SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies providing pavement markings and striping.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

A. Samples:
   1. Paint: One quart of each color.
   2. Spheres: Two pounds.
   3. Thermoplastic compound: Ten pounds of each color.
   4. Preformed plastic markings: Five each of plain and reflective, each three inches wide by one-foot long.

B. Certification.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. AASHTO: M249-79.
   3. USDOT/FHWA: Manual on Uniform Traffic Control Devices for Streets and Highways.
   4. Federal Test Method Standard 141.
   5. FED STD: 595.
   6. FS: TT-P-85, TT-B-1325.
      a. ASTM: D638.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver materials in factory-sealed containers plainly marked as follows:
   1. Manufacturer's name and address.
   2. Location of plant.
   3. Material.
   4. Color of material.
   5. Amount of contents.
   6. Date of manufacturer and lot number.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
   1. Traffic zone paint:

a. Apply only when ambient air temperature is above 40F and temperature of surface to be painted is above 45F.
b. If pavement is wet, allow surface to dry for eight hours minimum after surface appears dry.
c. Do not apply glass spheres in strong windy conditions.

2. Extruded thermoplastic compound:
   a. Apply by extrusion at 400F minimum, 440F maximum, when air temperature is more than 35F and pavement temperature is above 50F.
   b. If pavement is wet, delay application until the pavement has been exposed to at least two hours of direct sunlight after surface appears dry.
3. Preformed plastic traffic markings:
   a. Apply on dry pavement when ambient temperature and temperature of pavement surface is above 60F.
   b. When temperature of pavement surface is less than 60F and when approved, apply surface heating to degree necessary for application of plastic marking.

B. Protection:
1. Provide traffic protective devices and methods of protection to comply with requirements of the jurisdictional authorities.
2. Provide and maintain traffic cones, barricades, lights and other protective devices necessary to protect traffic, workmen and completed pavement marking and striping. Remove such devices when marking and striping, including painted sections of curbing and raised traffic bars, have sufficiently cured for intended use.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Traffic Zone Paint:
1. Primer: If recommended by paint manufacturer or required by jurisdictional authorities, type as recommended by paint manufacturer.
2. Paint: Traffic, FS TT-P-85, white and yellow.

B. Glass Beads: Retroreflective glass spheres, FS TT-B-1325, with the following additional gradation requirements:

1.	US Sieve Size	Percentage Passing
a.	40	100
b.	50	80 - 100
c.	80	35 - 80
d.	100	20 - 50
e.	200	0 - 15

C. Extruded Thermoplastic Compound: Hot-applied alkyd thermoplastic per AASHTO M249-79 and as follows:

1. Thermoplastic compound:
   a. Mixture of thermoplastic resins and other substances compounded for use in traffic markings which, when extruded hot in place and cooled to ambient temperature, will produce stark white or yellow reflective marking stripe.
   b. Permanently white or yellow, without blemish or discoloration, with straight, clean cut, sharply defined, parallel edges and of uniform cross section.
   c. Shaped to minimize tire impact and adhere permanently to road.
   d. Set to solid, non-tacky, non-slippery line of sufficient elasticity to resist cracking and chipping caused by weather and temperature changes, traffic action, as well as pavement crawl and lift in freezing weather.
   e. After curing, does not react with nor deteriorate in contact with snow removal chemicals, oil and other substances common to roadway surfaces.
   f. Chemically stable and emitting no dangerous fumes.
   g. Especially compounded for traffic markings, with no change in color and brightness characteristics after prolonged exposure to sunlight.
   h. No breakdown or deterioration when held at plastic temperature for extended periods of time nor when repeatedly reheated to plastic temperature.
   i. No change in temperature versus viscosity characteristics through repeated reheatings and from batch to batch.
2. White thermoplastic compound:
   a. Pure white, free from dirt or tint after drying.
   b. Maximum allowable compound deviations from magnesium oxide standard when tested by standard color difference meter, Gardner Color Difference Meter, Gardner Laboratories, Inc. Bethesda, Maryland or equal, with the following minimum requirements:

	Scale	Definition	Magnesium Oxide Standardized	Sample
(1)	Rd	Reflectance	100	70 minimum
(2)	a	Redness - Greenness	0	Minus five to plus five
(3)	b	Yellowness - Blueness	0	Minus 10 to plus 10

   c. The white compound pigment containing not less than six-percent titanium dioxide (TiO2).
3. Yellow thermoplastic compound:
   a. After drying, yellow, FED STD 595, Color 33538, tested in accordance with Federal Test Method Standard 141, Method 4252.
   b. Pigmented binder well dispersed and free from skins, dirt, foreign objects or ingredients that will cause bleeding, staining or discoloration and consisting of mixture of non-drying synthetic resins at least one of which is solid at room temperature.

c. Total binder content of thermoplastic compound: 15-percent minimum, 35-percent maximum by weight.

d. Filler incorporated with resins or binder: White calcium carbonate with compressive strength of 5,000 psi.

D. Preformed Plastic Traffic Markings:

1. Composed of preformed plastic, smooth on top surface, undersurfaces factory-coated with pressure-sensitive adhesive coating overlaid with protective paper, polyethylene or other suitable material which remains in place until plastic is ready for application to pavement.
2. Plain or reflectorized.
3. White or yellow.
4. Composition:
   a. Nonreflectorized plastic material: Consisting of basic plastic and plasticizers, 50-percent minimum by weight.
   b. Reflectorized plastic material: Consisting of 40-percent minimum by weight of basic plastic and plasticizer and 30-percent minimum by weight of clear, reflective glass spheres, thoroughly and uniformly dispersed throughout plastic.
5. Pigmentation:
   a. White plastic markings: Pure white, free from tint and containing not less than six-percent titanium dioxide.
   b. Yellow plastic markings: Yellow, FED STD 595, Color 33538, Federal Test Method 141, Method 4252.
   c. Uniform coloring throughout cross section of plastic.
6. Low-temperature stress resistance: No indication of breaking, chipping or cracking when sample of specified thickness is abruptly bent to right angle after being immersed in water at 32F for 30 minutes.
7. Resistance to wear: Endure not less than 2,500 cycles of a Taber Abraser, using CS-17 wheels under a load of 1,000 grams, when each 0.001-inch thickness of plastic is tested at 21C.
8. Tensile strength: Nonreflectorized markings not less than 1500 psi; reflectorized markings not less than 750 psi when tested in accordance with ASTM D638.
9. Bond strength: Withstand 50-pound static shear load for 15 seconds average at 21C before complete parting of bond when pair of two-inch wide strips are overlapped two inches and adhesive faces placed together.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL:

A. Layout of Work:

1. Lay out lane widths, parking spaces and crosswalks in accordance with regulations of jurisdictional authorities and as shown.

B. Letters and Symbols:

1. Unless otherwise shown or specified, apply letters, directional arrows and other pavement markings of size and configuration in accordance with referenced USDOT/FHWA Manual on Uniform Traffic Control Devices for Street and Highways.
2. Apply letters, directional arrows and other markings in color shown.

C. Width and Color of Lines for Pavement Striping:
   1. Apply lines for pavement striping as follows:
      a. Width:
         1) Continuous centerline striping and parking space markings: Four inches.
         2) Dashed lane striping: Four inches.
         3) Solid crosswalk lines: Six inches.
         4) Solid stop lines: Twelve inches.
      b. Lines:
         1) Dashed lane lines: White stripes nine feet in length separated by 15 feet of unmarked surface.
      c. Color:
         1) Stripes:
            a) Solid centerline stripe: White or yellow as shown.
            b) Lane striping, parking space marking, crosswalk and stop lines: White, unless otherwise shown.

D. Allowable Tolerances:
   1. Traffic-zone paint:
      a. Width of lines not to vary from specified width by more than 1/8 inch in each linear foot.
      b. Lengths of skip or lane lines and unpainted surface between skip lines not to vary by more than three inches from specified length.
      c. Coverage rate maximum: 100 square feet minimum and 110 square feet maximum of surface coverage per gallon of paint, yielding wet-film thickness of 0.015 inches minimum.
      d. Coverage rate of glass spheres: Ten pounds per gallon of paint minimum.
   2. Extruded thermoplastic compound:
      a. Thickness of stripe: 90 to 125 mils.
      b. Rate of application of binder-sealer: Between 800 linear feet and 1,000 linear feet per gallon for four-inch wide lines. For lines of other widths, apply in proportion based on such rate.
   3. Preformed plastic traffic markings:
      a. Thickness: 0.095 inch, minus 0.005 inch or plus 0.010 inch.
      b. Width: Four inches, plus-or-minus 1/8-inch per 12-inch length.
   4. Painting of curbing and raised traffic bars:
      a. Wet-film thickness: 0.015 inches minimum.

3.02 APPLICATION:

A. Traffic Zone Paint:
   1. Equipment:
      a. Use equipment suitable for mechanical application of paint and glass spheres.
      b. Apply paint with atomizing spray machines designed for striping to apply stripes of uniform cross section, and thickness, at specified coverage with clean-cut edges permitting easy and accurate adjustment of width and rate of application as well as immediate shutoff.

c. Use automatic mechanical equipment designed and constructed to distribute glass spheres in uniform pattern and at prescribed coverage regardless of variation in speed of travel. Equipment may be integral part of striping machines or self-contained unit designed for attachment to striping machines, so that glass spheres will be applied immediately following application of paint. Use equipment designed and constructed to permit adjustment of coverage rate.

2. Method of application:
   a. Schedule marking and striping operations to permit paint to set and harden before roadway is opened to traffic.
   b. Allow hot laid bituminous material to cool, prior to beginning striping operations.
   c. Remove foreign matter from surfaces prior to painting.
   d. Apply pigmented binder and glass spheres, mix and thin pigmented binder in accordance with manufacturer's recommendations.
   e. Apply glass spheres uniformly, immediately following application of paint. Do not premix paint and spheres.
   f. Apply pavement markings accurately with straight, clean-cut, sharply defined parallel edges and of uniform cross section.
   g. Clean striping machines as often as necessary to ensure application of markings of specified quality and physical requirements.

B. Extruded Thermoplastic Compound:
1. Equipment:
   a. Master kettle:
      1) Minimum capacity: 800 pounds of melted compound.
      2) Double oil jacket.
      3) Thermostatic controls.
      4) Approved heating device.
      5) Temperature gauges for oil and compound.
      6) Integrally mounted chopping device to chop and drop solid compound into kettle.
   b. Liner:
      1) Use liners with self-contained heat source, such as propane heater, capable of maintaining compound at drawing temperature of not less than 420F as well as radiant heater installed over die for same purpose.
      2) For installation of crosswalk lines, stop lines and solid center lines, use liner with capacity of approximately 150 pounds and automatic sphere dispenser capable of distributing reflective spheres on surface of line while still plastic.
      3) For centerline and lane line installation, use mobile unit equipped to automatically install dashed lines in combinations of line and skip up to 40 feet and for application of reflective spheres as specified for smaller liner.
      4) Provide for varying die widths in liner to produce specified line widths, including shaping die cutoff device to provide clean, square ends at beginnings and ends of lines.
2. Application of binder-sealer:
   a. Before applying binder-sealer or thermoplastic compound, prepare roadway surface by buffing and cleaning or other appropriate method.
   b. Where thermoplastic stripe is to be installed, spray surfaces with binder sealer consisting of two parts epoxy and one-part hardener-catalyst immediately prior to installation of compound.

c. Mix binder-sealer fresh each day. Do not premix.

3. Application of thermoplastic compound:
   a. Apply compound in colors shown and at locations shown.
   b. Do not use pans and aprons to control width of lines.
   c. Use equipment including extrusion dies capable of maintaining compound at specified extrusion temperature and density and capable of producing stripe of specified width.
4. Application of glass spheres:
   a. Perform reflectorizing of thermoplastic compound by immediate application of glass spheres to specified density.
   b. Perform reflectorizing so that completed line registers not less than 55 on Hunter Nite Visibility Meter.

C. Preformed Plastic Traffic Markings:
1. Prepare roadway surface by removing dirt, dust, oily substances and other foreign matter before installing plastic markings.
2. Do not install plastic marking on wet or damp pavement.
3. Make installations in neat, workmanlike manner with ends and edges of successive strips of material even.
4. Position center and lane markings using chalk as guides.
5. Installation on sheet-asphalt surfaces:
   a. When plastic markings are to be installed on new sheet-asphalt surfaces, install while asphalt is still hot and immediately before final rolling is performed.
   b. As part of final rolling operation, position and embed plastic marking into surface.
   c. To install plastic markings on existing sheet asphalt, accurately locate and press marking into place and obtain final bond by at least two longitudinal passes of ten-ton roller.
6. Installation on asphaltic-concrete surfaces:
   a. Install as specified for sheet-asphalt surfaces except apply prime coat recommended by manufacturer of plastic markings to pavement surface prior to installation of markings.
7. Installation on portland-cement concrete pavement:
   a. Seal surface of concrete pavement with quick-setting primer to reduce capillary action and improve bond between marking and pavement surface.
   b. Otherwise install as specified for sheet-asphalt pavement.

D. Painting of Curbing and Raised Traffic Bars:
1. Paint curbing and raised traffic bars with traffic-zone paint.
2. Clean surfaces to be painted of dirt, dust, laitance, oil or other foreign substances.
3. Allow 14 days minimum after installation of portland-cement concrete before painting.
4. Curbing:
   a. Paint top and front of curbing in locations shown with one coat of nonreflectorized traffic-zone paint as specified.
5. Raised traffic bars:
   a. Paint surfaces, except bottom of raised traffic bars with one coat of white traffic-zone paint and apply glass spheres before paint has hardened.
   b. Apply paint and glass spheres as specified.

END OF SECTION