



*Florida Department of Transportation*

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SECRETARY

January 8, 2014

Chad Thompson  
Programs Operations Engineer  
Federal Highway Administration  
545 John Knox Road, Suite 200  
Tallahassee, Florida 32303

Re: State Specifications and Estimates Office  
Section **971**  
Proposed Specification: **9710000 Traffic Marking Materials.**

Dear Mr. Thompson:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

These changes were proposed by Chester Henson to update the language to include new products, test methods and address problem areas.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to SP965DS or [daniel.scheer@dot.state.fl.us](mailto:daniel.scheer@dot.state.fl.us).

If you have any questions relating to this specification change, please call me at 414-4130.

Sincerely,

Daniel Scheer, P.E.  
State Specifications Engineer

DS/cah  
Attachment

cc: Florida Transportation Builders' Assoc.  
State Construction Engineer

**TRAFFIC MARKING MATERIALS.**(REV ~~11-2012-2-131-68-14~~)

SECTION 971 is deleted and the following substituted:

**SECTION 971  
TRAFFIC MARKING MATERIALS****971-1 General Requirements.**

**971-1.1 Packaging and Labeling:** All traffic marking materials shall be shipped in strong containers plainly marked with the weight in pounds per gallon, the volume of traffic marking materials content in gallons, the color, user information, date of manufacture, batch and DOT code number. Each batch manufactured shall have a unique number. A true statement of the percentage composition of the pigment, the proportion of pigment to vehicle, and the name and address of the manufacturer, also shall be shown. The label shall warn the user of any special handling or precautions of the material, as recommended by the manufacturer. Any package not so marked will not be accepted for use under these specifications.

Preformed thermoplastic materials and permanent tape products shall be marked with content, color, date of manufacture and batch number.

**971-1.2 Storage:** Any traffic marking materials which, although inspected and approved at the point of manufacture, hardens or livers in the containers so that it cannot be readily broken up with a paddle to a smooth, uniform painting consistency, will be rejected. All materials shall have a container storage life of one year from date of manufacture. Any traffic marking materials not acceptable for proper application will be rejected, even though it conforms to these Specifications in all other respects.

**971-1.3 Mixing:** All paints shall be delivered to the project completely mixed, and ready to be used without additional oil or thinner. Gasoline shall not be used for thinner under any circumstances.

**971-1.4 Qualified Products List (QPL):** All traffic marking materials shall be one of the products listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 accompanied by a copy of the infrared identification curve (2.5 to 15  $\mu$ m) for the vehicle component. Products may only be used for applications recommended by the manufacturer. A notation of the number of coats and the thickness of each coat at which the product passes testing may be placed on the QPL. When listed, this will be the minimum criteria for application of the traffic marking material.

**971-1. 5 Samples:** Field samples will be obtained in accordance with the Department's Sampling, Testing and Reporting Guide Schedule.

**971-1. 6 Color:** *Materials other than yellow shall meet the color requirements as identified in 23 CFR 665 Table 5 Appendix to Part 655, Subpart F. Yellow materials* for pavement markings shall meet the following performance requirements.

The initial daytime chromaticity for yellow materials shall fall within the box created by the following coordinates:

Initial Daytime Chromaticity Coordinates (Corner Points)

	1	2	3	4
X	0.530	0.510	0.455	0.472
Y	0.456	0.485	0.444	0.400

~~The in service daytime chromaticity for yellow materials shall fall within the box created by the following coordinates:~~

~~In Service Daytime Chromaticity Coordinates (Corner Points)~~

	1	2	3	4
X	0.530	0.510	0.435	0.449
Y	0.456	0.485	0.429	0.377

The nighttime chromaticity for yellow materials shall fall within the box created by the following coordinates:

Nighttime Chromaticity Coordinates (Corner Points)

	1	2	3	4
X	0.575	0.508	0.473	0.510
Y	0.425	0.415	0.453	0.490

**971-1.7 Additional Requirements:** Traffic marking materials shall be characterized as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) 40 CFR 261. Provide supporting independent analytical data or product material safety data sheets (MSDS) identifying any components listed in Table 1 of 40 CFR 261.24.

Additionally, retroreflective elements shall contain no more than 200 ppm by weight of lead or arsenic when tested in accordance with the Environmental Protection Agency (EPA) Testing Methods 3052, 6010B, and 6010C.

## **971-2 Glass Spheres.**

**971-2.1 General Requirements:** Glass spheres shall be of a composition designed to be highly resistant to traffic wear and to the effects of weathering for the production of a reflective surface, creating night visibility of the pavement markings without altering day visibility of the marking. The general requirements of 971-1 apply to glass spheres.

**971-2.2 Specific Properties:** The large (Type 3 or larger) glass spheres used for drop on beads shall have an adhesion coating. Type 1 glass spheres used for drop on beads shall have a dual coating. Beads used in the intermix of materials are not required to be coated.

The following physical requirements apply:

Property	Test Method	Specification
Roundness*	ASTM D1155	Min: 70 % by weight
Roundness**	ASTM D1155	Min: 80% by weight

Refractive Index*	Becke Line Method (25+/- 5C)	1.5 minimum
Refractive Index**	Becke Line Method (25+/- 5C)	1.9 minimum
*Type 1, 3, 4 and 5 beads		
**High Index beads		

Sieve Size	Percent by Mass Passing Designated Sieve (ASTM D1214)				
	Grading Designation				
	Type 1 (AASHTO)	Type 3 (FP 96)	Type 4 (FP 96)	Type 5 (FP 96)	High Index
No. 8				100	
No. 10			100	95 - 100	
No. 12		100	95 - 100	80 - 95	
No. 14		95 - 100	80 - 95	10 - 40	
No. 16	100	80 - 95	10 - 40	0 - 5	100
No. 18		10 - 40	0 - 5	0 - 2	
No. 20	95 - 100	0 - 5	0 - 2		95 - 100
No. 25		0 - 2			
No. 30	75 - 95				55 - 85
No. 40					15 - 45
No. 50	15 - 35				0 - 5
No. 80					
No. 100	0 - 5				

Provide the Engineer Certified test reports from the manufacturer confirming that all glass spheres conform to the requirements of this Section.

#### **971-2.3 Sampling:**

**971-2.3.1 Sampling:** A random 50 lb sample of glass spheres shall be obtained for each 50,000 lb shipped. Upon arrival, the quantity of material will be reduced in a sample splitter to a size of approximately one quart by the Engineer, or one 50 lb unopened bag.

**971-2.3.2 Containers:** The spheres shall be furnished in new 50 lb moisture-proof bags. All containers shall meet ICC requirements for strength and type and be marked in accordance with AASHTO 247 Part 5.

#### **971-3 Standard Waterborne Fast Dry Traffic Paint.**

**971-3.1 General:** Standard waterborne fast dry traffic paints intended for use under this Specification shall include water reducible products that are single packaged and ready mixed. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The material shall have the capability of being cleaned and flushed from the striping machines using regular tap water and any required rust inhibitors. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 710 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

**971-3.2 Composition:**

Component	Test Method	Criteria
Total Solids, by weight	ASTM D2369	minimum 75%
Pigments, by weight	ASTM D3723	minimum 57%
Vehicle Solids % of Vehicle*		minimum 40%
TiO <sub>2</sub> , Type II Rutile (white paint only)	ASTM D476	minimum 1.0 lb/gal
Volatile Organic Content, (VOC)	ASTM D3960	maximum 150 g/L
*Vehicle Solids % of Vehicle = $\frac{\% \text{ total solids} - \% \text{ pigment}}{100 - \% \text{ pigment}}$		

**971-3.3 Physical Requirements:** The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Density	ASTM D1475	13.5 ± 1.4 lb/gal	-
Viscosity at 77°F	ASTM D562	80 KU	100 KU
Fineness of Grind	ASTM D1210	3(HS)	
Dry Opacity at 5 mils WFT	ASTM D2805	0.92	-
Bleed Ratio	ASTM D969	0.95	-
Flexibility	ASTM D522 Method B	Pass	-
Abrasion Resistance	971-3.3.2	Pass	-

**971-3.3.1 Set To Bear Traffic Time:** The material shall set to bear traffic in not more than two minutes.

**971-3.3.2 Abrasion Resistance:** Test four samples per LOT using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils. Air dry each sample for 30 minutes and bake at 220°F for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

**971-3.3.3 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m<sup>2</sup> and 250 mcd/lx·m<sup>2</sup>. The retroreflectance of the white and yellow pavement markings at the end of the six month service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

**971-3.4 Packaging and Labeling:** The traffic paint shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons of material shall be placed in any drum to allow for expansion during transport and storage.

**971-4 Fast Dry Solvent Traffic Paint.**

**971-4.1 General:** Fast dry traffic paints intended for use under this Specification shall include products that are single packaged and ready mixed. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the

material according to his own specifications. However, the requirements delineated in this Specification and Section 710 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

#### 971-4.2 Composition:

Component	Test Method	Criteria
Total Solids, by weight	ASTM D2369	75% minimum
Pigments, by weight	ASTM D3723	57% minimum
Vehicle Solids, % on Vehicle*		40% minimum
TiO <sub>2</sub> , Type II Rutile (white paint only)	ASTM D476	1.5 lb/gal minimum
Volatile Organic Content, (VOC)	ASTM D3960	150 g/L maximum

#### 971-4.3 Physical Requirements: The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Density	ASTM D1475	13.5 ± 0.37 lb/gal	N/A
Viscosity at 77°F	ASTM D562	80 KU	100 KU
Fineness of Grind	ASTM D1210	3(HS)	
Dry Opacity at 5 mils WFT	ASTM D2805	0.92	-
Bleed Ratio	ASTM D969	0.95	-
Flexibility	ASTM D522 Method B	Pass	-
Abrasion Resistance	971-4.3.2	Pass	-

**971-4.3.1 Set To Bear Traffic Time:** The material shall set to bear traffic in not more than two minutes.

**971-4.3.2 Abrasion Resistance:** Test four samples per LOT using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils. Air dry each sample for 30 minutes and bake at 220°F for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

**971-4.3.3 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m<sup>2</sup> and 250 mcd/lx·m<sup>2</sup>, respectively. The retroreflectance of the white and yellow pavement markings at the end of the six month service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

**971-4.4 Application Properties:** Application properties shall meet the requirements of Section 710.

**971-4.5 Packaging and Labeling:** The traffic paint shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons

of material shall be placed in any drum to allow for expansion during transport and storage.

### 971-5 Thermoplastic Materials for Traffic Stripes.

**971-5.1 General:** Upon cooling to normal pavement temperature, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall utilize alkyd based materials only and shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 711 shall apply regardless of the type of formulation used. The pigment, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

#### 971-5.2 Composition:

Component	Test Method	White	Yellow
Binder		20.0% minimum	20.0% minimum
TiO <sub>2</sub> , Type II Rutile	ASTM D476	10.0% minimum	-
Glass Spheres	AASHTO T250	40.0% minimum	40.0% minimum
Yellow Pigment		-	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh sieve)		30.0% maximum	37.5% maximum
Percentages are by weight.			

The alkyd/maleic binder must consist of a mixture of synthetic resins (at least one synthetic resin must be solid at room temperature) and high boiling point plasticizers. At least one-half of the binder composition must be 100% maleic-modified glycerol of rosin and be no less than 15% by weight of the entire material formulation.

**971-5.3 Glass Spheres:** The glass spheres in the intermix shall consist of 50% Type 1 and 50% Type 3. Glass spheres shall meet the requirements of 971-2.

**971-5.4 Sharp Silica Sand:** Sharp silica sand used for bike lane symbols and pedestrian crosswalk lines shall meet the following gradation requirements:

Sieve Size	% Passing
20	100
50	0 to 10

**971-5.5 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM D4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D570	-	0.5%
Softening Point	ASTM D36	195°F	-
Low Temperature Stress Resistance	AASHTO T250	Pass	-
Specific Gravity	Water displacement	1.9	2.3



Property	Test Method	Minimum	Maximum
Indentation Resistance	ASTM D77352240* <del>Type A Shore Durometer, A2</del>	40	75
Impact Resistance	ASTM D256, Method A	1.0 N·m	-
Flash Point	ASTM D92	475°F	-
*The durometer and panel shall be at 115°F with a 1000 g #4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.			

**971-5.5.1 Set To Bear Traffic Time:** The thermoplastic shall set to bear traffic in not more than two minutes.

**971-5.5.2 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 450 mcd/lx·m<sup>2</sup> and not less than 350 mcd/lx·m<sup>2</sup>, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

~~**971-5.5.3 Durability:** Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0% at the end of the service life.~~

**971-5.6 Application Properties:** Application properties shall meet the requirements of Section 711.

**971-5.7 Packing and Labeling:** The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

## **971-6 Preformed Thermoplastic Materials for Traffic Stripes.**

**971-6.1 General:** Upon cooling to normal pavement temperature, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 711 shall apply regardless of the type of formulation used. The pigment, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

**971-6.2 Composition:** The preformed thermoplastic shall consist of high quality materials, pigments and glass spheres or other reflective material uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres or other reflective material embedded in the top surface.

**971-6.3 Glass Spheres:** Material shall contain no less than 30% glass spheres by weight.

**971-6.4 Color:** Materials shall meet the performance requirements specified in 971-1 and the following additional requirements. The initial luminance factor, Cap Y, shall not be less than 55.

**971-6.5 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM D4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
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Property	Test Method	Minimum	Maximum
Softening Point	ASTM D36	195°F	-
Low Temperature Stress Resistance	AASHTO T250	Pass	-
Indentation Resistance	ASTM D77352240* <del>Type A Shore Durometer, A2</del>	40	75
Impact Resistance	ASTM D256, Method A**	1.0 N·m	-
*The durometer and panel shall be at 115°F with a 1000 g #4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.			
**The test specimen for ASTM D256 shall be 1 in. x 1 in. x 6 in. and shall not be notched.			

**971-6.5.1 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m<sup>2</sup>. The retroreflectance of the white pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>. All pedestrian crosswalks, bike lane symbols and messages in a proposed bike lane shall attain initial retroreflectivity of not less than 275 mcd/lx·m<sup>2</sup>.

**971-6.5.2 Skid Resistance:** The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN (British Pendulum Number) when tested according to ASTM E303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

~~**971-6.5.3 Durability:** Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0% at the end of the service life.~~

**971-6.6 Application Properties:** Application properties shall meet the requirements of Section 711.

**971-6.7 Packing and Labeling:** The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage.

## **971-7 Permanent Tape Materials for Traffic Stripes and Markings.**

**971-7.1 General:** The materials for pavement stripes and markings shall consist of white or yellow weather-resistant reflective film as specified herein. The markings are classified as High Performance. The pigment, glass spheres, and filler shall be well dispersed in the resin. However, the requirements delineated in this Specification and Section 713 shall apply. The material shall be free from all skins, dirt and foreign objects.

**971-7.2 Composition:** The pavement stripes and markings shall consist of high-quality plastic materials, pigments, and glass spheres uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres embedded in the top surface.

**971-7.3 Skid Resistance:** The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN when tested according to ASTM E303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

**971-7.4 Thickness:** The QPL will list the specified thickness of each approved product.

**971-7.5 Durability and Wear Resistance:** When properly applied, the material shall provide neat, durable stripes and markings. The materials shall provide a cushioned resilient substrate that reduces sphere crushing and loss. The film shall be weather

resistant and, through normal wear, shall show no significant tearing, rollback or other signs of poor adhesion. ~~Durability is the measured percent of pavement marking material completely removed from the pavement. The pavement marking material line loss must not exceed 5.0% of surface area at the end of its service life.~~

**971-7.6 Conformability and Resealing:** The stripes and markings shall be capable of conforming to pavement contours, breaks and faults under traffic at pavement temperatures recommended by the manufacturer. The film shall be capable of use for patching worn areas of the same types of film in accordance with the manufacturer's recommendations.

**971-7.7 Tensile Strength:** The stripes and markings shall have a minimum tensile strength of 40 psi when tested according to ASTM D638. A rectangular test specimen 6 inches by 1 inch by 0.05 inches minimum thickness shall be tested at a temperature range of 40 to 80°F using a jaw speed of 0.25 inch/min.

~~**971-7.8 Elongation:** The stripes and markings shall have a minimum elongation of 25% when tested in accordance with ASTM D-638.~~

**971-7.89 Plastic Pull test:** The stripes and markings shall support a dead weight of 4 lb for not less than five minutes at a temperature range of 70 to 80°F. Rectangular test specimen size shall be 6 inches by 1 inch by 0.05 inches minimum thickness.

**971-7.910 Pigmentation:** The pigment shall be selected and blended to provide a material which is white or yellow conforming to standard highway colors through the expected life of the stripes and markings.

**971-7.1011 Glass Spheres:** The stripes and markings shall have glass retention qualities such that, when at room temperature a 2 inches by 6 inches specimen is bent over a 0.5 inch diameter mandrel axis, a microscopic examination of the area on the mandrel shall show no more than 10% of the spheres with entrapment by the material of less than 40%. The bead adhesion shall be such that spheres are not easily removed when the film surface is scratched firmly with a thumbnail.

**971-7.1112 Retroreflectivity:** The permanent tape materials for traffic stripes and markings shall have a service life of five years. The materials shall attain an initial retroreflectance of not less than 450 mcd/lx·m<sup>2</sup> for white and contrast markings and not less than 350 mcd/lx·m<sup>2</sup> for yellow markings. The pavement stripes and markings shall retain a minimum retroreflectance for two years of not less than 300 mcd/lx·m<sup>2</sup> for white and contrast markings and not less than 250 mcd/lx·m<sup>2</sup> for yellow markings. The retroreflectance of the white, yellow and contrast pavement markings at the end of the five year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

## **971-8 Two Reactive Component Materials For Traffic Stripes And Markings.**

**971-8.1 General:** Two reactive component materials intended for use under this Specification shall include, but not be limited to, epoxies, polyesters and urethanes. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the criteria outlined in this Specification and Section 709 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

### **971-8.2 Composition:**

Component	Test Method	Criteria
TiO <sub>2</sub> , Type II Rutile (white material only)	ASTM D476	minimum 10% by weight
Volatile Organic Content, (VOC)	ASTM D3960	maximum 150 g/L

**971-8.3 Physical Requirements:** The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Adhesion to Concrete	ASTM D4541, ASTM D7234 or ACI 503	Concrete Failure	-
Hardness	ASTM D77352240 <del>Type (Shore D)</del>	75	-
Abrasion Resistance	971-8.3.2	Pass	-

**971-8.3.1 Set To Bear Traffic Time:** The material shall set to bear traffic in not more than two minutes.

**971-8.3.2 Abrasion Resistance:** Test four samples per LOT using a Taber Abrader. The material shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils. Air dry each sample for 30 minutes and bake at 220°F for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

**971-8.3.3 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 450 mcd/lx·m<sup>2</sup> and not less than 350 mcd/lx·m<sup>2</sup>, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

**971-8.4 Application Properties:** Application properties shall meet the requirements of Section 709.

**971-8.5 Packaging and Labeling:** The two reactive component material shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons of material shall be placed in any drum to allow for expansion during transport and storage. Other containers will be used for applicable products. Each container shall designate the color, generic type (e.g. epoxy), user information, manufacturer's name and address, batch number and date of manufacture. Each batch manufactured shall have a unique number. The label shall warn the user of hazards associated with handling or using the material.

## **971-9 Thermoplastic Material for Audible and Vibratory Traffic Stripes.**

**971-9.1 General:** Upon cooling to normal pavement temperature, the thermoplastic material shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall utilize alkyd based materials only and shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification shall apply regardless of the

type of formulation used. The pigment, reflective elements, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

**971-9.2 Composition:**

Component	Test Method	White	Yellow
Binder		20.0% minimum	20.0% minimum
TiO <sub>2</sub> , Type II Rutile	ASTM D476	10.0% minimum	-
Reflective Elements	AASHTO T250	% minimum per manufacturer	% minimum per manufacturer
Yellow Pigment		-	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh sieve)		% minimum per manufacturer	% minimum per manufacturer

Percentages are by weight.

The alkyd/maleic binder must consist of a mixture of synthetic resins (at least one synthetic resin must be solid at room temperature) and high boiling point plasticizers. At least one-half of the binder composition must be 100% maleic-modified glycerol of rosin and be no less than 15% by weight of the entire material formulation.

**971-9.3 Retroreflective Elements:** The reflective elements in the intermix shall be determined by the manufacturer and identified for the QPL System.

**971-9.4 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM D4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D570	-	0.5%
Softening Point	ASTM D36	210°F	-
Low Temperature Stress Resistance	AASHTO T250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D77352240* <i>Type A Shore Durometer, A2</i>	65	-
Impact Resistance	ASTM D256, Method A	1.0 N·m	-
Flash Point	ASTM D92	475°F	-

\*The durometer and panel shall be at 80°F, but not exceeding 90°F with a 1000 g m4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.

**971-9.4.1 Set To Bear Traffic Time:** When applied at the temperatures and thickness specified by Section 701, the baseline material shall set to bear traffic in not more than two minutes. The audible bump shall set to bear traffic in not more than 10 minutes at ambient air temperatures of 80°F or less and in not more than 15 minutes for ambient air temperatures exceeding 80°F.

**971-9.4.2 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m<sup>2</sup> and not less than 250 mcd/lx·m<sup>2</sup>, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

**971-9.4.3 Durability:** ~~Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0% at the end of the three year service life.~~ Durability shall also include flattening of the profile or raised portions of the line. The flattening of the profile or raised portion of the line shall not exceed 25% at the end of the three year service life.

**971-9.5 Application Properties:** Application properties shall meet the requirements of Section 701.

**971-9.6 Packing and Labeling:** The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

## **971-10 Thermoplastic Material for Wet Weather Pavement Markings.**

**971-10.1 General:** Upon cooling to normal pavement temperature, the thermoplastic material shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall utilize alkyd based materials only and shall have the option of formulating the material according to their specifications. However, the requirements delineated in this specification shall apply regardless of the type of formulation used. The pigment, reflective elements, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

### **971-10.2 Composition:**

Component	Test Method	White	Yellow
Binder		20.0% minimum	20.0% minimum
TiO <sub>2</sub> , Type II Ructile	ASTM D476	10.0% minimum	N/A
Reflective Elements (intermix)	AASHTO T250	% minimum per manufacturer	% minimum per manufacturer
Yellow Pigment		N/A	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh sieve)		% minimum per manufacturer	% minimum per manufacturer

Percentages are by weight.

**971-10.3 Retroreflective Elements:** The reflective elements in the intermix shall be determined by the manufacturer and identified for the QPL System.

**971-10.4 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM D4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D570	-	0.5%
Softening Point	ASTM D36	200°F	-
Low Temperature Stress Resistance	AASHTO T250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D77352240* <del>Type A Shore Durometer, A2</del>	40	-
Impact Resistance	ASTM D256, Method A	1.0 N·m	-
Flash Point	ASTM D92	475°F	-

\*The durometer and panel shall be at 90°F with a ~~1000 gm~~4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.

**971-10.4.1 Set To Bear Traffic Time:** When applied at the temperatures and thickness specified by Section 702, the baseline material shall set to bear traffic in not more than two minutes. When the audible bump is required, the bump shall set to bear traffic in not more than 10 minutes at ambient air temperatures of 80°F or less and in not more than 15 minutes for ambient air temperatures exceeding 80°F.

**971-10.4.2 Retroreflectivity:** The white and yellow pavement markings shall attain an initial dry retroreflectivity of not less than 300 mcd/lx·m<sup>2</sup> and not less than 250 mcd/lx·m<sup>2</sup>, respectively, and also attain an initial wet recovery retroreflectivity of not less than 150 mcd/lx·m<sup>2</sup> and not less than 125 mcd/lx·m<sup>2</sup>, respectively. The dry retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>, and also the wet recovery retroreflectivity at the end of the service life shall not be less than 75 mcd/lx·m<sup>2</sup>. The retroreflectivity will be determined in accordance with Florida Method FM-5-541 for dry and ASTM E2177 (Bucket Method) for wet recovery.

**971-10.4.3 Durability:** ~~Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0% at the end of the three year service life.~~ When an audible bump is required, durability shall also include flattening of the profile or raised portions of the line. The flattening of the profile or raised portion of the line shall not exceed 25% at the end of the three year service life.

**971-10.5 Application Properties:** Application properties shall meet the requirements of Section 702.

**971-10.6 Packing and Labeling:** The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.



**TRAFFIC MARKING MATERIALS.****(REV 1-8-14)**

SECTION 971 is deleted and the following substituted:

**SECTION 971**  
**TRAFFIC MARKING MATERIALS**

**971-1 General Requirements.**

**971-1.1 Packaging and Labeling:** All traffic marking materials shall be shipped in strong containers plainly marked with the weight in pounds per gallon, the volume of traffic marking materials content in gallons, the color, user information, date of manufacture, batch and DOT code number. Each batch manufactured shall have a unique number. A true statement of the percentage composition of the pigment, the proportion of pigment to vehicle, and the name and address of the manufacturer, also shall be shown. The label shall warn the user of any special handling or precautions of the material, as recommended by the manufacturer. Any package not so marked will not be accepted for use under these specifications.

Preformed thermoplastic materials and permanent tape products shall be marked with content, color, date of manufacture and batch number.

**971-1.2 Storage:** Any traffic marking materials which, although inspected and approved at the point of manufacture, hardens or livers in the containers so that it cannot be readily broken up with a paddle to a smooth, uniform painting consistency, will be rejected. All materials shall have a container storage life of one year from date of manufacture. Any traffic marking materials not acceptable for proper application will be rejected, even though it conforms to these Specifications in all other respects.

**971-1.3 Mixing:** All paints shall be delivered to the project completely mixed, and ready to be used without additional oil or thinner. Gasoline shall not be used for thinner under any circumstances.

**971-1.4 Qualified Products List (QPL):** All traffic marking materials shall be one of the products listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 accompanied by a copy of the infrared identification curve (2.5 to 15  $\mu\text{m}$ ) for the vehicle component. Products may only be used for applications recommended by the manufacturer. A notation of the number of coats and the thickness of each coat at which the product passes testing may be placed on the QPL. When listed, this will be the minimum criteria for application of the traffic marking material.

**971-1. 5 Samples:** Field samples will be obtained in accordance with the Department's Sampling, Testing and Reporting Guide Schedule.

**971-1. 6 Color:** Materials other than yellow shall meet the color requirements as identified in 23 CFR 665 Table 5 Appendix to Part 655, Subpart F. Yellow materials for pavement markings shall meet the following performance requirements.

The initial daytime chromaticity for yellow materials shall fall within the box created by the following coordinates:

Initial Daytime Chromaticity Coordinates (Corner Points)



	1	2	3	4
X	0.530	0.510	0.455	0.472
Y	0.456	0.485	0.444	0.400

The nighttime chromaticity for yellow materials shall fall within the box created by the following coordinates:

Nighttime Chromaticity Coordinates (Corner Points)

	1	2	3	4
X	0.575	0.508	0.473	0.510
Y	0.425	0.415	0.453	0.490

**971-1.7 Additional Requirements:** Traffic marking materials shall be characterized as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) 40 CFR 261. Provide supporting independent analytical data or product material safety data sheets (MSDS) identifying any components listed in Table 1 of 40 CFR 261.24.

Additionally, retroreflective elements shall contain no more than 200 ppm by weight of lead or arsenic when tested in accordance with the Environmental Protection Agency (EPA) Testing Methods 3052, 6010B, and 6010C.

**971-2 Glass Spheres.**

**971-2.1 General Requirements:** Glass spheres shall be of a composition designed to be highly resistant to traffic wear and to the effects of weathering for the production of a reflective surface, creating night visibility of the pavement markings without altering day visibility of the marking. The general requirements of 971-1 apply to glass spheres.

**971-2.2 Specific Properties:** The large (Type 3 or larger) glass spheres used for drop on beads shall have an adhesion coating. Type 1 glass spheres used for drop on beads shall have a dual coating. Beads used in the intermix of materials are not required to be coated.

The following physical requirements apply:

Property	Test Method	Specification
Roundness*	ASTM D1155	Min: 70 % by weight
Roundness**	ASTM D1155	Min: 80% by weight
Refractive Index*	Becke Line Method (25+/- 5C)	1.5 minimum
Refractive Index**	Becke Line Method (25+/- 5C)	1.9 minimum
*Type 1, 3, 4 and 5 beads		
**High Index beads		

Sieve Size	Percent by Mass Passing Designated Sieve (ASTM D1214)
	Grading Designation

	Type 1 (AASHTO)	Type 3 (FP 96)	Type 4 (FP 96)	Type 5 (FP 96)	High Index
No. 8				100	
No. 10			100	95 - 100	
No. 12		100	95 - 100	80 - 95	
No. 14		95 - 100	80 - 95	10 - 40	
No. 16	100	80 - 95	10 - 40	0 - 5	100
No. 18		10 - 40	0 - 5	0 - 2	
No. 20	95 - 100	0 - 5	0 - 2		95 - 100
No. 25		0 - 2			
No. 30	75 - 95				55 - 85
No. 40					15 - 45
No. 50	15 - 35				0 - 5
No. 80					
No. 100	0 - 5				

Provide the Engineer Certified test reports from the manufacturer confirming that all glass spheres conform to the requirements of this Section.

**971-2.3 Sampling:**

**971-2.3.1 Sampling:** A random 50 lb sample of glass spheres shall be obtained for each 50,000 lb shipped. Upon arrival, the quantity of material will be reduced in a sample splitter to a size of approximately one quart by the Engineer, or one 50 lb unopened bag.

**971-2.3.2 Containers:** The spheres shall be furnished in new 50 lb moisture-proof bags. All containers shall meet ICC requirements for strength and type and be marked in accordance with AASHTO 247 Part 5.

**971-3 Standard Waterborne Fast Dry Traffic Paint.**

**971-3.1 General:** Standard waterborne fast dry traffic paints intended for use under this Specification shall include water reducible products that are single packaged and ready mixed. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The material shall have the capability of being cleaned and flushed from the striping machines using regular tap water and any required rust inhibitors. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 710 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

**971-3.2 Composition:**

Component	Test Method	Criteria
Total Solids, by weight	ASTM D2369	minimum 75%
Pigments, by weight	ASTM D3723	minimum 57%
Vehicle Solids % of Vehicle*		minimum 40%
TiO <sub>2</sub> , Type II Rutile (white paint only)	ASTM D476	minimum 1.0 lb/gal
Volatile Organic Content, (VOC)	ASTM D3960	maximum 150 g/L
*Vehicle Solids % of Vehicle = $\frac{\% \text{ total solids} - \% \text{ pigment}}{100 - \% \text{ pigment}}$		

**971-3.3 Physical Requirements:** The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Density	ASTM D1475	13.5 ± 1.4 lb/gal	-
Viscosity at 77°F	ASTM D562	80 KU	100 KU
Fineness of Grind	ASTM D1210	3(HS)	
Dry Opacity at 5 mils WFT	ASTM D2805	0.92	-
Bleed Ratio	ASTM D969	0.95	-
Flexibility	ASTM D522 Method B	Pass	-
Abrasion Resistance	971-3.3.2	Pass	-

**971-3.3.1 Set To Bear Traffic Time:** The material shall set to bear traffic in not more than two minutes.

**971-3.3.2 Abrasion Resistance:** Test four samples per LOT using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils. Air dry each sample for 30 minutes and bake at 220°F for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

**971-3.3.3 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m<sup>2</sup> and 250 mcd/lx·m<sup>2</sup>. The retroreflectance of the white and yellow pavement markings at the end of the six month service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

**971-3.4 Packaging and Labeling:** The traffic paint shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons of material shall be placed in any drum to allow for expansion during transport and storage.

#### **971-4 Fast Dry Solvent Traffic Paint.**

**971-4.1 General:** Fast dry traffic paints intended for use under this Specification shall include products that are single packaged and ready mixed. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in

this Specification and Section 710 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

#### 971-4.2 Composition:

Component	Test Method	Criteria
Total Solids, by weight	ASTM D2369	75% minimum
Pigments, by weight	ASTM D3723	57% minimum
Vehicle Solids, % on Vehicle*		40% minimum
TiO <sub>2</sub> , Type II Rutile (white paint only)	ASTM D476	1.5 lb/gal minimum
Volatile Organic Content, (VOC)	ASTM D3960	150 g/L maximum

#### 971-4.3 Physical Requirements: The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Density	ASTM D1475	13.5 ± 0.37 lb/gal	N/A
Viscosity at 77°F	ASTM D562	80 KU	100 KU
Fineness of Grind	ASTM D1210	3(HS)	
Dry Opacity at 5 mils WFT	ASTM D2805	0.92	-
Bleed Ratio	ASTM D969	0.95	-
Flexibility	ASTM D522 Method B	Pass	-
Abrasion Resistance	971-4.3.2	Pass	-

**971-4.3.1 Set To Bear Traffic Time:** The material shall set to bear traffic in not more than two minutes.

**971-4.3.2 Abrasion Resistance:** Test four samples per LOT using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils. Air dry each sample for 30 minutes and bake at 220°F for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

**971-4.3.3 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m<sup>2</sup> and 250 mcd/lx·m<sup>2</sup>, respectively. The retroreflectance of the white and yellow pavement markings at the end of the six month service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

**971-4.4 Application Properties:** Application properties shall meet the requirements of Section 710.

**971-4.5 Packaging and Labeling:** The traffic paint shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons

of material shall be placed in any drum to allow for expansion during transport and storage.

### 971-5 Thermoplastic Materials for Traffic Stripes.

**971-5.1 General:** Upon cooling to normal pavement temperature, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall utilize alkyd based materials only and shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 711 shall apply regardless of the type of formulation used. The pigment, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

#### 971-5.2 Composition:

Component	Test Method	White	Yellow
Binder		20.0% minimum	20.0% minimum
TiO <sub>2</sub> , Type II Rutile	ASTM D476	10.0% minimum	-
Glass Spheres	AASHTO T250	40.0% minimum	40.0% minimum
Yellow Pigment		-	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh sieve)		30.0% maximum	37.5% maximum
Percentages are by weight.			

The alkyd/maleic binder must consist of a mixture of synthetic resins (at least one synthetic resin must be solid at room temperature) and high boiling point plasticizers. At least one-half of the binder composition must be 100% maleic-modified glycerol of rosin and be no less than 15% by weight of the entire material formulation.

**971-5.3 Glass Spheres:** The glass spheres in the intermix shall consist of 50% Type 1 and 50% Type 3. Glass spheres shall meet the requirements of 971-2.

**971-5.4 Sharp Silica Sand:** Sharp silica sand used for bike lane symbols and pedestrian crosswalk lines shall meet the following gradation requirements:

Sieve Size	% Passing
20	100
50	0 to 10

**971-5.5 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM D4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D570	-	0.5%
Softening Point	ASTM D36	195°F	-
Low Temperature Stress Resistance	AASHTO T250	Pass	-
Specific Gravity	Water displacement	1.9	2.3

Property	Test Method	Minimum	Maximum
Indentation Resistance	ASTM D7735* Type A Durometer	40	75
Impact Resistance	ASTM D256, Method A	1.0 N·m	-
Flash Point	ASTM D92	475°F	-

\*The durometer and panel shall be at 115°F with a 1000 g load applied. Instrument measurement shall be taken after 15 seconds.

**971-5.5.1 Set To Bear Traffic Time:** The thermoplastic shall set to bear traffic in not more than two minutes.

**971-5.5.2 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 450 mcd/lx·m<sup>2</sup> and not less than 350 mcd/lx·m<sup>2</sup>, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

**971-5.6 Application Properties:** Application properties shall meet the requirements of Section 711.

**971-5.7 Packing and Labeling:** The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

## **971-6 Preformed Thermoplastic Materials for Traffic Stripes.**

**971-6.1 General:** Upon cooling to normal pavement temperature, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 711 shall apply regardless of the type of formulation used. The pigment, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

**971-6.2 Composition:** The preformed thermoplastic shall consist of high quality materials, pigments and glass spheres or other reflective material uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres or other reflective material embedded in the top surface.

**971-6.3 Glass Spheres:** Material shall contain no less than 30% glass spheres by weight.

**971-6.4 Color:** Materials shall meet the performance requirements specified in 971-1 and the following additional requirements. The initial luminance factor, Cap Y, shall not be less than 55.

**971-6.5 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM D4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Softening Point	ASTM D36	195°F	-
Low Temperature Stress Resistance	AASHTO T250	Pass	-

Property	Test Method	Minimum	Maximum
Indentation Resistance	ASTM D7735* Type A Durometer	40	75
Impact Resistance	ASTM D256, Method A**	1.0 N·m	-

\*The durometer and panel shall be at 115°F with a 1000 g load applied. Instrument measurement shall be taken after 15 seconds.

\*\*The test specimen for ASTM D256 shall be 1 in. x 1 in. x 6 in. and shall not be notched.

**971-6.5.1 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m<sup>2</sup>. The retroreflectance of the white pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>. All pedestrian crosswalks, bike lane symbols and messages in a proposed bike lane shall attain initial retroreflectivity of not less than 275 mcd/lx·m<sup>2</sup>.

**971-6.5.2 Skid Resistance:** The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN (British Pendulum Number) when tested according to ASTM E303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

**971-6.6 Application Properties:** Application properties shall meet the requirements of Section 711.

**971-6.7 Packing and Labeling:** The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage.

## **971-7 Permanent Tape Materials for Traffic Stripes and Markings.**

**971-7.1 General:** The materials for pavement stripes and markings shall consist of white or yellow weather-resistant reflective film as specified herein. The markings are classified as High Performance. The pigment, glass spheres, and filler shall be well dispersed in the resin. However, the requirements delineated in this Specification and Section 713 shall apply. The material shall be free from all skins, dirt and foreign objects.

**971-7.2 Composition:** The pavement stripes and markings shall consist of high-quality plastic materials, pigments, and glass spheres uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres embedded in the top surface.

**971-7.3 Skid Resistance:** The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN when tested according to ASTM E303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

**971-7.4 Thickness:** The QPL will list the specified thickness of each approved product.

**971-7.5 Durability and Wear Resistance:** When properly applied, the material shall provide neat, durable stripes and markings. The materials shall provide a cushioned resilient substrate that reduces sphere crushing and loss. The film shall be weather resistant and, through normal wear, shall show no significant tearing, rollback or other signs of poor adhesion.

**971-7.6 Conformability and Resealing:** The stripes and markings shall be capable of conforming to pavement contours, breaks and faults under traffic at pavement temperatures recommended by the manufacturer. The film shall be capable of use for



patching worn areas of the same types of film in accordance with the manufacturer's recommendations.

**971-7.7 Tensile Strength:** The stripes and markings shall have a minimum tensile strength of 40 psi when tested according to ASTM D638. A rectangular test specimen 6 inches by 1 inch by 0.05 inches minimum thickness shall be tested at a temperature range of 40 to 80°F using a jaw speed of 0.25 inch/min.

**971-7.8 Plastic Pull test:** The stripes and markings shall support a dead weight of 4 lb for not less than five minutes at a temperature range of 70 to 80°F. Rectangular test specimen size shall be 6 inches by 1 inch by 0.05 inches minimum thickness.

**971-7.9 Pigmentation:** The pigment shall be selected and blended to provide a material which is white or yellow conforming to standard highway colors through the expected life of the stripes and markings.

**971-7.10 Glass Spheres:** The stripes and markings shall have glass retention qualities such that, when at room temperature a 2 inches by 6 inches specimen is bent over a 0.5 inch diameter mandrel axis, a microscopic examination of the area on the mandrel shall show no more than 10% of the spheres with entrapment by the material of less than 40%. The bead adhesion shall be such that spheres are not easily removed when the film surface is scratched firmly with a thumbnail.

**971-7.11 Retroreflectivity:** The permanent tape materials for traffic stripes and markings shall have a service life of five years. The materials shall attain an initial retroreflectance of not less than 450 mcd/lx·m<sup>2</sup> for white and contrast markings and not less than 350 mcd/lx·m<sup>2</sup> for yellow markings. The pavement stripes and markings shall retain a minimum retroreflectance for two years of not less than 300 mcd/lx·m<sup>2</sup> for white and contrast markings and not less than 250 mcd/lx·m<sup>2</sup> for yellow markings. The retroreflectance of the white, yellow and contrast pavement markings at the end of the five year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

## **971-8 Two Reactive Component Materials For Traffic Stripes And Markings.**

**971-8.1 General:** Two reactive component materials intended for use under this Specification shall include, but not be limited to, epoxies, polyesters and urethanes. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the criteria outlined in this Specification and Section 709 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

### **971-8.2 Composition:**

Component	Test Method	Criteria
TiO <sub>2</sub> , Type II Rutile (white material only)	ASTM D476	minimum 10% by weight
Volatile Organic Content, (VOC)	ASTM D3960	maximum 150 g/L

**971-8.3 Physical Requirements:** The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Adhesion to Concrete	ASTM D4541, ASTM D7234 or ACI 503	Concrete Failure	-
Hardness	ASTM D7735 Type D	75	-
Abrasion Resistance	971-8.3.2	Pass	-

**971-8.3.1 Set To Bear Traffic Time:** The material shall set to bear traffic in not more than two minutes.

**971-8.3.2 Abrasion Resistance:** Test four samples per LOT using a Taber Abrader. The material shall be applied to specimen plates using a drawdown blade having a clearance of 26 mils. Air dry each sample for 30 minutes and bake at 220°F for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

**971-8.3.3 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 450 mcd/lx·m<sup>2</sup> and not less than 350 mcd/lx·m<sup>2</sup>, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

**971-8.4 Application Properties:** Application properties shall meet the requirements of Section 709.

**971-8.5 Packaging and Labeling:** The two reactive component material shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons of material shall be placed in any drum to allow for expansion during transport and storage. Other containers will be used for applicable products. Each container shall designate the color, generic type (e.g. epoxy), user information, manufacturer's name and address, batch number and date of manufacture. Each batch manufactured shall have a unique number. The label shall warn the user of hazards associated with handling or using the material.

## **971-9 Thermoplastic Material for Audible and Vibratory Traffic Stripes.**

**971-9.1 General:** Upon cooling to normal pavement temperature, the thermoplastic material shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall utilize alkyd based materials only and shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification shall apply regardless of the type of formulation used. The pigment, reflective elements, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

### **971-9.2 Composition:**

Component	Test Method	White	Yellow
Binder		20.0% minimum	20.0% minimum
TiO <sub>2</sub> , Type II Rutile	ASTM D476	10.0% minimum	-
Reflective Elements	AASHTO T250	% minimum per manufacturer	% minimum per manufacturer

Component	Test Method	White	Yellow
Yellow Pigment		-	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh sieve)		% minimum per manufacturer	% minimum per manufacturer
Percentages are by weight.			

The alkyd/maleic binder must consist of a mixture of synthetic resins (at least one synthetic resin must be solid at room temperature) and high boiling point plasticizers. At least one-half of the binder composition must be 100% maleic-modified glycerol of rosin and be no less than 15% by weight of the entire material formulation.

**971-9.3 Retroreflective Elements:** The reflective elements in the intermix shall be determined by the manufacturer and identified for the QPL System.

**971-9.4 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM D4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D570	-	0.5%
Softening Point	ASTM D36	210°F	-
Low Temperature Stress Resistance	AASHTO T250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D7735* Type A Durometer	65	-
Impact Resistance	ASTM D256, Method A	1.0 N·m	-
Flash Point	ASTM D92	475°F	-

\*The durometer and panel shall be at 80°F with a 1000 g load applied. Instrument measurement shall be taken after 15 seconds.

**971-9.4.1 Set To Bear Traffic Time:** When applied at the temperatures and thickness specified by Section 701, the baseline material shall set to bear traffic in not more than two minutes. The audible bump shall set to bear traffic in not more than 10 minutes at ambient air temperatures of 80°F or less and in not more than 15 minutes for ambient air temperatures exceeding 80°F.

**971-9.4.2 Retroreflectivity:** The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m<sup>2</sup> and not less than 250 mcd/lx·m<sup>2</sup>, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

**971-9.4.3 Durability:** Durability shall include flattening of the profile or raised portions of the line. The flattening of the profile or raised portion of the line shall not exceed 25% at the end of the three year service life.

**971-9.5 Application Properties:** Application properties shall meet the requirements of Section 701.

**971-9.6 Packing and Labeling:** The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh

approximately 50 lb. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.

### 971-10 Thermoplastic Material for Wet Weather Pavement Markings.

**971-10.1 General:** Upon cooling to normal pavement temperature, the thermoplastic material shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall utilize alkyd based materials only and shall have the option of formulating the material according to their specifications. However, the requirements delineated in this specification shall apply regardless of the type of formulation used. The pigment, reflective elements, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

#### 971-10.2 Composition:

Component	Test Method	White	Yellow
Binder		20.0% minimum	20.0% minimum
TiO <sub>2</sub> , Type II Rutile	ASTM D476	10.0% minimum	N/A
Reflective Elements (intermix)	AASHTO T250	% minimum per manufacturer	% minimum per manufacturer
Yellow Pigment		N/A	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh sieve)		% minimum per manufacturer	% minimum per manufacturer

Percentages are by weight.

**971-10.3 Retroreflective Elements:** The reflective elements in the intermix shall be determined by the manufacturer and identified for the QPL System.

**971-10.4 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM D4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D570	-	0.5%
Softening Point	ASTM D36	200°F	-
Low Temperature Stress Resistance	AASHTO T250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D7735* Type A Durometer	40	-
Impact Resistance	ASTM D256, Method A	1.0 N·m	-
Flash Point	ASTM D92	475°F	-

\*The durometer and panel shall be at 90°F with a 1000 g load applied. Instrument measurement shall be taken after 15 seconds.

**971-10.4.1 Set To Bear Traffic Time:** When applied at the temperatures and thickness specified by Section 702, the baseline material shall set to bear traffic in not more than two minutes. When the audible bump is required, the bump

shall set to bear traffic in not more than 10 minutes at ambient air temperatures of 80°F or less and in not more than 15 minutes for ambient air temperatures exceeding 80°F.

**971-10.4.2 Retroreflectivity:** The white and yellow pavement markings shall attain an initial dry retroreflectivity of not less than 300 mcd/lx·m<sup>2</sup> and not less than 250 mcd/lx·m<sup>2</sup>, respectively, and also attain an initial wet recovery retroreflectivity of not less than 150 mcd/lx·m<sup>2</sup> and not less than 125 mcd/lx·m<sup>2</sup>, respectively. The dry retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>, and also the wet recovery retroreflectivity at the end of the service life shall not be less than 75 mcd/lx·m<sup>2</sup>. The retroreflectivity will be determined in accordance with Florida Method FM-5-541 for dry and ASTM E2177 (Bucket Method) for wet recovery.

**971-10.4.3 Durability:** When an audible bump is required, durability shall include flattening of the profile or raised portions of the line. The flattening of the profile or raised portion of the line shall not exceed 25% at the end of the three year service life.

**971-10.5 Application Properties:** Application properties shall meet the requirements of Section 702.

**971-10.6 Packing and Labeling:** The thermoplastic material shall be packaged in suitable biodegradable or thermo-degradable containers which will not adhere to the product during shipment and storage. The container of thermoplastic material shall weigh approximately 50 lb. The label shall warn the user that the material shall be heated in the range as recommended by the manufacturer.