SECTION 6.44 – White and Yellow Thermoplastic Reflectorized Pavement Markings

6.44.1. INTENT. This section describes the furnishing and application of hot extruded reflectorized white and yellow thermoplastic pavement markings, for lane lines, centerlines, gore lines, edge lines, shoulder striping, etc., in specified constant widths and at locations indicated on the Contract Drawings, as ordered by the Engineer, and as specified herein.

6.44.2. DESCRIPTION. Under this section the Contractor shall be required to clean and prime the pavement surface and to apply the markings on the surface.

6.44.3. MATERIALS. The markings shall be a reflectorized thermoplastic pavement striping material, hereinafter referred to as "composition," of a type that is applied to the pavement surface in a molten state by mechanical means with surface application of glass beads and which, upon cooling to normal pavement temperature, produces an adherent reflectorized stripe of a specified constant width and of a uniform cross-section, between 1/8" and 3/16" in thickness, and is capable of resisting deformation.

(A) COMPOSITION REQUIREMENTS

The thermoplastic composition shall be specifically formulated for application at temperatures greater than 400^{o} F. The components in the composition shall show no significant breakdown, or deterioration at 475^{o} F.

The binder component shall be formulated as a hydrocarbon resin; or it shall be formulated as a mixture of high boiling point nonhydric primary alcohol and modified maleic resin. The pigment, beads and filler shall be uniformly dispersed in the binder resin.

The thermoplastic composition shall be free from all skins, dirt and foreign objects and shall comply with the following requirements:

	% by Weight	
Component	White	Yellow
Binder	17.0 min.	17.0 min.
Titanium Dioxide	10.0 min.	--
Glass Beads	20.0 min.	20.0 min.
Calcium Carbonate & Inert Fillers	49.0 max.	*
Yellow Pigments	--	*

* *Amount and type of yellow pigment, calcium carbonate and inert fillers must be used per the written recommendations of the manufacturer, providing the other composition requirements of this specification are met.*

(B) PHYSICAL PROPERTIES OF COMPOSITION

1. Color. White thermoplastic composition, as placed, shall be white, free from dirt or tint.

   Yellow thermoplastic composition, as placed, shall be yellow, free from dirt or tint and shall be a reasonable visual match to Munsell Book Notation 10Yr8/14 (ASTM D1535).

2. Drying Time. When installed at 70^{o}, and in thicknesses between 1/8 and 3/16", the composition shall be completely solid and shall show no damaging effect from traffic after ten (10) minutes.

3. Yellowness Index. White thermoplastic composition shall not exceed a yellowness index of 0.12 when tested in accordance with AASHTO Designation T-250.

4. Softening Point. The composition shall have a softening point of not less than 194^{o} F when tested in accordance with ASTM E28.

5. Specific Gravity. The specific gravity of the composition as determined by a water displacement method of 25^{o} C shall be between 1.9 and 2.2 (referred to water at 25^{o} C).

(C) REFLECTIVE GLASS BEADS (PRE-MIX AND DROP-ON)

Reflective glass beads for use in the composition and for drop-on shall conform to the following requirements:

1. The glass beads shall be colorless; clean; transparent; free from milkiness or excessive air bubbles; and essentially clean from surface scarring or scratching. They shall be spherical in shape and at least 70% of the glass beads shall be true spheres when tested in accordance with ASTM D1155.

2. The refractive index of the spheres shall be a minimum of 1.50 as determined by the liquid immersion method at 25^{O} C.

3. The silica content of the glass spheres shall not be less than 60%.

The crushing resistance of the beads shall be as follows: A forty (40) pound dead weight, for 20 to 30 mesh spheres.

The glass beads shall have the following grading when tested in accordance with ASTM D1214:

U.S. Standard Sieve	Mass % Passing
No. 20	100
No. 30	79-95
No. 50	15-60
No. 80	0-15

Glass beads for drop-on shall be treated with a moisture-proof coating.

(D) PRIMER

All pavement surfaces shall be primed except that on new bituminous pavements, when the thermoplastic pavement markings are applied within the same calendar year as the completion of paving operations, primer shall not be required.

The primer shall be either a one-component or a two-component, cold or hot applied material of the type recommended by the manufacturer of the thermoplastic pavement marking material and have a maximum VOC requirements of 2.1 lbs./gal. On Portland cement concrete pavements the primer shall be of a bitumen mixture of asphalt binder and mineral filler or epoxy resin type, black in color. At least five working days prior to the start of thermoplastic application, the Contractor shall provide the Engineer with the manufacturer's written instructions for primer application. The application of the primer shall be performed in accordance with the manufacturer's written recommendations which shall include the method of application, the application rate, and the drying time.

(E) In addition, the materials furnished shall meet the following requirements:

1. Composition shall be packed in slab form in individual boxes.

2. Each packaged unit shall be identified by the manufacturer’s name, manufacturing designation, date of manufacture, and color. Each shipment shall be accompanied by a notarized certification from the supplier certifying that the material is in conformance with the material specifications designated herein. Samples may be required to be submitted to the Engineer for tests and approval prior to its use. Materials received without a notarized certification, or materials which fail to pass the test, shall not be used and shall be removed from the site of the work.

3. Composition shall be reusable on the job site without deterioration of useful properties when subjected to three reheatings to its application temperature, and after being held at such temperature for one hour during each reheating.

4. All materials shall be composed of 100% pure virgin stock. No scrap or reprocessed materials may be used.

5. The composition when installed on and supported by pavement shall:

   a. be textured so as not to be slippery when wet.

   b. adhere securely to the pavement under repeated freezing and thawing.

   c. not discolor on prolonged exposure to sunlight.

d. not crack, chip or craze.

e. not spread or smear at temperatures at or below 140 Degrees F.

f. not deteriorate by contact with sodium chloride, calcium chloride, cinders or other similar pavement ice preventatives, or by contact with lubricant or fuel drippings from vehicles.

6. Thermoplastic material shall not give off toxic fumes which are harmful to persons or property when it is heated to application temperature.

(F) PREFORMED REFLECTORIZED PAVEMENT MARKINGS

The Contractor may request to use preformed reflectorized pavement markings for letters and symbols in lieu of hot extruded thermoplastic markings, at no extra cost. The preformed markings must be from the NYSDOT Approved List 727-04.

6.44.4. METHODS.

(A) GENERAL

Any pavement upon which two-way traffic will be maintained shall be properly marked with a centerline pavement lane marking before nightfall or the end of the working day, whichever comes sooner. In order to comply with this requirement, the Contractor may furnish and apply a temporary painted pavement marking in accordance with the requirement of Section 6.49. But where neither Temporary Painted Pavement Markings nor the final Thermoplastic Reflectorized Pavement Markings can be immediately installed as directed, the Contractor shall be required to furnish, install, maintain, and remove, when directed, rubber cones or other treatment deemed appropriate by the Engineer to safely maintain traffic at no additional cost to the City.

All final Thermoplastic Reflectorized Pavement Markings shall be installed as directed by the Engineer within 14 days after paving each block. Should the Contractor fail to install said final Thermoplastic Reflectorized Pavement Markings within 14 days after paving due to atmospheric conditions being inappropriate for satisfactory results as determined by the Engineer, the Contractor shall be required to install all pavement markings (e.g. edge lines, ten foot broken lines, stop bars, cross walks and arrows) using temporary painted pavement markings. Said temporary painted pavement marking shall be maintained as directed until the final Thermoplastic Reflectorized Pavement Markings are installed under this item. Maintenance of temporary painted pavement markings shall be done by re-applying the painted pavement markings where directed by the Engineer. Payment for the application of temporary painted pavement markings and each re-application, as may be directed, will be made in accordance with the requirements of Section 6.49.

Failure to meet this requirement shall be deemed a substantial deficiency in compliance with the specification requirements of Section 1.06.44(I) of the General Conditions, and will be cause for assessment of liquidated damages stipulated therein.

Where necessary, the Contractor shall establish marking line points at 25-foot intervals throughout the length of pavement, or as directed by the Engineer. Before any work is begun, a schedule of operations shall be submitted for the approval of the Engineer.

On bituminous concrete pavements that have been in-place since at least the previous calendar year, a thermosetting adhesive primer shall be placed at a wet film thickness of approximately 5±1 mils (265-400 sf/gal) prior to the application of the thermoplastic pavement markings.

On Portland cement concrete pavements a primer of bitumen or epoxy resin type shall be applied at a temperature range of between 55 and 110 Degrees F., at a width of two (2") inches greater than the width of the thermoplastic pavement marking such that it extends one (1") inch on each side of the thermoplastic pavement marking, and at a wet film thickness of between 4 and 5 mils or at a rate of 320-420 square feet per gallon. The marking material shall not be applied until the primer reaches a tack free condition (approximately 15 minutes under normal conditions). To shorten the curing time of the epoxy resin, an infrared heating device may be employed.

The thermoplastic material shall be applied to the pavement at composition temperatures no lower than 400 Degrees F. nor higher than 425 Degrees F. at the point of disposition. Marking shall be done only in seasonable weather in accordance with good practice and in a neat, workmanlike manner. Immediately after installation of the composition, drop-on glass beads shall be mechanically applied while still sufficiently

molten such that the beads will be held by and mechanically imbedded in the surface of the composition, in order to provide immediate night reflectivity.

The work included herein shall be pleasing to the eye, and shall be kept straight and aligned. Spilling of marking material will not be tolerated, especially if due to carelessness or lack of skill on the part of the Contractor, and must be removed by the Contractor. The line, or portion thereof, shall be protected from both vehicle and pedestrian traffic by use of adequate warning devices, until thoroughly past the point of tracking or smearing.

The Engineer's decision as to the acceptability of any installed line shall be final and binding on all parties to the contract. The Engineer may, at the Engineer's discretion, require the Contractor to remove all extraneous marks on the pavement made by the agents or employees of the Contractor. Unacceptable lines, damaged by others due to improper protection, or poor workmanship, poor appearance, poor performance, poor materials, improper width or improper alignment shall be reworked by the Contractor at no cost to the City to the satisfaction of the Engineer, within fifteen (15) days after written notification of the rejection of such completed work is received by him.

When raised reflectorized pavement markers exist, special care shall be taken to prevent the reflector from being covered by the thermoplastic material. Any reflectors so damaged shall be replaced by the Contractor at no cost to the City.

(B) SURFACE PREPARATION OF PAVEMENT

The Contractor shall be responsible for cleaning the pavement, to the satisfaction of the Engineer, such that at the time of application the pavement surface shall be free of oil, dirt, grease, concrete curing compounds and other foreign contaminants. Concrete curing compounds shall be removed by sandblasting or grinding the pavement surface.

The pavement shall be dry, to the satisfaction of the Engineer, before installation will be permitted (surface dry only, shall not be considered an acceptable condition). At the time of installation, the pavement surface temperature shall be a minimum of 55 Degrees F. and the ambient temperature shall be a minimum of 49 Degrees F. and rising. The Engineer shall be the sole determiner as to when atmospheric conditions are such as to produce satisfactory results

Note: To comply with the 55 Degrees F. pavement surface temperature requirement, the Contractor must schedule this striping work for seasons of warm weather. In cooler conditions, if so ordered and at locations directed by the Engineer, the Contractor must, temporarily, furnish and apply painted pavement markings complying with the requirements of Section 6.49 of the contract. Unless otherwise specified, payment therefor will be made at the unit price bid for Item No. 6.49 in the contract. Then at a later date when the pavement surface temperature is acceptable, as determined by the Engineer, the Contractor shall place the permanent thermoplastic markings over the temporary painted markings in a satisfactory manner.

(C) EQUIPMENT

1. Pavement Cleaning Equipment. Equipment must be provided to insure removal of dust, debris, and other foreign matter from the pavement immediately prior to the application of primer and subsequent installation of composition.

2. Primer Applicating Equipment. Application of primer shall be accomplished using equipment having the following features:

   a. The main storage tank shall be equipped with a visible gauge which will allow the Engineer to readily ascertain the rate of application.

   b. The main storage tank shall be equipped with a heating device which will maintain the primer at a constant efficient temperature.

   c. The spray nozzle shall be protected from the action of wind to insure placement where needed.

3. Thermoplastic Melting Equipment. A special kettle mounted on a mobile unit is required for melting and heating the composition. Such equipment shall incorporate the following features:

   a. The kettle shall be of sufficient capacity to satisfy the minimum installation requirements of the composition as specified hereinafter.

b. The kettle shall provide means of heating the composition by means of thermostatically controlled heat transfer liquid rather than by direct flame, so as to provide positive temperature control and prevent overheating of the composition.

c. Suitable temperature gauges to indicate liquid and composition temperatures at all times shall be provided in the kettle.

d. The kettle shall provide means of continually agitating the composition while the composition is being heated.

e. The kettle shall have a means of rapidly and efficiently discharging the liquid composition into appropriate application equipment.

f. The kettle shall be so equipped that, at the point where the liquid composition is discharged into the application equipment, a suitable temperature gauge shall be mounted in such a manner that the temperature of the liquid composition, at the point of discharge, shall be easily read at all times.

g. The kettle shall be equipped and constructed in such a manner so as to satisfy the requirements of the National Board of Fire Underwriters and the appropriate agencies of the City of New York.

4. Thermoplastic Applicating Equipment. Equipment shall be provided to place the composition on the pavement as a finished line, and shall include the following features:

a. The applicator shall provide agitation for the composition prior to its actual installation.

b. Applicator shall provide means of maintaining the composition at its proper application temperature (not lower than 400 Degrees F. nor higher than 425 Degrees F.).

c. Applicator shall maintain uniformity of specified width, and thickness of not less than 1/8" nor more than 3/16" of generally uniform cross-section.

d. Applicator shall provide a means of cleanly cutting off the ends of each length of line.

e. Applicator shall be capable of providing lines of variable widths by use of easily interchangeable parts.

f. Applicator shall be provided with a bead dispenser capable of uniformly dispensing reflective glass beads at controlled rates of flow. The bead dispenser shall be automatically operated in such a manner that it will only dispense beads while the composition is being applied. The beads shall be dispensed at a rate of one (1) pound per 20 square feet of composition.

g. Applicating equipment shall be of two general types:

Portable applicator - The portable applicator, capable of being propelled by the operator, shall be a device typically used for traffic line installations such as crosswalk lines, stop bars, and short lane, edge and center lines. The applicator shall be easily maneuverable and so constructed as to permit the installation of curved lines.

Mobile applicator - The mobile applicator shall contain equipment to provide for the automatic installation of skip lines in any combination of line and skip up to 40 feet. The mobile applicator shall be moved in conjunction with the melting and heating kettles in such a manner as to provide continuous highway operation of the kettles and the mobile applicator as an integral unit. The mobile applicator shall be capable of installing from 15,000 to 20,000 linear feet of line in an 8-hour day.

h. The applicators shall be equipped and constructed in such a manner so as to satisfy the requirements of the National Board of Fire Underwriters and the appropriate agencies of the City of New York.

(C) PREFORMED MARKINGS

Preformed reflectorized pavement markings shall be installed in accordance with the requirements above and the following additional requirements:

1. Pavement surface temperature: 70F Minimum, 170F Maximum

2. Ambient air temperature: 60F Minimum
3. Allowable Installation Dates: May 1 to September 30

Equipment used for the placement of preformed markings shall be of the type recommended by the manufacturer of the preformed material.

If required by the marking manufacturer, a primer or adhesive from NYSDOT Approved List 727-04 shall be used in accordance with the manufacturer's recommendations.

6.44.5. MEASUREMENT.

(A) THERMOPLASTIC REFLECTORIZED PAVEMENT MARKINGS.

The quantity to be measured for payment shall be the actual number of linear feet of 4" wide pavement markings measured along the centerline of the surface stripe. No payment will be made for the number of linear feet of skips in dashed lines. Payment for markings wider than 4" will be made at the contract price per linear foot of the 4" line multiplied by the factor:

$$\frac{\text{Actual Width of Marking (Inches)}}{4}$$

Payment for non-linear markings will be made at the contract price per linear foot of the 4" line multiplied by the factor:

$$\frac{\text{Actual square footage of marking}}{3}$$

The following markings will be paid for under Item 6.44:

1. Lane lines
2. Channelizing lines
3. Stop Bars
4. Crosswalks
5. Gore markings
6. Railroad crossing "X" (Per MUTCD Figure 8B-7, with the "R R" letters paid under item 9.44 L)
7. Diamond HOV marking
8. Chevrons in bike shared lane sharrows (Per MUTCD Figure 9C-9, with the Bike symbol paid under Item 9.44 S)
9. Cross-hatching in Do Not Block boxes
10. Parking space markings
11. Yield Ahead Triangles (20' and 13' per MUTCD Figure 3B-26)
12. Speed hump markings (per MUTCD Figure 3B-29)

(B) PRIMER FOR PORTLAND CEMENT CONCRETE PAVEMENTS.

The quantity of Primer for Portland Cement Concrete Pavements to be measured for payment shall be the actual number of linear feet of black colored primer satisfactorily applied to Portland cement concrete pavement. Measurement shall be made along the surface of the pavement and shall equal the number of linear feet of Thermoplastic Reflectorized Pavement Markings applied under Item No. 6.44, 6.44 L, or 6.44 S to new Portland Cement Concrete pavements. No payment will be made for the number of linear feet of skips in dashed lines or for any additional width of primer applied beyond that width of pavement markings to be applied, under Item No. 6.44, to new Portland Cement Concrete pavements.

(C) PAVEMENT MARKINGS – LETTERS AND NUMBERS

The quantity to be measured for payment will be the actual number of letters and numbers applied.

Item 6.44 L will be used for all 26 letters and 10 numbers, where the letters and numbers are 6' or greater in height. For example, the marking "SCHOOL" will be paid as 6 EACH.

(D) PAVEMENT MARKINGS – SYMBOLS

The quantity to be measured for payment will be the actual number of symbols applied.

Item 6.44 S will be used for all standard symbols, including:

1. All arrows, regardless of size or number of arrowheads.
2. Helmeted bicyclist symbol, regardless of size

3. Bike symbol, regardless of size (Per MUTCD Figure 9C-9, with the chevrons paid under item 9.44)
4. Bicycle detector pavement marking, including 2”x6” lines (per MUTCD Figure 9C-7)
5. Handicap symbol, regardless of size
6. Pedestrian symbol, regardless of size
7. Roller skater symbol, regardless of size
8. Yield line triangles (12”x18” and 24”x36” per MUTCD Figure 3B-16).

6.44.6. PRICES TO COVER.

(A) THERMOPLASTIC REFLECTORIZED PAVEMENT MARKINGS.

The contract price per linear foot of 4” wide pavement markings, white and/or yellow, shall cover the cost of all labor, materials, plant, equipment, insurance, and necessary incidentals required including, but not limited to, the cleaning of surfaces and priming the Asphaltic Concrete Wearing Courses where required, and application of striping materials, all in accordance with the Contract Drawings, the specifications and the directions of the Engineer.

(B) PRIMER FOR PORTLAND CEMENT CONCRETE PAVEMENTS.

The contract price per linear foot of Primer for Portland Cement Concrete Pavements shall cover the cost of all labor, materials, plant, equipment, insurance, and necessary incidentals required including, but not limited to, removal of concrete curing compounds and surface laitance by high pressure water, sandblasting, or grinding, and vacuuming the concrete surface, and furnishing and applying the black colored primer striping materials, all in accordance with the Contract Drawings, the specifications and the directions of the Engineer.

(C) PAVEMENT MARKINGS – LETTERS AND NUMBERS

The contract price per EACH pavement marking letter and number, white and/or yellow, will cover the cost of all labor, materials, plant, equipment, insurance, and necessary incidentals required including, but not limited to, the cleaning of surfaces and priming the Asphaltic Concrete Wearing Courses where required, and application of striping materials, all in accordance with the Contract Drawings, the Specifications, and the directions of the Engineer.

(D) PAVEMENT MARKINGS – SYMBOLS

The contract price per EACH pavement marking symbol, white and/or yellow, will cover the cost of all labor, materials, plant, equipment, insurance, and necessary incidentals required including, but not limited to, the cleaning of surfaces and priming the Asphaltic Concrete Wearing Courses where required, and application of striping materials, all in accordance with the Contract Drawings, the Specifications, and the directions of the Engineer.

Payment will be made under:

Item No.	Item	Pay Unit
6.44	THERMOPLASTIC REFLECTORIZED PAVEMENT MARKINGS (4” WIDE)	L.F.
6.44 L	PAVEMENT MARKINGS – LETTERS AND NUMBERS	EACH
6.44 PR	PRIMER FOR PORTLAND CEMENT CONCRETE PAVEMENTS	L.F.
6.44 S	PAVEMENT MARKINGS – SYMBOLS	EACH