

(9) **Painting.** Before final assembly, the Contractor shall clean \*| the case, door frame and Z-crate visor (aluminum portion only) and \*| apply a chromate conversion coating inside and out according to \*| Military Specification MIL-C-5541. The Contractor shall then apply \*| a synthetic enamel conforming to Federal Specification TT-K-529 \*| electrostatically. The color shall be the same as standard traffic \*| signal head. The Contractor shall oven clean the finish for a \*| minimum of twenty (20) minutes at three hundred fifty (350) degrees Fahrenheit.

(E) **Pedestrian Signal Push Button With Integral Sign.** Pedestrian push buttons shall be of tamperproof construction and weatherproof. The \*| Contractor shall construct the pedestrian push buttons so that \*| electrical shocks are impossible to receive. \*

The Contractor shall provide a half (1/2) inch threaded opening at \*| the bottom of the housing for conduit condition. The Contractor shall \*| provide a raise drip around the push button. \*

The sign shall conform to Section 621 - Traffic Control Signs and \*| shown in the contract. The Contractor need not reflectorize the signs. \*

(F) **Dual Indication Unit (Fiberoptics).**

(1) **Functional Requirements.** The dual indication unit shall: \*

(a) display two (2) alternate colored legends of green arrow \*| or yellow arrow. Combinations of colors shall be available by \*| changing color filters installed in the unit. |

(b) The legend shall be clearly visible under any lighting \*| conditions. The Contractor shall provide a visor with the \*| unit.

(c) The signal shall be visible at full intensity anywhere \*| within a twenty (20) degree cone centered about the optical axis.

**712.40 Pavement Markers.** The markers shall have the shape, dimensions and tolerances shown in the contract. The markers shall be of uniform composition \*| and free from surface irregularities, cracks, checks, chipping and other physical damages interfering with appearance or application.

(A) **Type of Markers.**

(1) Type A - Non-Reflective White Markers.

(2) Type C - Red-Clear Reflective Markers.

(3) Type D - 2-Way Yellow Reflective Markers.

(4) Type H - One-Way Yellow Reflective Markers.

- (5) Type J - Non-Reflective Yellow Markers. |
- (6) Type CL - Red-Clear Reflective Markers. |
- (7) Type DL - 2-Way Yellow Reflective Markers. |
- (8) Type HL - One-Way Yellow Reflective Markers. |
- (9) Type DB - 2-Way Blue Reflective Markers. |

(B) **Non-Reflective Markers.** Type A and J Pavement markers shall have the following characteristics:

(1) **Composition of Markers.** The markers shall be ceramic and Class III or Class IV according to each application. The Contractor shall use Class III markers on portland cement concrete or asphalt cement concrete pavement. The Contractor shall use Class IV markers on portland cement concrete pavement only. \*

The Class III and IV pavement markers include a heat-fired, vitreous, ceramic base and a heat-fired, opaque, glazed surface to produce the properties required. The manufacturer shall make markers from suitable combination of mixed clays, shales, talcs, flints, feldspars, or other inorganic material that meets the properties required. The manufacturer shall age the markers thoroughly and evenly. The markers shall be free from defects that affect appearance or serviceability. \*

(2) **Properties of Markers.** |

(a) **Finish.** The top surface of the marker shall be convex. The radius of curvature shall be between three and a half (3-1/2) inches and six (6) inches except that the radius of the half (1/2) inch nearest the edge may be less. Changes in curvature shall be gradual. The top and sides shall be smooth and free of mold marks, pits, indentations, air bubbles, or other objectionable marks or discolorations. \*

The bottoms of the ceramic markers shall be free from gloss or glaze and shall have a number of integrally formed protrusions approximately 0.050 inch projecting from the surface in a uniform pattern of parallel rows.

Each protrusion shall have a face parallel to the bottom of the marker. The area of each parallel face shall be between 0.01 and 0.065 square inches and the combined area of these faces shall be between 2.2 and 4.4 square inches.

The protrusions shall be circular in section.

The number of protrusions should be more than forty-eight (48) and less than two hundred (200). |

To ease forming and mold release, the Contractor may taper the sides of each protrusion. This taper shall not exceed fifteen (15) degrees from perpendicular to the marker bottom. Markers manufactured with protrusions whose diameter is less than 0.15 inch may have an additional taper not exceeding thirty (30) degrees from perpendicular to the marker bottom and extending less than half (1/2) the total height of the protrusion.

The overall height of the marker shall be between 0.68 to 0.80 inch.

**(b) Glaze Thickness.** The thickness of the glazed surface shall be more than 0.007 inch at points located and less than quarter (1/4) inch from the edge of the marker circumference. The manufacture shall measure the glaze thickness on a fractured edge with a calibrated reticle of a microscope of at least twenty-five (25) power.

**(c) Moh Hardness.** The glazed surface of the marker shall have a hardness of a six (6) minimum in the Moh hardness scale. This shall be determined relative to the mineral orthoclase that has a hardness of six (6). Using moderate hand pressure, the hand pressure must be possible to scratch orthoclase with the marker but not possible to scratch the marker with the orthoclase.

**(d) Directional Reflectance (Type A markers only).** The forty-five (45) degrees zero (0) degrees directional reflectance of the marker shall have the following values when tested according to ASTM E 97:

Glazed Surface	75 minimum
Body of Marker	65 minimum

The manufacturer shall make the test on the glazed surface on the top of the convex surface of the marker. The manufacturer shall make the test on the body of the marker on a flat surface of the marker where the manufacturer removes the glaze by grinding with a carborundum wheel.

**(e) Yellowness Index (Type A markers only).** The yellowness index of the marker shall have the following values when tested according to ASTM E 313:

Glazed Surface	0.07 maximum
Body of Marker	0.12 maximum

The manufacturer shall make the test on the glazed surface \*|  
 on the top of the convex surface of the marker. The \*|  
 manufacturer shall make the test on the body of the marker on \*|  
 a flat surface of the marker where the manufacturer removes \*|  
 the glaze by grinding with a carborundum wheel. \*|

(f) **Color (Type J markers only).** The chromaticity of the glazed surface of the marker shall be within the following limits:

Purity (percent)	76 to 96
Dominant Wave Length (mu)	579 to 585
Total Luminous Reflectance (minimum Y value)	0.41

The manufacturer shall make the chromaticity measurements \*|  
 according to California Test Method No. 660. \*|

(g) **Water Absorption.** The average water absorption of the ceramic marker shall not exceed two (2) percent of the dry \*|  
 weight of the test piece when tested according to ASTM C 373. \*|

(h) **Autoclave Test.** The glazed surface of the marker shall not craze, spall or peel when subjected to one (1) cycle at one hundred (100) pounds per square inch for one (1) hour of the autoclave test when tested according to ASTM C 424. \*|

(i) **Strength Test.** The Engineer will select a random sample \*|  
 of five (5) markers of each type and/or Class used for the load \*|  
 test. Each Class III marker shall support a minimum load of one thousand five hundred (1500) pounds and each Class IV marker shall support a minimum load of seven hundred fifty (750) pounds when applying the load in the following manner: \*|

The manufacturer shall make the base of the marker flat \*|  
 using plaster of paris or some other suitable material. The \*|  
 manufacturer shall apply sufficient amount of material to the \*|  
 base of the marker to fill the spaces around the protrusions up to the faces of the protrusions. The protrusions shall not protrude from the prepared finished base.

The prepared marker shall be centered, base down, over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be one (1) inch high, with an internal diameter of three (3) inches and a wall thickness of quarter (1/4) inch. The manufacturer shall apply a load necessary to break the \*|

marker at a speed of 0.2 inch per minute to the top of the marker through a one (1) inch diameter solid metal cylinder centered on the top of the marker. Failure includes a breakage of the marker at a load of less than one thousand five hundred (1500) pounds when applied to Class III markers or less than seven hundred fifty (750) pounds when applied to Class IV markers.

**(j) Sampling.** Twenty (20) markers selected at random will constitute a representative sample for each batch consisting of ten thousand (10,000) markers or less.

Forty markers will constitute a representative sample for lots consisting of more than ten thousand (10,000) markers.

The lot size shall not exceed twenty-five thousand (25,000) markers. However, if a batch represents less than one hundred (100) markers, the Engineer may delete sampling and may accept the markers based on certification of compliance and certified test results.

**(k) Tolerances.**

1. The Contractor shall select three test specimens randomly selected from the sample for each test except as noted in (i) above. The Contractor shall test the specimens according to the contract. If one (1) of the specimens fail according to the contract, the Contractor will test additional samples of double the number of samples originally taken. The failure of one of these additional samples shall be cause for rejection of the entire lot or shipment represented by the sample.

2. At the discretion of the Engineer, the Contractor may take a resample double the number of samples originally taken. Tolerances for resamples shall be in the same ratio as specified above.

**(l) Packaging.** The Contractor shall make shipments in containers that are acceptable to common carriers. The Contractor shall package the shipments to insure delivery in perfect condition. The Contractor shall replace damaged shipments. The Contractor shall mark each package clearly as to the name of the manufacturer, type, color, quantity enclosed, lot and/or batch number, and date of manufacture.

**(C) Reflective Pavement Markers.** The two (2) types of reflective pavement markers are regular size (nominal 4 inches x 4 inches) and low profile size (nominal 2.3 inches x 4.7 inches).



	Specific Intensity		
	Clear	Yellow	Red
0° Incidence Angle	3.0	1.8	0.75
20° Incidence Angle	1.2	0.72	0.30

**NOTE:**

(a) **Angle of Incidence.** The angle formed by a ray from the light source to the marker and the normal to the leading edge normal to the leading edge of the markers face.

(b) **Angle of Divergence.** The angle formed by a ray from the light source to the marker and the returned ray from the marker to the measuring receptor.

(c) **Specific Intensity.** The mean candle power of the reflected light at a given incidence and divergence angle for each foot candle at the reflector on a plane perpendicular to the the incident light.

$$SI = \frac{RL}{IL} \times D^2$$

Where: SI = Specific Intensity  
 RL = Reflected Light  
 IL = Incident Light  
 D = Test Distance

(d) **Test Method.** The Contractor shall locate the markers with the center of the reflecting face five (5) feet from a uniformly bright light source having an effective diameter of 0.2 inch. The photocell receptor width shall be 0.05 inch. The Contractor shall shield the photocell receptor to eliminate stray light. The distance from the center of the light source aperture to the center of the photo cell shall be 0.21 inch. If the Contractor uses a test distance of other than five (5) feet, the Contractor shall modify the source and receptor in the same proportion as the test as the test distance.

(2) **Color.** The color of the reflectors when illuminated by an automobile headlight shall be an accepted red, yellow, clear or blue as required. The outer surface of the shell shall be the same color as the reflective face. Off-color reflection will constitute grounds for rejection.

(3) **Strength Requirements.**

(a) The Engineer will select a random sample of three (3) \*|  
 markers for the load test. \*|

(b) Regular marker (4 inches by 4 inches) shall support a minimum load of two thousand (2,000) pounds as applied in the following manner:

1. The marker shall be centered, base down, over the open end of a vertically positioned hollow metal cylinder.

2. The cylinder shall be one (1) inch high, with an internal diameter of three (3) inches and wall thickness of quarter (1/4) inch.

3. The Contractor shall apply a load necessary to break the marker at a speed of 0.2 inch per minute to the top of the marker through a one (1) inch diameter solid metal cylinder centered on the top of the marker.

(c) Low profile marker (2.3 inches x 4.7 inches) shall support a minimum load of four thousand (4,000) pounds as applied in the following manner:

1. The marker shall be centered base down on the center of a 0.5 inch thick flat steel plate.

2. Apply a load to the top center of the marker by a one (1) inch diameter solid steel plug at a rate of 0.03 inch per minute.

(d) Failure shall constitute breakage or significant deformation of the marker at loads of less than two thousand (2,000) pounds for the regular marker and four thousand (4,000) pounds for the low profile marker.

(4) **Sampling.** The Engineer will select six (6) markers at random from each batch for testing. If a batch represents less than one hundred (100) markers, the Engineer may delete sampling and may accept the markers based on certification of compliance and certified test results.

(5) **Tolerances.** If one of the three (3) samples selected for strength testing fails according to the contract, the Engineer will test six (6) additional samples. The failure of one of these six (6) samples will be cause for the rejection of the entire lot or shipment represented by the samples.

(6) **Packaging.** The Contractor shall make shipments in containers that are acceptable to common carriers. The Contractor shall package the shipments to insure delivery in perfect condition. The Contractor shall replace damaged shipments. The Contractor shall mark each package clearly as to the name of the manufacturer, color, type, lot number, quantity enclosed, and date of manufacture.

(7) The Contractor shall use Type DB reflective markers to show fire hydrant locations. The markers shall measure four (4) inches by four (4) inches and have a minimum area exposed to traffic of twelve and a half (12-1/2) square inches. Maximum slope of the reflective faces shall be less than thirty (30) degrees and more than twenty-seven (27) degrees from the horizontal.

The lens shall be a brilliant blue color and be a true cube-corner type reflex reflector molded of optic grade methyl methacrylate (plastic).

The shell shall be white, molded of high impact acrylonitrile butadiene styrene (ABS).

Type DB reflective markers shall conform to Subsection 712.40(C) - Reflective Pavement Markers and the additional requirements specified herein.

**(D) Temporary Reflective Pavement Markers.** Temporary reflective pavement markers includes an acrylic plastic shell containing one (1) or two (2) hermetically sealed prismatic air cell reflective lenses as required to reflect incident light from a single or opposite directions. The markers shall be about four (4) inches by four (4) inches by three-quarters (3/4) inch with each reflecting lens face sloping at about forty-five (45) degrees. The marker shall be smooth, with rounded corners, except for purposes of identification. The outer surface of the shell shall be of the same color as the reflective face. Off-color reflection will constitute grounds for rejection.

Temporary reflective pavement markers shall conform to:

**(1) Optical Performance.** The manufacturer shall design the shape, finish and color of the marker to provide a diffused specular daytime signal.

The specific intensity of each reflective surface, when tested at 0.2 - degree angle of divergence, shall be not less than the following specified values:

	Specific Intensity		
	Clear	Yellow	Red
0° Incidence Angle	1.00	0.60	0.25
20° Incidence Angle	0.40	0.24	0.10
<b>NOTE:</b> See notes listed in Subsection 712.40(C)(1)			

The Engineer will test a random lot of markers. Failure of \*|  
more than four (4) percent of the reflecting faces will be the \*|  
cause for rejection of the lot.

(2) **Color.** The color of the reflectors when illuminated by an \*|  
automobile headlight shall be an accepted clear, yellow or red \*|  
color as required. Off-color reflection will constitute grounds \*|  
for rejection.

(3) **Strength Requirements.** The Engineer will select a random \*|  
sample of three markers for test purposes. Markers shall support a \*|  
load of ten thousand (10,000) pounds: \*

The Contractor shall center a marker between the flat parallel \*|  
platens of a compression testing machine. The Contractor shall \*|  
center a flat piece of sixty-five (65) durometer rubber six (6) \*|  
inches by six (6) inches by three-eighths (3/8) inch on top of the \*|  
marker. The Contractor shall apply the load slowly through the \*|  
rubber to the top of the marker.

Failure shall constitute cracking or significant deformation \*|  
of the marker at loads less than ten thousand (10,000) pounds. \*

(4) **Sampling, Tolerances and Packaging.** The requirements for \*|  
sampling, tolerances and packaging shall be the same as described \*|  
in Subsections 712.40(C)(4), 712.40(C)(5) and 712.40(C)(6).

(E) **Certification.** The Contractor shall submit a certificate of \*|  
compliance and certified test results indicating that types of markers \*|  
conform to the contract. \*

**712.41 Adhesives for Pavement Markers.** The adhesives used shall be epoxy \*|  
adhesive or bituminous adhesive according to Section 629 - Pavement Markings. \*

(A) **Epoxy Adhesives.** The Contractor shall furnish the adhesives in two \*|  
(2) components. The adhesives are described as Rapid Set Type and \*|  
Standard Set Type.

Adhesives shall have a white "A" epoxy component and a black "B" \*|  
curing agent component. The Contractor shall package each component \*|  
separately. The mixing ratio of Component "A" to Component "B" shall be \*|  
one-to-one by volume. The color of the material when mixed, shall be \*|  
about that of color Nos. 26132 to 26152 of Federal Standard No. 595A. The \*|  
adhesives shall have compositional specifications, together with test \*|  
requirements. No volatile solvents or thinners shall be present in the \*|  
epoxy adhesives.

The Contractor shall not use the adhesives before sampling and \*|  
testing unless the Engineer permits its use. \*

The Contractor shall conduct the tests according to the latest test methods of the American Society for Testing and Materials, Federal Test Method Standard No. 141, and methods in use by the State. \*

The Contractor shall package each component in containers of size proportional to the amount of that component in the mix so that the Contractor uses one (1) container of each component in mixing one (1) batch of epoxy. The containers shall be of such design that the Contractor may remove the contents readily. The Contractor shall seal the containers well to prevent leakage. The containers and labeling shall meet the U.S. Department of Transportation Hazardous Material Shipping Regulations. The containers shall be of a material or lined with a material of such character as to resist actions by the components. The Contractor shall label each container clearly including: \*

- (1) authorized modifications; \*
- (2) designation (Component A or B); \*
- (3) type (Standard or Rapid) if applicable; \*
- (4) manufacturer's name; \*
- (5) date of manufacture; \*
- (6) batch number (a batch includes a single charge of components in a mixing chamber); \*
- (7) directions for use (as specified elsewhere) and \*
- (8) such warning or precautions concerning the contents as may be required by State or Federal Laws and Regulations. \*

The manufacturer of the finished epoxy components shall furnish a notarized Certificate of Compliance and a copy of the label for each material. The certificate shall include a list, by Title and Section, of the State and Federal packaging and labeling laws and regulations that the manufacturer has complied with.

The Contractor shall see the characteristic of the epoxy components to crystallize or thicken excessively before use when stored at temperatures below thirty-five (35) degrees Fahrenheit. The Contractor shall not use materials that shows: \*

- (1) evidence of crystallization, \*
- (2) permanent increase in viscosity or \*
- (3) settling of pigments that cannot be readily redispersed with a paddle. \*

At the time of mixing, components "A" and "B" shall be at a temperature between sixty (60) and eighty-five (85) degrees Fahrenheit. The Contractor shall heat the adhesive components by application of indirect heat. Immediately before mixing, the Contractor shall mix each component thoroughly with a paddle. The Contractor shall use separate paddles to stir each component. Immediately before use, the Contractor shall mix the two (2) components thoroughly together in a one (1) to one (1) ratio by volume. When the Contractor uses automatic proportioning and mixing machine, the Contractor shall maintain the temperature of the components by indirect heating or cooling so that the adhesive will meter, mix and extrude properly. The maximum temperature shall be such that after proper mixing there shall be no excess flow of adhesive from under the marker. When mixed, adhesives shall have a uniform gray color without black or white streaks. The Contractor shall not add solvent to the epoxy.

After mixing, the Contractor shall place the epoxies before thickening of the epoxy begins. Surfaces shall be free of rust, paint, grease, asphalt, and loose and deleterious material.

**(1) Rapid Set Epoxy Adhesive.** Rapid set epoxy adhesive shall be a high viscosity paste formulated primarily for use in bonding pavement markers to portland cement concrete and asphalt concrete. Rapid set epoxy adhesive shall include the following components:

Component A	Parts by Weight
Epoxy Resin <sup>1</sup> . . . . .	90.00
Orthocresol Glycidyl Ether <sup>2</sup> . . . . .	10.00
Titanium Dioxide . . . ASTM D 476 . . . . .	3.00
Talc <sup>3</sup> . . . . .	50.00
Oleophilic Fumed Silica <sup>4</sup> . . . . .	4.50*

Component B	Parts by Weight
High Functionality Polymercaptan Hardener <sup>5</sup> . . . . .	60.00
2, 4, 6-Tri (Dimethylaminomethyl) Phenol <sup>6</sup> . . . . .	7.00
Polysulfide Polymer <sup>7</sup> . . . . .	35.00
Furnace Black <sup>8</sup> . . . . .	0.10
Talc <sup>3</sup> . . . . .	52.00
Oleophilic Fumed Silica <sup>4</sup> . . . . .	3.50 <sup>9</sup>
Silicone Anti-Foam, Type DB 100, 100% Solids . . . . .	0.005

1 Di glycidyl ether of bisphenol A, viscosity, 100-160 poise at 25 degrees Celsius; weight per epoxide equivalent 180-200. Color, Gardner 19 max

2 Viscosity at 25 degrees Celsius, 5-10 Centipoise. Weight per gallon 9.00-9.10 pounds. Weight per epoxide equivalent 180-200.

3 Specific Gravity . . . . . 2.68 to 2.86  
 Oil Absorption, ASTM D 281 . . . . . 26 to 33  
 pH . . . . . 8.9 to 9.6  
 Hegman Rating . . . . . 3 to 5  
 Particle Shape . . . . . Platey  
 Maximum Particle Size, microns . . . . . 55  
 Percent Passing U.S. No. 325 Screen, Minimum . . . . . 99  
 Dry Brightness, minimum . . . . . 93

4 High purity fumed silica, surface treated with a silicone oil, with the following properties: Appearance, fluffy powder; surface area, N2 B.E.T. method, 70+15 M2/gram; pH, 4 grams dispersed in 100 mls of 20/80 volume mixture of ethyl alcohol and distilled water, 4.7; weight percent carbon, 5.0 minimum; ignition loss (dry basis) 2 hours at 1000 degrees Celsius, 6 to 7; specific gravity, 1.8

5 Liquid polymercaptopan resin, viscosity 100-130 poise at 25 degrees Celsius; specific gravity 1.14-1.16; mercaptan value, 3.6 meq/gram. Color, Gardner 1933, 1 maximum. Infrared curve shall match the curve on file in the Transportation Laboratory.

6 Formula weight 265; specific gravity at 25 degrees Celsius/25 degrees Celsius, 0.973; refractive index 1.514 at 25 degrees Celsius; distillation range 96 percent at 130 degrees Celsius to 160 degrees Celsius (0.5-1.5mm); flash point, Tag Open Cup, 300 degrees Fahrenheit minimum; water content 0.06 percent maximum.

7 Specific gravity, 1.24-1.30 at 20 degrees Celsius /200 degrees Celsius; viscosity, 700-1200 centipoise, Brookfield at 25 degrees Celsius; pH water extract 6.0-8.0; moisture content, 0.1 percent maximum; pour point, -15 degrees Fahrenheit; average molecular weight, 1000; flash point, degrees Fahrenheit, Cleveland Open Cup, 390 minimum; sulfur content, percent 36-40; color, Hellige, 9-12. The product shall be a difunctional mercaptan made from 98 mole percent of bis (2-chloroethyl) formal and 2 mole percent of trichloropropane.

8 Surface area, square meters/gram, 115-130; particle diameter, millimicrons, 18-30; pH, 7.0-8.5; fixed carbon (moisture free), percent, 96-98; volatile matter, percent, 1-4; oil absorption, stiff paste endpoint, CCS/gram, 0.80-0.90.

9A range of 4.0 to 5.0 parts is permitted in the A Component and 3.0 to 4.0 parts in the B Component, to achieve the required viscosity and thixotropy. Small preproduction batches should be made to determine the oleophilic silica level best suited for manufacturing equipment used.

The Contractor shall test according to California Test 425. \*|

The components shall have the following characteristics:

Test	Requirements	
	Component A	Component B
Brookfield viscosity, Helipath Spindle TE at 5 rpm, Poise at 77°F.	3000 to 4000	3000 to 4000
Shear Ratio, Minimum at 77°F.	2.0	2.0
Density, lbs. per gallon at 77°F.	11.9 to 12.2	11.9 to 12.2
Skinning, (original container)	None	Slight
Percent Air, maximum	2.0	2.0
<p>Infrared Curves. The Components A and B shall match curves in California Test 425.</p> <p>Storage Stability. The Components A and B shall not change in viscosity and shear ratio by more than <math>\pm 15</math> percent when stored for 2 weeks in closed containers at <math>115^{\circ} \text{ F.} \pm 2^{\circ} \text{ F.}</math> measurements shall be made at <math>77^{\circ} \text{ F.}</math> using the same spindle and apparatus as first test above.</p> <p>The adhesive shall meet other requirements for twelve (12) months from date of manufacture. There shall be no settling of the fillers that cannot be easily be dispersed with a paddle.</p>		

The combined components shall have the following characteristics:

Characteristic	Requirements
Gel time, minutes (minimum)	7
Bond Strength to Concrete, Time, minutes (maximum) to reach not less than 200 psi	
at 77°F. +2°F.	35
at 50°F. +2°F.	45
at 30°F. +2°F.	85
Slant Shear Strength, psi (minimum)	
24 hours at 77°F. +2°F.	1000
24 hours at 77°F. +2°F., plus water soak	800
Tensile Adhesion and Cohesion, psi (min)	
Ceramic marker bottom	700
Ceramic marker bottom, including post cure	700
Reflective pavement marker bottom	500
Color of Mixed Components	About that of Color No. 26152 of Federal Standard No. 595A.

(2) **Standard Set Epoxy Adhesive.** Standard set epoxy adhesive shall be a high viscosity paste formulated primarily for use in bonding pavement markers to portland cement concrete and asphalt concrete. The standard set epoxy adhesive shall compose of the following components:

Component A	Parts by Weight
Epoxy Resin <sup>1</sup> . . . . .	87.00
Aliphatic Glycidyl Ether <sup>2</sup> . . . . .	13.00
Titanium Dioxide . . . . . ASTM D 476 . . . . .	3.00
Talc <sup>4</sup> . . . . .	34.00
Oleophilic Fumed Silica <sup>3</sup> . . . . .	6.50*

Component B	Parts by Weight																
N-Aminoethyl Piperazine <sup>5</sup> . . . . .	23.20																
Nonylphenol <sup>6</sup> . . . . .	52.00																
Furnace Black <sup>7</sup> . . . . .	0.10																
Oleophilic Fumed Silica <sup>3</sup> . . . . .	6.50 <sup>B</sup>																
Talc <sup>4</sup> . . . . .	65.00																
Silicone Anti-Foam, Type DB 100, 100% Solids	0.005																
<p><sup>1</sup> Di glycidyl ether of bisphenol A, viscosity, 100-160 poise at 25 degrees Celsius; weight per epoxide equivalent, 180-200. Color, Gardner 1933, maximum.</p>																	
<p><sup>2</sup> Aliphatic mono functional reactive glycidyl ether, derived from an aliphatic alcohol. Viscosity 1-15 centipoise. Weight per epoxide equivalent 220 - 250. Specific gravity 0.88-0.95.</p>																	
<p><sup>3</sup> High purity fumed silica, surface treated with a silicone oil, with the following properties: Appearance, fluffy white powder surface area, N2 B.E.T. method, 70±15 M<sup>2</sup>/gram; pH, 4 grams dispersed in 100 mls of 20/80 volume mixture of ethyl alcohol and distilled water, 4.7; weight percent carbon, 5.0 minimum; ignition loss (dry basis) 2 hours at 1000 degrees Celsius, 6 to 7; specific gravity, 1.8.</p>																	
<p><sup>4</sup></p> <table border="0"> <tr> <td>Specific Gravity . . . . .</td> <td>2.68 to 2.86</td> </tr> <tr> <td>Oil Absorption, ASTM D 281 . . . . .</td> <td>26 to 33</td> </tr> <tr> <td>pH . . . . .</td> <td>8.9 to 9.6</td> </tr> <tr> <td>Hegman Rating . . . . .</td> <td>3 to 5</td> </tr> <tr> <td>Particle Shape . . . . .</td> <td>Platey</td> </tr> <tr> <td>Maximum Particle Size, microns . . . . .</td> <td>55</td> </tr> <tr> <td>Percent Passing U.S. No. 325 Screen, Min. . . . .</td> <td>99</td> </tr> <tr> <td>Dry Brightness, minimum . . . . .</td> <td>93</td> </tr> </table>		Specific Gravity . . . . .	2.68 to 2.86	Oil Absorption, ASTM D 281 . . . . .	26 to 33	pH . . . . .	8.9 to 9.6	Hegman Rating . . . . .	3 to 5	Particle Shape . . . . .	Platey	Maximum Particle Size, microns . . . . .	55	Percent Passing U.S. No. 325 Screen, Min. . . . .	99	Dry Brightness, minimum . . . . .	93
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pH . . . . .	8.9 to 9.6																
Hegman Rating . . . . .	3 to 5																
Particle Shape . . . . .	Platey																
Maximum Particle Size, microns . . . . .	55																
Percent Passing U.S. No. 325 Screen, Min. . . . .	99																
Dry Brightness, minimum . . . . .	93																
<p><sup>5</sup> Color (APHA) 50 maximum; amine value 1250-1350 based on titration which reacts with the 3 nitrogens in the molecule; appearance clear and substantially free of suspended matter.</p>																	
<p><sup>6</sup> Color (APHA) 50 maximum; hydroxyl number 245-255; distillation range, degrees Celsius at 760 mm first drop 295 minimum, 5 percent 298 minimum, 95 percent 325 maximum; water, percent (K.F.) 0.05 maximum.</p>																	
<p><sup>7</sup>Surface area, square meters/gram, 115-130; particle diameter, millimicrons, 18-30; pH, 7.0-8.5; fixed carbon (moisture free), percent, 96-98; volatile matter, percent 1-4; oil absorption, stiff paste endpoint, CCS/gram, 0.80-0.90.</p>																	
<p><sup>B</sup> A range of 6.0 to 7.0 parts permitted in the A Component and B Component to achieve the required viscosity and shear ratio.</p>																	

The Contractor shall test according to the California Test \*| 425. The components shall have the following characteristics:

Test	Requirements	
	Component A	Component B
Brookfield viscosity, Helipath Spindle TE at 5 rpm, Poise at 77°F.	3000 to 4000	3000 to 4000
Shear Ratio, Minimum at 77°F.	2.0	2.0
Density, lbs. per gallon at 77°F.	11.0 to 11.3	11.3 to 11.6
Skinning, (original container)	None	None
Percent Air, maximum	2.0	2.0
<p><b>Infrared Curves.</b> The Components A and B shall match curves in California Test 425.</p> <p><b>Storage Stability.</b> The Components A and B shall not change in viscosity and shear ratio by more than +15% when stored for 2 weeks in closed container at 115°F <math>\pm</math> 2°F. Measurements shall be made at 77°F. using the same spindle and apparatus as in the first item above. Adhesive shall meet other requirements for twelve (12) months from date of manufacture. There shall be no settling of the fillers that cannot be easily redispersed with a paddle.</p>		

The combined components shall have the following:

Characteristic	Requirements
Gel time, minutes	8 to 13
Bond Strength to Concrete, Time hours (maximum) to reach not less than 200 psi, at 77°F. $\pm$ 2°F	3.5
Slant Shear Strength, psi (minimum): 24 hours at 77°F. $\pm$ 2°F.	2200
24 hours at 77°F. $\pm$ 2°F., plus water soak	1500
Tensile Adhesion and Cohesion, psi (min): Ceramic marker bottom	700
Ceramic marker bottom incl. post cure	700
Reflective pavement marker bottom	500
Color of Mixed Components . .	About that of Color No. 26152 of Federal Standard No. 595A.

**(3) Packaging and Labeling of Adhesive.** The Contractor shall package \*|  
 each component in containers of size proportional to the amount of \*|  
 that component in the mix so that the Contractor uses one (1) \*|  
 container of each component in mixing one (1) batch of epoxy. The \*|  
 containers shall be of such design that the Contractor may remove \*|  
 the contents. The Contractor shall seal the containers well to \*|  
 prevent leakage. The containers and labeling shall meet the U.S. |  
 Department of Transportation Hazardous Material Shipping |  
 Regulations. The containers shall be of a material or lined with a \*|  
 material of such character as to resist actions by the components. |  
 The Contractor shall label each container clearly including: \*|

- (a) authorized modifications; \*|
- (b) designation (Component A or B); \*|
- (c) type (Standard or Rapid) if applicable; \*|
- (d) manufacturer's name; \*|
- (e) date of manufacture; \*|
- (f) batch number (a batch includes a single charge of \*|  
 components in a mixing chamber); \*|
- (g) directions for use and such warning or precautions \*|  
 concerning the contents as may be required by State or Federal \*|  
 Laws and Regulations. \*|

The manufacturer of the finished epoxy components shall furnish |  
 a notarized Certificate of Compliance and a copy of the label for |  
 each material. The certificate shall include a list, by Title and |  
 Section, of the State and Federal packaging and labeling laws and |  
 regulations that the manufacturer has complied with. |

The Contractor shall see the characteristic of the epoxy \*|  
 components to crystalize or thicken excessively before use when \*|  
 previously stored at temperatures below thirty-five (35) degrees |  
 Fahrenheit. If materials within twelve (12) months of delivery shows \*|  
 evidence of crystallization or a permanent increase in viscosity or \*|  
 settling of pigments that cannot be readily redispersed with a |  
 paddle, the Contractor shall replace the material. The vendor shall \*|  
 be responsible for costs incurred in replacing material that is \*|  
 unfit for use. |

**(4) Sampling.** The Engineer will take a quart sample of each \*|  
 component, "A" and "B", for each batch of adhesives delivered for \*|  
 testing. If the Contractor delivers less than five (5) gallons of \*|  
 adhesive, the Engineer may delete sampling and accept the material \*|  
 by the certificate of compliance. \*|

(B) **Bituminous Adhesive.** The bituminous adhesive shall be an asphaltic material with a homogenously-mixed filler and shall comply with the following requirements:

(1) **Adhesive Properties.**

Property	Min	Max	Method
Softening Point, deg F	200	-	ASTM D 36
Penetration, 100 g, 5 sec, 77°F	10	20	ASTM D 5
Flow, inch	-	0.2	ASTM D 3407 as modified in Test Methods
Viscosity, 400°F, Poises	-	75	ASTM D 2669 as modified in Test Methods
Flash Point, C.O.C., deg F	550	-	ASTM D 92

(2) **Asphalt Properties** determined on the filler-free material derived from the extraction and Abson recovery process as explained in Test Methods.

Property	Min	Max	Method
Penetration, 100 g, 5 sec, 77°F	25	-	ASTM D 5
Viscosity, 275° F. Poises	12	-	ASTM D 2171
Viscosity Ratio, 275° F	-	2.2	Explained in Test Methods

(3) **Filler properties** determined using the filler separation technique described in Test Methods.

Property	Min	Max	Method
Filler Content, percent by Weight	50	75	As explained in Test Methods
Filler Fineness, percent passing			
No. 325	75	-	ASTM C 430 as
No. 200	95	-	modified in
No. 100	100	-	Test Methods

(4) **Test Methods.** The Contractor shall establish the flow according \*  
to Section 6, Flow, of ASTM D 3407 with the exception that the oven |  
temperature shall be one hundred fifty-eight (158) degrees  $\pm$  two (2) |  
degrees Fahrenheit and sample preparation shall be according to \*  
Section 7.1 of ASTM D 5. \*

The Contractor shall establish the viscosity according to ASTM \*  
D 2669 using a spindle speed of ten (10) revolution per minute. The |  
Contractor shall heat the adhesive to about four hundred ten (410) \*  
degrees Fahrenheit and allow to cool. The Contractor shall establish \*  
the viscosity at four hundred (400) degrees  $\pm$  one (1) degrees |  
Fahrenheit. |

The Contractor shall establish the properties of the base \*  
asphalt on the material obtained from the following extraction and \*  
Absor recovery methods. The Contractor shall extract the asphalt by \*  
heating the adhesive just to the point where the asphalt will easily |  
flow and then transferring one hundred twenty-five (125) to one |  
hundred fifty (150) grams into four hundred (400) ml of |  
trichloroethylene with a temperature of one hundred twenty-five |  
(125) degrees to one hundred fifty (150) degrees Fahrenheit. The \*  
Contractor shall stir this mixture thoroughly to dissolve the \*  
asphalt. The Contractor shall decant the trichloroethylene-asphalt \*  
mixture and recover the asphalt using the Absor recovery method, \*  
ASTM D 1856 as modified by the following. The extraction methods of |  
ASTM D 2712 shall not apply and there shall be no filtration of the |  
solvent-asphalt mixture. The Contractor shall centrifuge the \*  
extraction solution of trichloroethylene and asphalt for at least \*  
thirty (30) minutes at seven hundred seventy (770) times gravity in \*  
a batch centrifuge. |

The Contractor shall decant this solution into the distillation \*  
flask taking care not to include filler sediments. The Contractor \*  
shall apply heat and bubble carbon dioxide slowly to bring the \*  
solution temperature to three hundred (300) degrees Fahrenheit. At |  
this point, the Contractor increases the carbon dioxide flow to |  
eight hundred (800) to nine hundred (900) ml per minute. The |  
Contractor maintains the solution temperature at three hundred \*  
twenty (320) degrees to three hundred thirty-five (335) degrees \*  
Fahrenheit with this carbon dioxide flow for at least twenty (20) |  
minutes and until the Contractor removed the trichloroethylene \*  
vapors completely from the distillation flask. The Contractor shall \*  
repeat the above extraction-recovery method as necessary to get the \*  
desired quantity of asphalt. The Contractor shall use the asphalt \*  
recovered to establish penetration, two hundred seventy-five (275) \*  
degrees Fahrenheit viscosity, and two hundred seventy-five (275) |  
degrees Fahrenheit viscosity ratio. |

The Contractor shall establish two hundred seventy-five (275) \*  
degrees Fahrenheit viscosity ratio by comparing the two hundred \*  
seventy-five (275) degrees Fahrenheit viscosity on the base asphalt |