of linear feet of pavement surface from which the curing compounds are satisfactorily removed. All other surface preparation will be incidental to the work covered by this section. Measurement will be made along the surface of the pavement.

Curing Compound Removal, Symbols & Characters will be measured and paid as the actual number of symbols and characters for which the curing compound has been satisfactorily removed. All other surface preparation will be incidental to the work covered by this section.

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; removal of all pavement marking materials spilled on the roadway surface; and repair of markings tracked by a vehicle.

Premarketing will be incidental to other items in the contract. Unless directed by the Engineer, there will be no direct payment for interim paint. No direct payment will be made for black paint or tape.

The 5 to 8 mils of paint installed before placing the polyurea will be incidental to the work of this section.

The Contractor may choose to use heated-in-place thermoplastic symbols, characters and transverse lines instead of molten thermoplastics pavement markings at no additional cost to the Department.

1 Replacement of pavement markings that prematurely deteriorated, failed to adhere to the
 2 pavement, lacked reflectorization or were otherwise unsatisfactory during the life of the
 3 project or during the 12 month observation period as determined by the Engineer will be at no
 4 cost to the Department.

5 Payment for Paint Pavement Marking Lines required to winterize the project will be made in
 6 accordance with Article 1205-10 except that no payment will be made on resurfacing projects
 7 where paving is completed more than 30 days before the written notification by the
 8 Department that winterization is required.

9 Payment will be made under:

| Pay Item | Pay Unit |
|---|-----------------|
| Paint Pavement Marking Lines, __" | Linear Foot |
| Thermoplastic Pavement Marking Lines, __", __ mils | Linear Foot |
| Polyurea Pavement Marking Lines; __" | Linear Foot |
| Cold Applied Plastic Pavement Marking Lines, Type ____ (__) | Linear Foot |
| Heated-In-Place Thermoplastic Pavement Marking Lines, __", __ mils | Linear Foot |
| Paint Pavement Marking Symbols | Each |
| Thermoplastic Pavement Marking Symbols, __ mils: | 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 |
| Cold Applied Plastic Pavement Marking Characters, Type ____ | Each |
| Heated-In-Place Pavement Marking Characters __ mils | Each |
| Removal of Pavement Marking Lines, __" | Linear Foot |
| Removal of Pavement Marking Symbols & Characters | Each |
| Curing Compound Removal, Lines | Linear Foot |
| Curing Compound Removal, Symbols & Characters | Each |

10 **SECTION 1250**
 11 **PAVEMENT MARKERS GENERAL REQUIREMENTS**

12 **1250-1 DESCRIPTION**

13 Furnish and place pavement markers in accordance with the contract.

14 **1250-2 MATERIALS**

15 **(A) General**

16 Refer to Division 10.

| Item | Section |
|------------------|----------------|
| Pavement Markers | 1086 |

17 **(B) Material Qualifications**

18 Use pavement markers that are on the NCDOT Approved Products List.

Section 1250

1 (C) Historical Performance

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

7 1250-3 CONSTRUCTION METHODS

8 (A) Weather Limitations

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

13 (B) Preparing for installation

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

18 (C) Removal of Existing Pavement Markers

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

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

26 (D) Installation

27 (1) General

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

29 (2) Color

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

34 (3) Appearance

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

38 (4) Spacing

39 Space pavement markers as shown in the plans. Position pavement marker lenses
40 perpendicular to the flow of traffic as shown in the *Roadway Standard Drawings*.
41 Adjust marker longitudinal spacing up to 1 foot in either direction and/or adjust
42 marker lateral spacing up to 3" to avoid installation of the marker at a pavement
43 construction joint or surface defect. If a marker can not be relocated as described
44 above, do not install the affected marker.

(E) Pavement Marker Installer Qualifications

Ensure at least one member of every pavement marker crew is certified through the NCDOT Pavement Marking Technician Certification Process. Keep the certification current throughout the life of the project. A certified crewmember shall be present anytime this work is being performed. 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.

| Item | Section |
|-----------------------------------|----------------|
| Temporary Raised Pavement Markers | 1086-1 |
| Permanent Raised Pavement Markers | 1086-2 |

Use pavement markers that are on the NCDOT Approved Products List.

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:

(A) Three segment failures occur in any roadway section. Three consecutive damaged or missing markers in any group of 7 represents a segment failure.

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

(C) Engineer determines replacement is necessary.

Maintain all installed permanent raised pavement markers until final acceptance of the project.

1251-5 MEASUREMENT AND PAYMENT

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

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

Payment will be made under:

| Pay Item | Pay Unit |
|-----------------------------------|-----------------|
| Temporary Raised Pavement Markers | Each |
| Permanent Raised Pavement Markers | Each |

Section 1253

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**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.

| Item | Section |
|-------------------------------|----------------|
| Snowplowable Pavement Markers | 1086-3 |

Use pavement markers that are on the NCDOT Approved Products List.

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 before 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.

(C) 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 before acceptance.

1253-5 MEASUREMENT AND PAYMENT

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

Payment will be made under:

| Pay Item | Pay Unit |
|------------------------------|-----------------|
| Snowplowable Pavement Marker | Each |

**SECTION 1264
OBJECT MARKERS**

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3 **1264-1 DESCRIPTION**

4 Furnish and install object markers in accordance with the contract.

5 **1264-2 MATERIALS**

6 Refer to Division 10.

| Item | Section |
|-----------------|----------------------|
| Object markers | 1088-4 |
| U-channel posts | 1094-1(B), 1094-1(C) |
| Joint Sealer | 1028-2 |

7 Use pavement markers that are on the NCDOT Approved Products List.

8 **1264-3 CONSTRUCTION METHODS**

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

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

18 Use Type 3 object markers to mark larger obstructions within or outside the roadway, such as
19 bridge piers, abutments, rails, culvert headwalls or narrow shoulder drop-offs. Ensure the
20 stripes slope downward toward the side of the obstruction on which traffic is to pass. They
21 may be required to be mounted on the actual obstruction or individually on 7 ft U-channel
22 posts.

23 Mount end of road object markers on 7 ft U-channel posts at the end of a roadway where there
24 is no alternate vehicular path.

25 **1264-4 MEASUREMENT AND PAYMENT**

26 *Object Markers (Type ____)* will be measured and paid as the actual number of object
27 markers satisfactorily placed and accepted by the Engineer

28 *7' U-Channel Posts* will be measured and paid as the actual number of 7 ft U-channel posts
29 satisfactorily placed and accepted by the Engineer.

30 Payment will be made under:

| Pay Item | Pay Unit |
|------------------------------|-----------------|
| Object Markers (Type 1) | Each |
| Object Markers (Type 2) | Each |
| Object Markers (Type 3) | Each |
| Object Markers (End of Road) | Each |
| 7' U-Channel Posts | Each |

Section 1266

**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.

| Item | Section |
|-----------------|----------------|
| Tubular Markers | 1088-7 |

Use pavement markers that are on the NCDOT Approved Products List.

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:

(A) Use yellow tubular markers with white and crystal retroreflective sheeting on top of asphalt islands as shown in the plans.

(B) 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.

(C) 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:

(A) Three segment failures occur in any roadway section. Two consecutive damaged or missing tubular markers in any group of 7 represents a segment failure

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

(C) Engineer determines replacement is necessary.

1266-5 MEASUREMENT AND PAYMENT

Tubular Markers (Fixed) will be measured and paid 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:

| Pay Item | Pay Unit |
|-------------------------|-----------------|
| Tubular Markers (Fixed) | Each |

SECTION 1267
FLEXIBLE DELINEATORS

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1267-1 DESCRIPTION

Furnish and install flexible delineators in accordance with the contract.

1267-2 MATERIALS

Refer to Division 10.

| Item | Section |
|----------------------|----------------|
| Flexible Delineators | 1088-8 |

Use pavement markers that are on the NCDOT Approved Products List.

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 48" 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 at least 20 ft-lb 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 before acceptance.

1267-5 MEASUREMENT AND PAYMENT

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

Payment will be made under:

| Pay Item | Pay Unit |
|---------------------------------------|-----------------|
| Flexible Delineator (Crystal) | Each |
| Flexible Delineator (Yellow) | Each |
| Flexible Delineator (Crystal and Red) | Each |
| Flexible Delineator (Yellow and Red) | Each |