SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 GENERAL

1.1 DESCRIPTION

A. The work of this section includes, but is not limited to:
   1. Application of traffic lines, markers or legends on roadway surfaces.
   2. Surface preparation.
   3. Removal of any conflicting pavement markings.
   4. Inlaid thermoplastic pavement markings.

B. Related Work Specified Elsewhere:
   1. Asphalt Paving (Bituminous paving and surfacing): Section 32 12 16
   2. Concrete (Trench paving and restoration): Section 32 13 13.02

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. Pennsylvania Department of Transportation (PennDOT), latest revision:
      Publication 408, Specifications.
      Publication 68 Regulations – Traffic Signs, Signals and Markings
      Publication 213, Temporary Traffic Control Guidelines
   2. American Society for Testing and Materials (ASTM), latest revision:
      D868 Standard Method of Evaluating Degree of Bleeding of Traffic Paint
      D1309 Standard Test Method for Settling Properties of Traffic Paint During Storage
   3. The Institute of Transportation Engineer (ITE):
      "A Model Performance Specification for the Purchase of Pavement Marking Paints and Powders", approved September 25, 1977.
   4. American Association of State Highway and Transportation Officials (AASHTO):
      M247 Glass Beads Used in Traffic Paints
      M249 White and Yellow Reflective Thermoplastic Striping Materials (Solid Form)
   5. Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), latest edition.

B. Qualifications:
   1. Installer shall specialize in application of traffic lines and pavement markings and have five (5) years documented experience in Pennsylvania.
   2. CONTRACTOR shall meet PennDOT standards for installing pavement markings.

1.3 SUBMITTALS

A. Letter of certification from the paint manufacturer stating that traffic line paint supplied meets either PennDOT' spec for Traffic Line Paint (required type) or the referenced ITE spec. This letter shall accompany the delivery of the material and be given to the ENGINEER prior to the installation of pavement markings. CONTRACTOR shall supply certification (CS-4171).

B. Application method, material and manufacturer's required mixing instruction and surface preparation details.

C. Schedule of operations.

D. Inlaid thermoplastic pavement markings:
   1. Product data sheet from manufacturer.

2. A four (4) square foot pre-cut sample of each lot or batch for each color for testing physical properties, if required.
3. Certification from manufacturer that the CONTRACTOR has been properly trained in the handling and installation of the product.

1.4 JOB CONDITIONS

A. Control of Traffic:
1. Take measures to control traffic during line painting operations. Line painting machine shall not appreciably impede traffic flow in adjacent lanes while painting centerline and one lane shall be left completely open to traffic when painting edge lines.
2. Employee traffic control measures in accordance with Publication 213, Temporary Traffic Control Guidelines.

B. Temperature and Weather Restrictions:
1. Painted traffic lines and markings shall not be placed when the ambient temperature is less than 40 degrees Fahrenheit.
2. Cold plastic markers or legends shall be applied only when the surface temperature is 60 degrees Fahrenheit or higher, unless otherwise directed by the ENGINER.

C. Protection of Markings:
1. Protect markings during and after application using barrier cones or other devices to keep traffic off newly applied markings until track free.

D. Environmental Requirements:
1. Adhere to manufacturer's data on air and surface temperature limits and relative humidity during application and curing of coatings. Schedule coating work to avoid dust and airborne contaminants.

E. Material Storage:
1. If paint is stored for more than two (2) months, invert container several days prior to use.
2. Store glass bead in a cool, dry place.
3. All products shall be protected from weather and freezing.

1.5 WARRANTY

A. The CONTRACTOR shall guarantee to replace, at his expense, that portion of the pavement marking installed under this Contract which, in the opinion of the ENGINEER, has not remained effective in performing useful daylight and nighttime service for a period of 6 months from the date of installation. The required service is defined as 90% of markings being effective and in place.

PART 2 PRODUCTS

2.1 PAINT

A. Paint shall be PennDOT Paint Type I, unless otherwise noted, and shall consist of either an alkyd resin type or a combination of alkyd resin type modified with chlorinated rubber ready-mixed white and yellow traffic paints, for use on bituminous and Portland cement concrete pavements. These paints shall be reflectorized for night visibility, if specified, by adding reflective spheres before the paint dries or sets, using the drop-on or pressurized methods.

B. Traffic paint shall consist of ready-mixed pigmented binder in a one package system. When applied at the wet-film thickness of 15 mils, the paint shall be suitable for application to traffic bearing surfaces such as Portland cement concrete, bituminous pavements, and plain or vitrified brick surfaces of streets, highways, bridges, tunnels and parking lots.

C. Pigments:

1. White - Any combination of pigments provided the finished paint meets all the requirements specified herein. Sufficient suspending and dispersing agents shall be used to prevent excessive settling.

2. Yellow - Any organic yellow pigment provided it does not contain any of the metals listed in EPA Code of Regulations 40. Sufficient suspending and dispersing agents shall be used to prevent excessive settling. Color of dry paint film shall match Color No. 33538 of Federal Standard 595a.

D. Binder: The supplier may use any combination of ingredients, except tall oil resins, provided the finished paint meets all the requirements herein. Sufficient amounts of anti-skinning agents shall be used to prevent skinning. Sufficient resin solids, compatible thinners and driers, if necessary, shall be used.

2.2 GLASS SPHERES

A. Glass spheres shall meet the requirements of Publication 408, Section 1103.14 (a) 2. and all current supplements.

B. Glass beads shall be in units of 50 lbs. and packed in moisture-proof bags. The beads shall be stored in a cool dry place.

2.3 COLD PLASTIC PAVEMENT MARKINGS

A. Pigmented plastic which contains glass beads and capable of being attached to bituminous and/or cement concrete pavement by means of a factory applied, pressure-sensitive adhesive.

B. Pigments shall meet requirements in Section 1103.14 (a) 1. in Publication 408.

C. Glass beads - AASHTO M247

2.4 HEAT APPLIED THERMOPLASTIC MARKINGS

A. A durable, retro-reflective pavement marking material suitable for use as roadway, intersection, commercial or private delineation markings. Must be composed of hydrocarbon resin, aggregate, pigments, binders and glass beads which have been factory produced as a finished product, and is designed to meet the requirements of the current edition of the MUTCD. The thermoplastic material conforms to AASHTO M249, with the exception of the relevant differences due to supplying the material in a preformed state.

B. The markings must be a resilient white or yellow hydrocarbon thermoplastic product with uniformly distributed glass beads throughout the entire cross section area. Lines, legends and symbols are capable of being affixed to bituminous and/or Portland concrete pavements by the use of the normal heat of a propane type of torch. Other colors shall be available as required.

C. The markings must be capable of conforming to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The markings shall have resealing characteristics, such that it is capable of fusing with itself and previously applied thermoplastic when heated with the torch.

D. The markings must be able to be applied in temperatures down to 32 degrees Fahrenheit without any special storage, preheating or treatment of the material before application.

E. Pigments:

1. White: Sufficient titanium dioxide pigment is used to ensure a color similar to Federal Highway White, Color No. 17886, as per Federal Standard 595a.
2. Yellow: Sufficient yellow pigment is used to ensure a color similar to Federal Highway Yellow, Color No. 15358, as per Federal Standard 595a. The yellow pigment must be of organic origin only.

F. Environmental Resistance: The material must be resistant to deterioration due to exposure to sunlight, water, oil, gasoline, salt or adverse weather conditions.

2.5 M ETHYL METHACRYLATE MARKINGS (MMA)

A. A durable, cold applied, 2 component material composed of resins in reactive monomers, pigment, plasticizer, fillers and/or glass beads and is to be reacted just prior to application with a benzoyl-peroxide catalyst. It shall be suitable for use as roadway intersection, commercial or private delineation markings on asphaltic or Portland cement surfaces.

B. Color shall be as required by project (white and/or yellow).

C. MMA shall be lead free and cure to a minimum 99% solids when reacted as per the manufacturer's instructions. All mixed material shall cure to a no track condition within 15 minutes of application at min. 40 mils wet at 77˚F.

D. Applied markings shall not deteriorate due to ultraviolet light, water, oil, pavement oil, salt and adverse weather conditions.

E. Material shall be capable of conforming to pavement contours, breaks and faults through action of traffic at normal pavement temperatures.

2.6 RAISED PAVEMENT MARKERS

A. Plowable or non-plowable as per Section 1103.05(c) in Publication 408 and the Contract Drawings.
1. Plowable: Shaped to fit in a depression in the pavement.
2. Non-plowable: Attached to roadway surface by use of pressure sensitive adhesive.

B. Plastic, retro-reflective surface, color and one-way or two-way marker as indicated on Contract Drawings.
1. Retroreflectors shall be prismatic type, acrylic plastic molded polycarbonate or other suitable material designed to provide strength, abrasion resistance, impact resistance, resilience and adhesion. The retroreflective shall be ultraviolet stabilized grade material which provides resistance to color change over long periods of outdoor exposure.
2. The retroreflective surface shall contain two (2) prismatic reflective faces to reflect light in two (2) directions. The surface of the reflective face shall be protected by a permanently bonded glass face or other transparent, abrasion resistant material. Reflective face colors shall be selected by the ENGINEER.

2.7 INLAID THERMOPLASTIC PAVEMENT MARKINGS

A. The inlaid thermoplastic pavement markings shall be provided pre-cut in sizes to conform to the specified pattern, widths and shapes shown on the Contract Drawings. The material shall be packaged in accordance with accepted commercial standards and, when stored in cool dry area indoors, shall be suitable for use for one year after the date of purchase. Color for insert and surrounding shall be in accordance to Contract Drawings. Pattern shall be in accordance to Contract Drawings.

B. Accepted pre-cut reflectorized inlaid thermoplastic pavement markings materials shall be the thermoplastic material for inlay into hot mix asphalt (HMA). The inlaid thermoplastic material shall have a minimum thickness of 90 mils (2.3mm), and consist of a mixture of high quality polymeric materials, pigments, fibers, and glass beads distributed throughout the cross-section, and with a reflective layer of glass beads bonded to the top surface.

C. Softening Point: The softening point shall be measured by the Ring and Bell method, as described in ASTM D-36-95 (2000). Acceptable range shall be 210-250˚ F (100-120˚ C).

D. Bond Strength: Thermoplastic bond strength to asphalt substrate shall be measured by Cross-Cut Test, as described in ASTM D-3359. A minimum of 50% of thermoplastic bond surface shall exhibit attached particles of asphalt.

E. Acceptable manufacturer for inlaid thermoplastic marking is Streetprint Duratherm at (800).688.5653, unless noted on the Contract Drawings.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

A. Clean the surface of the roadway before application of traffic lines or pavement markings to provide a clean, dry roadway surface which is free of loose dirt and other debris, to the satisfaction of the ENGINEER.

B. The surface cleaning for Cold Plastic markings shall include as a last operation the use of compressed air or a fine bristled broom over the application area to provide a dust-free surface.

C. New concrete road surfaces shall be cured at least seven (7) days prior to marking. Remove curing compounds prior to applying markings.

D. MMA markings may be placed on top of existing MMA markings which are in good condition. Other non-MMA markings must be mechanically removed prior to placement of new MMA markings. Remove chipped or flaking MMA markings prior to placing new MMA markings.

3.2 APPLICATION OF PAINTED MARKINGS

A. Paint: Paint shall be dispensed in a wet film thickness of 15+1 mils. The rate of application of paint on bituminous surface treatment roads may be 25% greater. The ENGINEER will determine whether roadways require an increased application rate.

B. Glass Beads: Glass beads shall be applied at a rate of six (6) pounds per gallon of paint.

C. Apply new pavement markings and “touch-up” existing markings within the limits of work. The finished project shall match the Contract Drawings.

3.3 EQUIPMENT FOR PAINTED MARKINGS

A. The line painting machine type shall be such that it shall not appreciably impede the traffic flow in adjacent lanes while painting the centerlines of the roadway and one lane shall be left completely open to traffic when painting edge lines.

B. The line painting machines used on this project shall be capable of a simultaneous application of two parallel lines in either a solid or broken pattern in forming the centerline. It shall also be capable of the automatic dispensing of glass beads onto the painted surface at the required application rate, by the pressurized glass gun method.

C. The machinery shall also be capable of providing a paint line in 4-inch, 6-inch and 8-inch widths.

D. Each piece of machinery used to apply centerlines and edge lines shall be equipped with a measuring device which automatically and continuously measures to the nearest foot, the length of each line placed.

E. Legends shall be applied with equipment approved by the ENGINEER; hand brushes or rollers are not permitted. Glass beads may be hand applied.

3.4 CENTERLINE APPLICATION

A. Where existing centerlines are visible and properly located, the new centerlines shall be applied directly over the existing pattern. Where centerlines do not exist, or existing centerlines are improperly located, as determined by the ENGINEER, the new centerlines shall be applied at the correct location. If the existing markings have to be removed to allow correct placement of the new markings, such work shall be done in accordance with Section 963 of Publication 408. This work is incidental to the application of the new centerline.

B. In general, on two-lane roadways, the centerline shall evenly divide the roadway; however, if a portion of the roadway on either or both sides is to be utilized for parking, the centerline shall evenly divide the traveled way.

C. Apply the centerline in its proper location; any centerline pattern placed more than six (6) inches from the center of the roadway or traveled way shall be removed and replaced by the CONTRACTOR at his own expense.

3.5 EDGELINE APPLICATION

A. Field-check all roadways shown on the Contract Drawings which require application of edge lines. Only those roadway sections which are 20 feet or greater in width for more than 50 percent of their length shall be painted with edge lines.

3.6 APPLICATION OF COLD PLASTIC MARKINGS

A. Inlaids: Place material on new bituminous surface just before final compaction. Roll material into new surface to achieve flush finished surface.

B. Surface applied: Apply onto the existing, cleaned surface of concrete or bituminous roadways.

C. Use compatible “adhesive activator” or “primer sealer”, if recommended by adhesive manufacturer.

3.7 APPLICATION OF HEAT APPLIED THERMOPLASTIC MARKINGS

A. Asphalt: The materials shall be applied using the propane torch method recommended by the manufacturer. The material must be able to be applied at ambient and road temperatures down to 32 degrees F. without any preheating of the pavement to a specific temperature. The pavement shall be clean, dry and free of debris. Supplier must enclose application instructions with each box/package.

B. Portland Concrete: The same application procedure shall be used as described under above Paragraph 3.7A. However, a compatible primer sealer may be applied before application to assure proper adhesion.

3.8 APPLICATION OF METHYL METHACRYLATE MARKINGS

A. Apply MMA markings using one method chosen from the three listed below, depending on project type and size:

1. Extrude using trowel, drag box, push cart or shoe. (Applicable for all types of markings). Recommended film thickness is 90 mils, drop on glass rate of 10 lbs. /100 sq. ft.

2. Stencil Spray using spray applicator (for all types of markings). Recommended film thickness for transverse markings and symbols is 90 mils; 60 mils for longitudinal markings.
3. Truck Spray using driven vehicle and paint guns to apply longitudinal lines. Recommended film thickness is 40 mils with a double drop of glass beads.

3.9 RAISED PAVEMENT MARKERS

A. Install markers as per manufacturer's requirements and the Contract Drawings, according to the MUTCD. Installation shall be performed so as not to cause damage to the surrounding pavement. The CONTRACTOR shall be responsible for repairing any damaged pavement surfaces at no additional cost. The edges of pavement markers shall be a minimum of four (4") inches from pavement joints.
   1. The pavement shall be cut to the dimensions and depth recommended by the manufacturer.
   2. All cutting shall be performed to minimize airborne dust and similar dust. All debris from cutting shall be vacuumed up from the pavement cut and adjacent pavement surfaces and disposed of properly.
   3. Only install raised pavement markers when the ambient and pavement temperatures are above 50˚F.
   4. The epoxy resin adhesive material shall follow manufacturer's recommendations for proportioning, mixing and application.
   5. The pavement markers shall be immediately placed into the epoxy-filled pavement cut.
B. CONTRACTOR shall provide manufacturer PennDOT certification (CS-4171) that all raised pavement markers meet all current Federal and State regulations previously stated.

3.10 INLAID THERMOPLATIC PAVEMENT MARKINGS

A. Pre-cut inlaid thermoplastic pavement marking material shall be furnished and installed by the CONTRACTOR at the locations and with the proper dimensions or as directed by the ENGINEER at the appropriate time after the completion of the asphalt surface.
B. The surface shall be clean and free of all dust, silt, debris and, most importantly, chemical residue from de-icing materials. If de-icing material has been used on the road in the past, cleaning shall be carried out using pressure washing.
C. Placement shall be in accordance with the Manufacturer's recommendations and the installers shall posses an appropriate Certification of training from the Manufacturer.
D. Layout and imprinting of the pattern into the surface of the hot mix asphalt (HMA) shall be as per the Contract Drawings. Imprinting shall be carried out after the HMA paving work has been completed. The asphalt surface shall be re-heated to make the upper portion of the asphalt surface pliable enough to accept the imprint of the template. The application of heat to existing asphalt surface shall be done using reciprocating infra-red re-heating equipment.
E. The asphalt surface temperature shall not exceed 325˚ F (163˚C). The temperature of the asphalt surface shall be regularly monitored during the reheating process, to avoid over heating and degradation of the asphalt cement. Direct flame heaters and non-reciprocating heaters shall not be allowed to be used for this purpose. Once the asphalt has reached imprinting temperature, the templates shall be place in position and pressed into the surface using vibratory plate compactors.

F. Supply and install the inlaid thermoplastic panels on completely dry asphalt, in the imprinted area. Heat shall be gently applied to the surface using reciprocating infra red heaters, slowly raising the surface temperature until the thermoplastic material in the panels starts to liquefy and flow, but no higher than 325˚F. Once the thermoplastic material has liquefied, the heat source shall be removed and the surface allowed cooling to ambient temperature. Only once the asphalt surface and the thermoplastic have reached ambient temperature may the road be opened to traffic.

END SECTION