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SECTION 1087
PAVEMENT MARKINGS

1087-1 GENERAL

Yellow and white pavement markings shall be retroreflective. Black pavement markings shall be matte, non-retroreflective.

The material manufacturer has the option of formulating the pavement marking material according to his own specifications; however, the manufacturer shall meet all the minimum requirements specified herein.

All pavement marking materials, pigments, beads, highly reflective media and resins shall be free from all skins, dirt and foreign objects.

Use pavement marking materials capable of being fabricated into pavement markings of specified dimensions and adhering to asphalt and Portland cement concrete pavements when applied in accordance with their manufacturer’s recommendation.

Pavement marking materials upon heating shall not exude fumes, which are toxic, or injurious to persons or property.

Homogeneously mix all pavement marking materials.

1087-2 COMPOSITION

(A) Paint Composition

Pavement marking paint shall be a ready mixed type paint product conforming to Federal Specification TTP 1952F with spraying consistency suitable for use as a retroreflective pavement marking. Glass beads are dropped by suitable pressurized means into the wet paint as it is applied to the pavement.

(B) Removable Tape Composition

Removable tape pavement marking shall be composed of materials as specified by their manufacturer.

Use removable tape markings capable of conforming to pavement contours, breaks, faults, etc. through the action of traffic at normal pavement temperatures. The tape shall have resealing characteristics such that it is capable of fusing with itself and previously applied marking tape of the same composition under normal conditions of use. The removable tape markings shall be patchable.

Use removable tape markings capable of adhering to the pavement by a pressure-sensitive pre-coated adhesive or as directed by the manufacturer.

(C) Thermoplastic Composition

Use thermoplastic alkyd/maleic pavement markings composed of the materials in Table 1087-1.

TABLE 1087-1 PHYSICAL PROPERTIES OF THERMOPLASTIC ALKYD/MALEIC PAVEMENT MARKINGS	
Component	By Weight
Alkyd/Maleic Binder	18.0% Min
Glass Beads (Premixed)	30.0% Min
Titanium Dioxide Pigment (ASTM D476 Type 2)	10.0% Min.
Yellow Pigment (For Yellow Marking Only) Silica Encapsulated Lead Chromate Pigment	4.0% Min.

Use white thermoplastic that does not contain anatase titanium dioxide pigment.

1 Provide yellow thermoplastic that contains only heat resistant silica encapsulated lead
2 chromate pigment. The lead chromate pigment shall contain at least 60% lead chromate.

3 Calcium carbonate and inert fillers may be as opted by the manufacturer, providing all
4 other qualifications are met.

5 The total silica content used in the formulation of the thermoplastic shall be the premixed
6 glass beads and/or highly reflective media. Uniformly disperse the pigment, beads,
7 media and filler in the binder.

8 The Alkyd/maleic binder shall consist of a mixture of synthetic resins (at least one
9 synthetic resin shall be solid at room temperature) and a high boiling point plasticizers.
10 At least 1/2 of the binder composition shall be 100% maleic-modified glycerol of resin
11 and be no less than 15% by weight of the entire material formulation. The binder shall
12 contain no petroleum hydrocarbon resins. Use resins/rosins that are maleic-modified
13 glycerol esters.

14 The thermoplastic material shall be free of contaminates and be homogeneously dry-
15 blended or hot mixed from 100% virgin stock using no reprocessed materials, (excluding
16 the requirement to use reprocessed glass).

17 The thermoplastic material shall not deteriorate or discolor when held at the application
18 temperatures for at least 4 hours or upon repeated reheating (at least 4 times).

19 The color, viscosity and chemical properties versus temperature characteristics of the
20 thermoplastic material shall remain constant for up to 4 hours at the application
21 temperature and be the same from batch to batch.

22 The thermoplastic material shall be readily applicable at temperatures between 400°F and
23 440°F from the approved equipment to produce lines and symbols of the required above
24 the pavement thickness.

25 **(D) Cold Applied Plastic Composition**

26 The cold applied plastic pavement marking shall consist of a mixture of high quality
27 polymeric materials, pigments and glass beads distributed throughout its base cross-
28 sectional area, with a reflective layer of beads bonded to the top surface.

29 The cold applied plastic markings shall adhere to the pavement by a pressure-sensitive
30 pre-coated adhesive.

31 The cold applied plastic shall conform to pavement contours, breaks, faults, etc. through
32 the action of traffic at normal pavement temperatures. The film shall have resealing
33 characteristics such that it is capable of fusing with itself and previously applied marking
34 tape of the same composition under normal conditions of use. The cold applied plastic
35 pavement marking shall be patchable.

36 **1087-3 COLOR**

37 All pavement markings, without drop-on beads and/or media, shall visually match the color
38 chips that correspond to the Federal Standard Number 595b for the following colors:

Crystal: Color No. 17886 (White)

Yellow: Color No. 13538

Black: Color No. 37038

39 **1087-4 GLASS BEADS**

40 **(A) Composition**

41 The silica content of the glass beads shall be at least 60%.

42 Manufacture the beads from 100% recycled non-pigmented glass from a composition
43 designed to be highly resistant to traffic wear and to the effects of weathering. All

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1 standard intermix and drop-on glass beads shall be manufactured using 100% North
2 American recycled glass cullet.

3 All intermixed and drop-on glass beads shall not contain more than 75 ppm arsenic or
4 200 ppm lead.

5 **(B) Physical Characteristics**

6 Use glass beads that are colorless, clean, transparent and free from milkiness, excessive
7 air bubbles, skins and foreign objects. Use glass beads with a minimum refractive index
8 of 1.50 when tested by the liquid immersion method at 77°F ± 9°F in accordance with
9 ASTM D1214 using the Becke Line Method or an equivalent method. Use glass beads
10 that are spherical in shape and essentially free of sharp angular particles or particles
11 showing surface scarring or scratching.

12 All intermixed and drop-on glass beads shall comply with NCGS § 136-30.2 and 23 USC
13 § 109(r).

14 **(C) Gradation & Roundness**

15 Use drop-on and intermixed glass beads in all pavement markings with at least 80% true
16 spheres when tested in accordance with ASTM D1155. Drop-on and intermixed glass
17 beads used on any pavement markings shall meet Table 1087-2.

TABLE 1087-2 GLASS BEAD GRADATION REQUIREMENTS		
Sieve Size	Gradation Requirements	
	Minimum	Maximum
Passing #20	100%	--
Retained on #30	5%	10%
Retained on #50	40%	80%
Retained on #80	15%	40%
Passing #80	0%	5%
Retained on #200	0%	5%

18 **(D) Chemical Resistance**

19 Conduct the following chemical resistance test on all glass beads:

20 Place 3 to 5 g portions of the same glass bead batch to be tested in three separate glass
21 beakers or three porcelain dishes. Cover one sample with distilled water, cover the
22 second sample with 3N solution of sulfuric acid and cover the third sample with 50%
23 solution of sodium sulfides. After one hour of immersion, examine the glass bead
24 samples microscopically for evidence of darkening or frosting. All three samples shall
25 show no evidence of darkening or frosting.

26 **(E) Moisture Resistance**

27 Conduct the following moisture resistance test on drop-on glass beads:

28 Place a 2 lb. minimum sample of glass beads in a clean, washed cotton bag with a thread
29 count of 50 warp, 50 woof. Immerse the bag containing the sample in a container of
30 water for 30 seconds or until the water covers the spheres, whichever is longer. Remove
31 the bag from water and force excess water from the sample by squeezing the bag.
32 Suspend the bag and allow to drain for 2 hours at room temperature 70°F to 72°F. Then
33 mix the sample in the bag by shaking thoroughly. Transfer the sample slowly to a clean
34 dry glass funnel having a stem of 4 inches in length with 1/4 inch inside diameter. The
35 entire sample shall flow freely through the funnel without stoppage. When first
36 introduced in the funnel, if the spheres clog, it is permissible to lightly tap the funnel to
37 start the flow.

1 **1087-5 PACKAGING FOR SHIPMENT**

2 Deliver all pavement marking and glass bead materials to the project in suitable containers
3 packaged by the manufacturer. Clearly and adequately mark each material container to
4 indicate the material, color, date of manufacture, process, batch or lot number, manufacturer's
5 name and location, temperature application range, shelf life and include the MSDS.

6 Thermoplastic pavement marking materials shall be in block or granular form packaged in
7 either suitable corrugated containers or thermal degradable plastic bags to which it will not
8 adhere during shipment or storage.

9 Package glass beads in moisture resistant packaging.

10 **1087-6 STORAGE LIFE**

11 All pavement marking materials shall meet this Specification for one year from the date of
12 shipment from the manufacturer to the Contractor, or the project when stored properly by the
13 manufacturer's recommendation. Replace any pavement marking materials not meeting these
14 Specifications.

15 **1087-7 TESTS TO BE PERFORMED**

16 When independent test laboratory tests are required, perform them on samples taken by
17 an agency certified by the Department from the same process, batch or lot number as the
18 material shipped to the project. The test reports shall contain the lot number. Use Department
19 approved independent test laboratories.

20 Perform the following tests on thermoplastic pavement marking materials, intermixed glass
21 beads and drop-on glass beads unless prescribed otherwise by the Engineer:

22 **(A) Intermixed and Drop-on Glass Beads**

23 Use X-ray Fluorescence for the normal sampling procedure for intermixed and drop-on
24 beads, without crushing, to check for any levels of arsenic and lead. If any arsenic or
25 lead is detected, the sample shall be crushed and repeat the testing using X-ray
26 Fluorescence. If the X-ray Fluorescence test shows more than LOD of 5 ppm, test the
27 beads using United States Environmental Protection Agency Method 6010B, 6010C or
28 3052 for no more than 75 ppm arsenic or 200 ppm lead.

29 **(B) Thermoplastic Pavement Marking Material Composition**

- 30 (1) % Binder tested in accordance with ASTM D4797.
31 (2) % Titanium Dioxide Pigment tested in accordance with ASTM D3720 or D4764.
32 (3) % Lead Chromate Pigment tested in accordance with D4797.
33 (4) % Glass Beads tested in accordance with ASTM D4797.

34 Except ash, use a 100 gram sample rather than a 10 gram sample to allow for testing of
35 gradation and percent of rounds. Provide the results of sieve analysis and % rounds.

36 **(C) Flash Point**

37 The thermoplastic shall have a flashpoint of no less than 500°F when tested in
38 accordance with ASTM D92 COC.

39 **(D) Requirements**

40 The thermoplastic material after heating for 240 ± 5 minutes at $425 \pm 3^\circ\text{F}$ and cooled to
41 $77 \pm 3^\circ\text{F}$ shall meet the following:

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- 1 (1) Color
- 2 (a) White
- 3 Daylight reflectance 2° Standard observer and CIE illuminant
- 4 Using XYZ scale D65/10° - 80% minimum
- 5 ASTM E1349
- 6 Yellowness Index - The white thermoplastic shall not exceed a yellowness index
- 7 of 0.12
- 8 (b) Yellow
- 9 Daylight reflectance at 2° Standard observer and CIE illuminant
- 10 Using XYZ scale D65/10° - 45% minimum =Y
- 11 ASTM E1349
- 12 (2) Bond Strength
- 13 The bond strength shall be 200 psi or greater in accordance with ASTM D4796.
- 14 (3) Cracking Resistance at Low Temperatures
- 15 After applying a 4 inches, 125 mil draw-down to concrete blocks and cooling to 15 ±
- 16 3°F, the material shall show no cracks at an observation distance of 12 inches.
- 17 (4) Specific Gravity
- 18 The specific gravity shall be 1.95-2.20 in accordance with ASTM D792.
- 19 (5) Softening Point
- 20 The softening point shall be 215 ± 15°F in accordance with ASTM D36.
- 21 (6) Drying Time
- 22 When applied at a thickness of 125 mils, the material shall set to bear traffic in no
- 23 more than 2 minutes when air and substrate temperature is 50°F ± 3°F (and no more
- 24 than 10 minutes when the air and substrate temperature is 90°F ± 3°F when applied
- 25 at temperature of 412.5 ± 12.5°F in accordance with AASHTO T 250.
- 26 (7) Alkyd Binder Determination
- 27 The thermoplastic material shall immediately dissolve in diacetone alcohol. Slow
- 28 dissolution is evidence of the presence of hydrocarbon binder components.
- 29 (8) Indentation Resistance
- 30 The Shore Type A2 Durometer with a 4.41 lb. load applied shall be between 40 and
- 31 75 units after 15 seconds at 115°F in accordance with ASTM D2240.

1087-8 MATERIAL CERTIFICATION

33 Furnish the following pavement marking material certifications in accordance with
34 Article 106-3:

Glass Beads	Type 3 Material Certification and Type 4 Material Certification
Paint	Type 3 Material Certification
Removable Tape	Type 3 Material Certification
Thermoplastic	Type 3 Material Certification and Type 4 Material Certification
Cold Applied Plastic	Type 2 Material Certification and Type 3 Material Certification
Polyurea	Type 3 Material Certification