

**SECTION M.07
PAINT**

M.07.01--General for All Paints and Enamels:

1--Paints and enamels shall consist of pigments of the required fineness and composition, ground in the required vehicle by a suitable grinding machine to the required fineness. All pigments, resins, oils, thinners and driers used shall be of the best quality, free from adulterants of any kind and shall comply with the specific requirements of the specifications. Materials not definitely covered by specifications shall be of the best quality used for the purpose in good commercial practice.

2--Proportions: All proportions as specified in formulas are by mass unless otherwise specified.

3--Fineness: All pigments, except aluminum, unless otherwise specified, shall be so finely ground that 100 percent shall pass through a 75 μm sieve; and not less than 97 percent shall pass through a 45 μm sieve.

4--Curdling, Livering, Leveling: No paint or enamel shall liver or curdle, and the pigment shall remain in suspension in a satisfactory manner. The enamel type paints shall level properly and not show brush marks.

5--Colors: All paints and enamels shall be matched to the Department's standard shades. Color chips may be obtained at the Laboratory.

6--Time of Drying: All paints or enamels, unless otherwise specified, shall dry to the full gloss in not more than 18 hours.

7--Mass per Liter: The mass per liter of all paints and enamels shall be determined at 25° C.

8--Shipping: All paints and enamels shall be shipped in strong metal containers, plainly marked with the name, net mass and volume of paint or enamel content. The manufacturer's name, address, date and lot number shall be stenciled on every package.

9--Samples, Sampling, and Testing: When so requested, samples and certified analysis of all pigments, oils, resins, thinners, driers or paint furnished shall be supplied by the manufacturer within 10 days after request is made therefor.

Sampling and testing will be in accordance with ASTM, Federal Supply Service, or by methods on file in the Laboratory of the Department.

The following tests on the paints will follow the procedures outlined in Federal Test Method Standard No. 141: Paint, Varnish, Lacquer and Related Materials; Methods of Inspection, Sampling and Testing.

Tests	Methods
Percentage of pigment	4021
Isolation of vehicle	4032
Nonvolatile in vehicle	4041
Phthalic anhydride	7021
Mass per liter	4184
Uncombined water	4081
Coarse particles and skins	4092
Viscosity: Krebs-Stormer	4281
Drying time	4061

Condition in container	3011
Fineness of Grind	4411
Skinning (48 hours)	4141
Brushing properties	2141,4321
Spraying properties	2131,4331

M.07.02--Coating Systems for Structural Steel: The coating system to be used shall be selected from the Product Reference List of the latest Product Use Status Lists for CDOT Projects. Coating materials on this list are prequalified by meeting the NEPCOAT Specification Criteria for Protective Coatings.

Color: The color of the topcoat shall be as noted on the plans (FS 595 Color Number).

Packaging and Labeling of Coating Material: The container shall be designed to store the specific coating material. Each container of coating materials shall bear a label that clearly shows the name of the coating manufacturer, the name of the product, the lot and batch numbers, the date of manufacture and the shelf life expiration date. The label shall also include complete specific instructions for opening the container and for mixing, thinning, and applying the coating material contained therein. If the coating material cannot be positively identified from the label on the container, it shall not be used.

Delivery: Coating material shall be furnished in the manufacturer's original sealed and undamaged container.

Control of Materials: For each coating material, a Certified Test Report and a Materials Certificate shall be submitted in conformance with Article 1.06.07. The Certified Test Report shall contain the data required in NEPCOAT Specification Criteria for Protective Coatings, Section VII, Groups I and II.

M.07.03--Vacant

M.07.04--Vacant

M.07.05--Vacant

M.07.06--Vacant

M.07.07--Black Paint: Black paint shall be a refined tar product. It shall be homogeneous and shall dry hard in 5 hours, under normal weather conditions, with a jet black color.

It shall conform to the following requirements:

	Min.	Max.
Water Content, %	-----	0.5
Engler Viscosity at 40° C.	5	8
	Min.	Max.
Free Carbon Insoluble in CS ₂ %	-----	12
Distillation:		
0—170 °C, %	8	20
0—235 °C, %	15	35
0—270 °C, %	-----	41
0—300 °C, %	-----	46
Softening Point of Distillation Residue (R&B), ° C	55	70

M.07.08--White Undercoat for Semigloss White Enamels: This white undercoat for semigloss white enamel shall meet the requirements of FS TT-P-659 for primer-surfacer, synthetic tints, and white for metal and wood surface.

M.07.09--Semigloss White Enamel:

1—Enamel Composition:

	Min.	Max.
Pigment, %	37	-----
Vehicle, %	-----	63
Volatile matter in vehicle, %	-----	55
Coarse particles retained on 45 µm screen based on pigment, %	-----	0.5
Viscosity, Krebs Units at 25 °C.	65	75
Mass per Liter, kg	1.2	-----
Fineness of grind (North Standard)	5	-----

2—Pigment Composition:

	Min.	Max.
Titanium Dioxide, %	60	-----
Zinc Oxide (lead free), %	-----	7
Extender Pigments, %	-----	33

The titanium-dioxide shall meet FS TT-P-442, Type 3.

The lead-free zinc oxide shall meet FS TT-P-00463 French process.

The extender pigments shall consist of any one of the following or combination thereof: magnesium silicate, barium sulfate or diatomaceous silica. A ratio of 50 percent magnesium silicate and 50 percent diatomaceous silica has been found to be satisfactory in order to produce the desired semigloss appearance.

3--Vehicle: The vehicle shall contain not less than 45 percent solids by mass and shall be composed of a long oil soya-modified alkyd resin solution or solutions, petroleum solvent thinners and driers. Rosin or rosin derivatives shall not be present. The alkyd resin solution or solutions shall conform to the FS TT-R-266, Type 1, Class A.

4--Specular Gloss: The enamel shall be flowed on a tin panel and allowed to dry for 24 hours before measuring. The specular gloss at 60 degree angle of incident, ASTM D 523 shall be between 35 and 45.

5--Setting and Drying Time: This enamel shall set to touch in less than 5 hours. It shall dry hard and tough in not more than 24 hours.

6--Flash Point: The flash point shall not be below 30° C when determined by the Pensky-Martin closed flash tester.

7--Water Resistance: The enamel shall be flowed on a tin panel and allowed to dry for 48 hours. After being immersed for 18 hours in distilled water, it shall show no blistering or wrinkles upon removal and shall show no dulling or change in color after two hours' recovery.

8--Skinning: This enamel shall not skin over within 48 hours in a three-quarters filled closed container. Small amounts of antiskinning agents, wetting agents, suspension agents and antidrier absorption agents may be added at the discretion of the manufacturer.

9--Working Properties: The enamel shall be well ground, shall not settle in the container, shall be capable of being broken up with a paddle to a smooth, uniform enamel of good brushing consistency and shall have good flowing, covering and leveling properties.

M.07.10--Vacant

M.07.11--Vacant

M.07.12--Aluminum Finish Coat--Bridge Color Number 17178: This ready-mixed aluminum paint shall be applied over the second field coat and shall conform to the following requirements:

Pigment: The leafing aluminum pigment shall consist entirely of finely divided, polished aluminum flakes in paste form, and shall meet the minimum requirements for coarse particles and leafing of FS TT-P-320, Type II, Class B, latest revisions. The leafing aluminum paste shall be mixed with the vehicle on the basis of 0.24 kg of paste to 1 liter of vehicle.

Vehicle: The vehicle shall consist of a long oil alkyd resin varnish suitable for making a ready-mixed aluminum paint. The resin shall conform to the type described in FS TT-R-226, Type I, Class A. The vehicle shall be formulated as follows:

Long oil alkyd resin solution conforming to FS TT-R-266, Type I, Class A	45 kg (47 L)
Mineral Spirits	18 kg (22.5 L)

After accurately determining the acid number of the vehicle, and before adding driers, 113 g of Alcoa Stabilizer No. 5 per acid number per 45 kg of vehicle solids shall be added. Example: For a vehicle with an acid number of 7 on nonvolatile basis, add 790 g of Stabilizer for every 45 kg of vehicle solids.

The vehicle, with Stabilizer added, shall stand for at least 18 hours before mixing with the aluminum paste pigment.

Driers shall not be added until after mixing the stabilized vehicle with the aluminum paste pigment. At that time cobalt naphthenate, manganese naphthenate and zirconium octoate shall be added using 0.5% cobalt, 0.03% manganese and 0.3% zirconium, based on vehicle solids.

The finished vehicle shall meet the following requirements:

- (1) It shall be clear and transparent. (4261)*
- (2) The viscosity shall be between 0.085 and 0.125 Pa-s corresponding to tubes C to E of the Gardner Bubble Viscometer. (4271)
- (3) It shall contain not less than 48% by mass of nonvolatile matter. (4041)
- (4) It shall contain not less than 23% phthalic anhydride (quantitative) based on nonvolatile content. (7021)
- (5) The moisture content shall not exceed 0.1% (4081)
- (6) There shall be no skinning after 48 hours in a half-filled, tightly closed container. (4141)

- (7) A flow-out film of the vehicle (with drier added for test purposes) on a 28-gage tin plate panel, air-dried for 48 hours, shall withstand immersion in water at $24 \pm 3^\circ \text{C}$ for 24 hours without showing whitening, dulling, checking, or other serious defect 2 hours after removal. (Paragraph 4.47 of TT-R-266).

Mixed Paint:

(1) **Composition** --The paint shall show the following composition by mass:

	Min. %	Max. %
Paint nonvolatile (4041)	53.0	—
Pigment (aluminum pigment non-volatile)	13.0	—
Total impurities (mica, filler, or other adulterants)		None
Coarse pigment particles on 45 μm mesh screen (paint basis)	—	0.2
Vehicle		84.0
Nonvolatile matter	44.0	—
Volatile thinner	—	56.0

(2) **Mass per liter**--1.0 kg min. (4184)

(3) **Working properties** --The paint, as received, shall show only slight settling, and the pigment shall be readily dispersed by moderate stirring. The resulting paint shall be smooth and uniform in appearance, free from skins or coarse particles and suitable for application by brush or spray.

(4) **Leafing** --The paint, when flowed on a clean glass panel, supported at an angle of 45, and then allowed to dry, protected from all drafts, for 24 hours at $24 \pm 3^\circ \text{C}$, shall produce a film comparable in smoothness, color, luster and opacity to that of a similar film applied at the same time and in the same manner, using a standard comparison paint. The comparison standard shall be prepared by freshly mixing 142 g of aluminum paste meeting FS TT-P-320, Type II, Class B, with 0.5 L of long oil alkyd varnish, conforming to the vehicle described in M.07.12.

(5) **Stability** --Sample of the paint under test, set aside in full, tightly closed container for 30 days at $24 \pm 3^\circ \text{C}$, shall also pass the test for leafing, given in Paragraph (4).

(6) **Moisture Content** --The paint shall contain not more than 0.1% water as received. (4081). The paint container described in paragraph (5) shall show no gas pressure after 30 days storage at $24 \pm 3^\circ \text{C}$.

(7) **Drying Time:**

Set-to-touch	1 hour max.
Handling	12 hours max.

(8) **Viscosity** --The viscosity of the paint as received shall be between 40 and 55 seconds as determined by a No. 4 Ford Cup. (4282).

*Unless otherwise noted, all numbers in parenthesis refer to sections in Federal Test Method Standard No. 141.

M.07.13--Vacant

M.07.14--Vacant

M.07.15--Vinyl Wash Pretreatment: This pretreatment shall be a two-component paint mixture conforming to the requirements of DOD-P-15328 PRIMER (WASH) PRETREATMENT prepared in accordance with the manufacturer's printed instruction.

The addition of a suspending agent to the wash pretreatment may be permitted subject to the approval by the Engineer as to the type and quantity of agent requested.

M.07.16--Vacant

M.07.17--Zinc Silicate Primer: The zinc silicate primer shall be a self-cure, two-component, ethyl silicate vehicle type, zinc silicate paint, which, when properly mixed and applied, cures without use of a separate curing solution.

It shall conform to the following requirements:

1--Properties of Pigment Component: The zinc portion of the pigment component shall be a finely divided zinc powder containing, by mass, a minimum of 94 percent metallic zinc and a minimum of 98 percent total zinc using Federal Test Standard No. 141, Method 7221. All other materials contained in the pigment component shall be inert. The pigment component shall also conform to the following requirements:

	Min.	Max.
Specific gravity of zinc powder (ASTM D 153)	7.0	7.15
Average particle size in micrometers (as determined by the Fisher Sub-Sieve Sizer)	—	9.5

2--Properties of Vehicle Components: The vehicle shall consist primarily of a partially hydrolyzed ethyl silicate in an appropriate alcohol solvent and shall have the following properties:

	Min.	Max.
Matter non-volatile at 105 °C, percent by mass	39	43
Silicon Dioxide, percent by mass of vehicle (without pigments)	9.0	12
Mass per liter, kg at 25 °C	1.0	—
Storage life of vehicle at 25 °C, months, min.	12	—

3--Properties of Mixed Paint:

	Min.	Max.
Mass per liter at 25° C, kg	2.0	--

The total zinc portion shall be at least 79 percent by mass of the total solids of the dried coating. The total solids, when heated at 105 C for one-half hour shall be not less than 72% by mass.

The total solids by volume shall be not less than 65%.

The paint shall tolerate up to one percent water contamination by mass without gellation.

The usable pot life of the mixed paint shall be not less than 8 hours at 25° C There shall be no hard settling which cannot be easily redispersed during this period.

Working properties shall be satisfactory at all temperatures and conditions under which the paint is applied to produce a satisfactory sprayable coating.

The mixing paint shall be so formulated as to produce a distinct contrast in color with the blast cleaned metal surfaces and any top coat.

4--Resistance Tests: Test panels of steel meeting the requirements of ASTM D 609 having dimensions of 50 mm by 127 mm by 3.2 mm, shall be blast cleaned in accordance with SSPC-SP 10 "Near-White Blast Cleaning." A 75 µm coating (dry thickness) shall then be applied to the test panels in accordance with the manufacturer's current printed instructions. The coating shall be cured as recommended by the manufacturer. Each of the following tests shall be performed on one or more test panels. The materials will not be accepted if any individual test panel fails any of the following tests:

(a) Fresh Water Resistance. Panels shall be scribed down to base metal with an X of at least 50 mm legs and shall be immersed in fresh tap water at $24 \pm 3^\circ$ C. The panels shall show no rusting, blistering, or softening when examined after 30 days.

(b) Salt Water Resistance. Panels shall be scribed down to base metal with an X of at least 50 mm legs and immersed in 5 percent sodium chloride at $24 \pm 3^\circ$ C. The panels shall show no rusting, blistering, or softening upon examination after 7, 14 and 30 days. The sodium chloride solution shall be replaced with fresh solution after each examination.

(c) Weathering Resistance. Panels shall be tested in accordance with ASTM G 23, Type D. The panels shall be placed on test at the beginning of the wet cycle. After 1,000 hours continuous exposure, the coating shall show no rusting, loss of adhesion to the steel test panel, or blistering.

(d) Salt Fog Resistance. The test panels will be scribed in an X pattern of at least 50 mm legs, to the steel substrate and shall be tested in accordance with ASTM B117. After 3,000 hours of continuous exposure, the coating shall exhibit no loss of bond, rust creepage or blistering at the scribe beyond 4.2 mm and no more than 2 percent rust at the edges.

(e) Resistance to Elevated Temperature and Thermal Shock. Panels shall be exposed to a temperature of 260° C for one hour, then quenched immediately in $18 \pm 3^\circ$ C water. Panels subjected to this test shall show no blistering or flaking of the coating.

5--Application: 75 µm (dry thickness). The coating shall be capable of being applied in accordance with Specification requirements. All application shall be done in accordance with the manufacturer's latest printed instructions. Procedures shall also conform to the following requirements:

After initial mixing, the paint shall be strained through a metal 600 µm to 300 µm mesh screen.

Up to 0.5 L of thinner per 4 L may be added to the paint. The type of thinner shall be that approved by the manufacturer of the paint.

Stirring paddles on mechanical mixers shall reach to within 25 mm of the bottom of the stirring container during mechanical mixing.

Airless spray equipment for application of inorganic zinc silicate paint shall provide pressure of about 15 MPa at the nozzle. Fluid hose between pot and nozzle shall not be less than 9.5 mm inside diameter. Pressure may vary depending on tip size and pump.

Conventional spray equipment for application of inorganic zinc silicate paint shall provide pressure of not less than 70 kPa at the pot and 210 kPa at the nozzle. Fluid hose between pot and nozzle shall not be less than 12.5 mm inside diameter. The inorganic zinc primer coat shall not be applied when the surrounding air temperature is below 4° C.

6--Packaging and Labeling: The two components shall be packaged, in two separate containers, so that one unit of the pigment shall be mixed with one unit of the vehicle in making the paint. The lining of the vehicle container shall be of a type that will prevent attack of the container.

Each container shall bear a label clearly showing the name of manufacturer, brand name of paint, lot number, date of manufacture, net mass of contents and complete instructions and precautions for use. The instructions and precautions need only appear on the vehicle component container. The labels shall also state that containers of unused material must be kept tightly sealed, and the paint must be used within 12 hours from the time it was mixed when the temperature does not exceed 32° C. All mixed paint not used within this time shall be wasted.

7--Control of Materials: A Certified Test Report and a Materials Certificate will be required in accordance with Article 1.06.07. The Certified Test Report shall specifically include the pigment composition, the vehicle composition, the pigment properties previously stated, the vehicle properties previously stated, including the initial viscosity at 25° C and the viscosity after 72 hours at 60° C, and the PH of the vehicle. The test viscosities listed shall be Brookfield viscosity, Model RVT, No. 1 spindle at 50 rpm. Pa·s.

The mixed paint properties shall include: (a) the exact ratio, by mass, of the pigment component, (b) mass per liter at 25° C, kg, (c) viscosity, KU @ 25° C, (d) Viscosity, KU @ 25° C, after 24 hours, (e) Non-Volatile @ 105° C, percent by mass, (f) Dry Time @ 25° C, and 50% relative humidity, 150 µm doctor blade clearance: (1) Set to touch, hours and (2) Dry Hard, hours, (g) Pencil Hardness when applied to plate glass panel with a 150 µm gap doctor blade and cured for 15 days at a relative humidity of 90-100 percent, (greater than H, 2H, etc.)

M.07.18--Vacant

M.07.19--Vacant

M.07.20--Waterborne Pavement Marking Paint: This is for white and yellow waterborne pavement marking paint that is to be applied to bituminous concrete and portland cement concrete pavements. This paint shall be capable of being applied with paint striping equipment that does not require heating above ambient temperatures. All requirements shall be as specified in Article M.07.21, except as follows:

1. Total nonvolatile shall not be less than 70 percent by mass;
2. Pigment shall be 45-55 percent by mass;
3. Mass per liter shall not be less than 1.50 kg/L when tested in accordance with ASTM D 1475; and
4. Drying time to no pick up shall be 15 minutes or less when tested in accordance with ASTM D 711.

M.07.21--Hot-Applied Waterborne Pavement Marking Paint: This is for white and yellow fast-drying waterborne pavement marking paint to be applied to bituminous concrete and portland cement concrete pavements. This paint shall be capable of being applied with paint striping equipment at an application temperature of 54°C to 63°C.

General: Specifications and publications that apply are as follows:

FS: TT-P-1952D Paint, Traffic and Air Field Marking, Water Emulsion Base; Federal Test-Method Standard #141 Paint, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling and Testing; FS No. 595 Colors; and HH-R-590 Roofing Felt (Asbestos, Asphalt-saturated).

ASTM Standards: D211-Specifications for Chrome Yellow and Chrome Orange; D476-Specifications for Titanium Dioxide Pigments; D562 Test for Consistency of Paints Using the Stormer Viscometer; D869-Test for 45-deg, 0-deg Directional Reflectance Factor of Opaque Specimens by Broad Band Filter Reflectometry.

Detailed Requirements, Formulation and Manufacture: The paint shall be formulated and manufactured from first-grade raw materials and shall be free from defects and imperfections that might adversely affect the serviceability of the finished product. The materials shall not exhibit settling or jelling after storage in the sealed containers as received that will affect the performance of the products. The paint shall provide the proper anchorage, refraction and reflection for the finished glass spheres when applied as specified.

Composition: The composition of the paint shall be at the discretion of the manufacturer, provided that the finished product meets the requirements of any applicable Federal, State or Local regulations for products of this type and the requirements as follows:

1. Paint shall not contain more than 0.06 percent lead;
2. Total nonvolatile shall not be less than 76 percent by mass;
3. Pigment shall be 58-63 percent by mass;
4. Resin solids shall be composed of 100 percent acrylic emulsion polymer;
5. Volatile organic compounds shall not exceed 150 g/L, excluding water;
6. Closed-cup flash point shall not be less than 38°C, and mass per liter shall not be less than 1.50 kg/L when tested in accordance with ASTM D1475.

Viscosity: The consistency of the paint shall not be less than 80, nor more than 90 Krieb units when tested in accordance with ASTM D562. The paint shall have good spraying characteristics when the material is heated to application temperature of 54-63°C.

Flexibility: The paint shall not show cracking or flaking when subjected to the TT-P-1952D flexibility test in which the panels used shall be tin plates that are 76 mm x 127 mm in area and 35 - 31 U.S. Gauge in thickness. The tin panels shall be lightly buffed with steel wool and thoroughly cleaned with solvent before being used for tests.

Dry Opacity: Both white and yellow paints shall have a minimum contrast ratio of 0.96. Contrast ratio shall be determined by applying a wet film thickness of 127 mm to a standard hiding power chart. After drying, the black and white reflectance values shall be determined using a suitable reflectometer and the contrast ratio determined.

Bleeding: The paints shall have a minimum bleeding ratio of 0.97 when tested in accordance with FS TT-P-1952D. The asphalt-saturated felt shall conform to FS HH-R-590.

Abrasion Resistance: No less than 210 liters of sand shall be required to remove paint film when tested in accordance with TT-P-1952D.

Color: The paint shall not discolor in sunlight and shall maintain colorfastness throughout its life, approximately two years. Color determination shall be made without beads, after a minimum of 24 hours. Color for yellow paint shall be a visual match for 595-13538. If not a visual match, the diffuse day color of the paint shall conform to the CIE Chromaticity coordinate limits as follows:

	<u>x</u> <u>y</u>	<u>x</u> <u>y</u>	<u>x</u> <u>y</u>	<u>x</u> <u>y</u>	<u>y</u> <u>Brightness</u>
White	0.305 0.295	0.360 0.360	0.388 0.377	0.280 0.310	84.0 min
Yellow	0.485 0.455	0.506 0.452	0.484 0.428	0.477 0.438	50.0 min

Glass Bead Adhesion: The paint with glass beads conforming to M.07.30, applied at the rate of 0.72 kg/L of paint, shall require not less than 150 liters of sand to remove paint film and glass beads.

Scrub Resistance: The paint shall pass 300 cycles minimum when tested in accordance with ASTM D2486.

Drying Time: The reflectorized line shall dry to no pick up in 120 seconds or less when applied at the ratio provided for specified glass spheres to paint (the paint at 381 mm \pm 25 mm wet film thickness equivalent to 2.45-2.82 m²/L and the glass spheres at the equivalent rate of 0.72 kg/L). The paint shall be applied with equipment so as to have the paint at a temperature of 54 to 63°C at the spray gun.

Article M.07.22 – Epoxy Resin Pavement Markings:

General Requirements:

Standards: All standards herein are minimum standards.

Identification: Each container must bear a label with the following information thereon: Name and address of manufacturer, production batch number, date of manufacture, shipping point, grade name and/or identification number, type of material, number of gallons, contract number, use intended, directions for application and formula. Improperly labeled samples and deliveries shall be rejected.

Certification: The manufacturer shall furnish a certified test report by an independent testing laboratory prior to the start of work indicating that the material as specified has been tested in accordance with ASTM or ACI testing procedures noted in this specification. The certified test report shall indicate the results of testing for the criteria contained herein.

Additionally, infrared spectrophotometer plots for both components of the test material shall be included by the independent laboratory in the certified test report. The unused material submitted for testing by the independent laboratory (minimum four (4) liters unmixed components) shall be forwarded to the CDOT, Materials Testing Laboratory, 280 West Street, Post Office Box 207, Rocky Hill, Connecticut 06067. This sample shall be labeled as required under Section 1.06.07.

The manufacturer shall furnish certified test reports, in accordance with Section 1.06.07 for each batch delivered for application at the project site.

Detailed Requirements:

(a) **Epoxy Resin Material:** The material shall be composed of epoxy resins and pigments only.

(b) Composition:	WHITE (percent by weight)	YELLOW (percent by weight)
	20% \pm 2% Titanium Dioxide (ASTM D476 Type III)	25% \pm 2% Chrome Yellow (ASTM D 211 Type III)
	80% \pm 2% Epoxy Resins	75% \pm 2% Epoxy Resins

(c) **Color:** The color of the white material shall be no darker or yellower than color chip 17778 of FS No. 595a of the latest issue, when the material is placed in a type EH weatherometer for a period of 500 hours and weathered according to ASTM G 23. Any noticeable discoloration of the epoxy markings, either during or after application to the pavement surface, as determined by the Engineer, will be considered unacceptable. Any discolored areas shall be removed and the markings shall be reapplied in accordance with this specification. The color of the yellow shall be reasonably close to color chip 13538 of the Federal Standard No. 595a of the latest issue.

(d) **Adhesion Capabilities:** When the adhesion of the material to portland cement concrete (the concrete shall have a minimum of 2070 kPa tensile strength) is tested according to ACI 503R testing procedure, the failure of the system must take place in the concrete. The concrete shall be 32° C when the material is applied, after which the material shall be allowed to cure for 72 hours at 23° \pm 2° C.

(e) **Abrasion Resistance:** When the abrasion resistance of the material is tested according to ASTM C 501 with a CS-17 wheel under a load of 1000 grams for 1000 cycles, the wear index shall be no greater than 82. (The wear index is the weight in milligrams that is abraded from the sample under the test conditions).

(f) **Hardness:** The Type D durometer hardness of the material shall be not less than 75 nor more than 90 when tested according to ASTM D2240 after the material has cured for 72 hours at $23^{\circ} \pm 2^{\circ}$ C.

(g) **Tensile Strength:** The tensile strength of the material, when tested according to ASTM D 638, shall not be less than 41 370 kPa after 72 hours cure at $23^{\circ} \pm 2^{\circ}$ C.

(h) **Compressive Strength:** The compressive strength of the material, when tested according to ASTM D 695, shall not be less than 82 740 kPa after 72 hours cure at $23^{\circ} \pm 2^{\circ}$ C.

(i) **Shelf Life:** The individual components shall not require mixing prior to use when stored for a period of 12 months.

(j) **Glass Beads:** General Requirements – The beads shall be transparent, clean, colorless glass, smooth and spherically shaped, free of milkiness, pits, or excessive air bubbles and conform to the following specific requirements:

- **Quality Assurance Control** – The beads shall be segregated into maximum lots of 1125 kg and lot numbers shall be stamped onto each lot. Each lot shall be tested for gradation, rounds and embedment coating.
- **Gradation** – The glass spheres shall meet the following gradation requirements:

<u>Grading “A”</u>		<u>Grading “B”</u>	
<u>Sieve Size</u>	<u>% Passing</u>	<u>Sieve Size</u>	<u>% Retained</u>
#20	100	#10	0
#30	80 – 95	#12	0 – 5
#50	9 – 42	#14	5 – 20
#80	0 – 10	#16	40 – 80
		#18	10 – 40
		#20	0 – 5
		Pan	0 – 2

- **Roundness** – The glass beads shall have a minimum of 80 percent rounds per screen for two highest sieve quantities and no more than 3 percent angular particles per screen for Grading “B”. The remaining sieve fractions shall typically be no less than 75% rounds.
- **Refractive Index** – The glass beads shall have a refractive index of 1.50 to 1.52.

Article M.07.24 - Preformed Black Line Mask Pavement Marking Tape

General Requirements: The preformed, patterned black line mask pavement marking tape shall consist of a matte black, non-reflective tape in widths or sizes sufficiently large to mask the existing markings which are to be temporarily covered.

The patterned masking tape shall be pre-coated with a pressure sensitive adhesive and shall be capable of being adhered to existing markings, on bituminous concrete pavement or Portland cement concrete in accordance with the manufacturer's instructions without the use of heat, solvents or other additional adhesives, and shall be immediately ready for traffic use after application. The Contractor shall identify equipment necessary for proper application and removal, and make recommendations for application that will assure effective product performance.

The preformed, patterned black line masking pavement marking tape shall be suitable for use for one year after the date of receipt when stored in accordance with the manufacturer's recommendations.

Detailed Requirements:

(a) Composition: The non-reflective, patterned black line mask pavement marking tape shall not contain metallic foil and shall consist of a mixture of high quality polymeric materials, pigments and inorganic fillers distributed throughout its base cross-sectional area, with a matte black non-reflective top layer. The patterned surface shall have a minimum of 20 percent of the surface area raised and coated with non-skid particles. The channels between the raised areas shall be substantially free of particles. The film shall be pre-coated with a pressure sensitive adhesive. A non-metallic medium shall be incorporated to facilitate removal.

(b) Skid Resistance: The surface of the patterned, non-reflective black line mask pavement marking tape shall provide an initial average skid resistance value of 60 BPN when tested in accordance with ASTM E 303.

(c) Thickness: The patterned material, without adhesive, shall have a minimum thickness of 1.65 mm at the thickest portion of the patterned cross-section and a minimum thickness of 0.5 mm at the thinnest portion of the cross-section.

(d) Adhesion: The black line mask pavement marking tape shall adhere to the roadway and existing roadway markings under climatic and traffic conditions normally encountered in the construction work zone.

(e) Removability: The black line mask pavement marking tape shall be removable after its intended use, intact or in large pieces, manually, at temperatures above 4° C without the use of heat, solvents, grinding or sand or water blasting. The black line mask pavement marking tape shall be totally removed from existing markings that are adequately adhered to the pavement surface, without damage to the underlying markings.

Article M.07.25 - Black Epoxy Resin Pavement Markings:

Identification: Each container shall have a label affixed to it with the following information thereon: name and address of manufacturer, shipping point, grade production batch number, date of manufacture, grade name and/or identification number, type of material, number of liters, contract number, use intended, directions for application, and formula. Improperly labeled samples and deliveries shall be rejected.

Certification: For each batch of black epoxy resin, Certified Test Reports conforming to Article 1.06.07 shall be submitted from an independent testing laboratory and approved by the Engineer, prior to installation on the project.

Detailed Requirements:

(a) Epoxy Resin Material: The material shall be composed of epoxy resins and pigments only.

(b) Composition:	<u>Component</u>	<u>Percent by Weight</u>
	Carbon Black (ASTM D476 Type III)	7 ± 2
	Talc	14 ± 2
	Epoxy Resins	79 ± 4

(c) Black Aggregate: The moisture resistant aggregate shall meet the gradation requirements as follows:

<u>Sieve Size</u>	<u>Percent Retained</u>
#20	23 - 38
#50	58 - 74
#270	1 - 6
Pan	0 - 0.5

The moisture resistant aggregate shall have a urethane coating. The aggregate shall be angular with no dry dispensement pigment allowed.

(d) Adhesion: The black epoxy resin pavement marking material shall be formulated so as to adhere to the roadway and existing roadway markings under climatic and traffic conditions normally encountered in the construction work zone.

(e) Abrasion Resistance: When the abrasion resistance of the material is tested according to ASTM D 4060 with a CS-17 wheel under a load of 1000 grams for 1000 cycles, the wear index shall be no greater than 82.

(f) Hardness: The Type D durometer hardness of the material shall not be less than 75 nor more than 90 when tested according to ASTM D 2240 after the material has cured for 72 hours at $23^{\circ} \pm 2^{\circ}$ C.

(g) Compressive Strength: The compressive strength of the material, when tested according to ASTM D 695, shall not be less than 82 740 kPa after 72 hours cured at $23^{\circ} \pm 2^{\circ}$ C.

M.07.30--Glass Beads : The glass beads shall conform to the requirements of AASHTO M 247, Type 1.

