Florida Department of Transportation

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June 23, 2009

Monica Gourdine
Program Operations Engineer
Federal Highway Administration
545 John Knox Road, Suite 200
Tallahassee, Florida 32303

Re: Office of Design, Specifications
Section 971
Proposed Specification: 9710000 Traffic Marking Materials

Dear Ms. Gourdine:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.
These changes were proposed by Chester Henson of the State Roadway Design Office to update and clarify the non-hazardous requirements; to provide requirements for high index glass beads; to clarify two types of paint – standard waterborne fast dry paint and durable waterborne paint; to replace Federal Standard test methods with ASTM methods for both types of paint for dry opacity, bleed ratio and flexibility; to specify the required 18 month service life for durable paint; and to delete Subarticle 971-6 because thermoplastic material hot spray will no longer be used as decided by the maintenance engineers and to renumber the remaining articles as needed.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via Email to ST986RP or rudy.powell@dot.state.fl.us.

If you have any questions relating to this specification change, please call Rudy Powell, State Specifications Engineer at 414-4110.

Sincerely,

Rudy Powell, Jr., P.E.
State Specifications Engineer

RP/dt
Attachment
cc: Gregory Jones, Chief Civil Litigation

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TRAFFIC MARKING MATERIALS.
(REV *6*~~5-136~~*25*-09)

SECTION 971 (pages 922-936) is deleted and the following substituted:

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, ~~LOT,~~ 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*~~lot~~ 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: All traffic marking materials shall be one of the products listed on the Qualified Products List. 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 µm) 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 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 stripe materials shall be characterized as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) ~~Subarticle C rules, Table 1 of~~ 40 CFR 261.~~24~~ *and the material shall not exude fumes which are hazardous, toxic or detrimental to persons or property. Provide supporting independent analytical data or product Material Safety Data Sheets (MSDS) identifying nonhazardous designations.*

Additionally, traffic stripe materials shall contain no more that 5.0 ppm lead by weight when tested in accordance with the RCRA reference above. Provide supporting independent analytical data.~~"Toxicity Characteristic". Traffic stripe materials shall contain no more than 3.0 ppm lead by weight*~~*not exceed the regulatory limits for arsenic, barium, cadmium, chromium, lead, mercury, selenium or silver*~~ ~~in a cured state when tested by EPA methods 3050 and 6010 *TCLP 1311. The method used for determining the concentrations of the above stated contaminants shall be capable of measuring the detection limits stated in 40 CFR 261.24.*~~

~~The material shall not exude fumes which are hazardous, toxic or detrimental to persons or property.~~

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.

~~The glass spheres shall conform to the requirements of AASHTO M 247 and FP 96.~~

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
~~Gradation~~	~~ASTM D 1214~~	~~AASHTO M 247 & FP~~
Roundness*	ASTM D 1155	Min: 70 % ~~true spheres~~ by weight ~~per sieve size~~
*Roundness***	*ASTM D 1155*	*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 D 1214)				
	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	*95 - 100*
No. 20	95 - 100	0 – 5	0 – 2		*85 - 95*
No. 25		0 – 2			
No. 30	75 – 95				*65 - 85*
No. 40					*45 - 65*
No. 50	15 – 35				*25 - 45*
No. 80					
No~~0~~. 100	0 – 5				*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 1 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 ~~– Water Borne~~.

971-3.1 General: *Standard waterborne f*~~F~~ast 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 D 2369	minimum 75%
Pigments, by weight	ASTM D 3723	minimum 57%
Vehicle Solids % o*f*~~n~~ Vehicle*		minimum 40%
TiO_2, Type II Rutile (white paint only)	ASTM D 476	minimum 1.5 lb/gal
Volatile Organic Content, (VOC)	ASTM D 3960	maximum 150 g/L
**Vehicle Solids % of Vehicle =* $\frac{\text{\% total solids - \% pigment}}{\text{100 - \% pigment}}$		

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

Property	Test Method	Minimum	Maximum
Density	ASTM D 1475	13.5 ± 1.4 lb/gal	-
~~Consistency~~*Viscosity* at 77ºF	ASTM D 562	80 KU	100 KU
Fineness of Grind	ASTM D 1210	2(HS)	3(HS)
Dry Opacity at 5 mils WFT	~~Fed Std 141a Method 4121~~*ASTM D 2805*	0.96	-
Bleed Ratio	~~Fed Spec TT-P-85D~~*ASTM D 969*	0.95	-
Flexibility	~~Fed Spec TT-P-115D~~*ASTM D 522 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 220ºF 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^2 and 250 mcd/lx·m^2. 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^2.

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 *Durable Waterborne* ~~Fast Dry Solvent~~ Traffic Paint.

971-4.1 General: *Durable waterborne* ~~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 D 2369	75% minimum
Pigments, by weight	ASTM D 3723	57% minimum
Vehicle Solids, % o*f* ~~n~~ Vehicle*		40% minimum
TiO_2, Type II Rutile (white paint only)	ASTM D 476	1.5 lb/gal minimum
Volatile Organic Content, (VOC)	ASTM D 3960	150 g/L maximum

**Vehicle Solids % of Vehicle = $\frac{\text{\% total solids - \% pigment}}{\text{100 - \% pigment}}$*

Vehicle solids shall be 100% acrylic ~~cross-linking~~ emulsion polymer. Polymer shall be Fastrack ~~II~~ HD-21 manufactured by Rohm & Haas or DT 400NA by Dow.

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

Property	Test Method	Minimum	Maximum
Density	ASTM D 1475	13.5 ± *1.4*~~0.37~~ lb/gal	N/A
Viscosity~~Consistency~~ at *77*~~170~~ºF	ASTM D 562	80 KU	100 KU
Fineness of Grind	ASTM D 1210	2 (HS)	3(HS)
Dry Opacity at 5 mils WFT	~~Fed Std 141a Method 4121~~*ASTM D 2805*	0.96	-
Bleed Ratio	~~Fed Spec TT-P-85D~~*ASTM D 969*	0.95	-
Flexibility	~~Fed Spec TT-P-115D~~*ASTM D 522 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~~*ten* 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 220ºF for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with ~~1.1 lb~~*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 ~~0.178 oz~~*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^2 and 250 mcd/lx·m^2, respectively. The retroreflectance of the white and yellow pavement markings at the end of the ~~six~~*18* month service life shall not be less than 150 mcd/lx·m^2.

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_2, Type II Rutile	ASTM D 476	10.0% minimum	-
Glass Spheres	AASHTO T 250	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 D 4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D 570	-	0.5%
Softening Point	ASTM D 36	195ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D 2240* Shore Durometer, A2	40	75
Impact Resistance	ASTM D 256, Method A	1.0 N·m	-
Flash Point	ASTM D 92	475ºF	-
*The durometer and panel shall be at 110ºF with a 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^2 and not less than 350 mcd/lx·m^2, 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^2.

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 Thermoplastic Material-Hot Spray.**~~

~~**971-6.1 General:** This work shall consist of furnishing and applying thermoplastic material when the project requires refurbishing existing thermoplastic stripes. 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.~~

~~**971-6.2 Composition:**~~

~~Component~~	~~White~~	~~Yellow~~
~~Binder~~	~~25.0% minimum~~	~~25.0% minimum~~
~~TiO_2 (ASTM D 476 Type II Ructile)~~	~~10.0% minimum~~	~~-~~
~~Glass Spheres~~	~~35.0% minimum~~	~~35.0% minimum~~
~~Yellow Pigment~~	~~-~~	~~% minimum per manufacturer~~
~~Calcium Carbonate and Inert Filler (No. 200 sieve)~~	~~30.0% maximum~~	~~40.0% maximum~~

~~**971-6.3 Binders:** The manufacturer shall have the option of formulating the material according to his own specifications. However, the physical and chemical properties contained in this Specification shall apply regardless of the type of formulation used. The pigment, beads and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.~~

~~**971-6.4 Physical Requirements:** Sample specimens shall be prepared in accordance with ASTM D 4960.~~

~~Procedure shall meet the following requirements:~~

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D 570	-	0.5%
Softening Point	ASTM D 36	190ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-
Specific Gravity	Water displacement	1.87	2.3
Indentation Resistance	ASTM D 2240* Shore Durometer, A2	5	30
Impact Resistance	ASTM D 256, Method A	1.0 N·m	-
Flash Point	ASTM D 92	475ºF	-
*The durometer and panel shall be at 110ºF with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.			

971-6.4.1 Set To Bear Traffic Time: The thermoplastic shall set to bear traffic in not more than two minutes.

971-6.4.2 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and not less than 250 mcd/lx·m^2, respectively. The retroreflectance of the white and yellow pavement markings at the end of the one year service life shall not be less than 150 mcd/lx·m^2.

971-6.4.3 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 one year service life.

971-6.5 Glass Spheres: Glass spheres shall be Type 1 and meet the requirements of 971-2.

971-6.6 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

971-6.7 Application Properties: The thermoplastic material shall readily apply and adhere to the existing traffic stripe at temperatures as recommended by the manufacturer from equipment approved by the Engineer to produce a line which shall be continuous and uniform in shape having clear and sharp dimensions at a minimum thickness as identified in the plans. No signs of moisture shall be visible on the pavement surface as determined in accordance with the binder manufacturer's recommendations.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of the same material. Such new material shall bond itself to the old line in a manner such that no splitting or separation occurs.

Overlay stripe thicknesses shall be measured as specified in Section 711 for refurbishing of thermoplastic stripes.

971-6.8 Packing and Marking: The thermoplastic material shall be packed 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-~~7~~*6* Preformed Thermoplastic Materials for Traffic Stripes.

971-~~7~~*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-~~7~~*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-~~7~~*6*.3 Glass Spheres: Material shall contain no less than 30% glass spheres by weight.

971-~~7~~*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. The in-service luminance factor at the end of the three year service life shall not be less than 35 when measured outside the wheel paths.

971-~~7~~*6*.5 Physical Requirements: Laboratory samples shall be prepared in accordance with ASTM D 4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Softening Point	ASTM D 36	195ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-
Indentation Resistance	ASTM D 2240* Shore Durometer, A2	40	75
Impact Resistance	ASTM D 256, Method A**	1.0 N·m	-

*The durometer and panel shall be at 110ºF with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.
**The test specimen for ASTM D 256 shall be 1 in. x 1 in. x 6 in. and shall not be notched.

971-~~7~~*6*.5.1 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2. 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^2. 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^2.

971-~~7~~*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 E 303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

971-~~7~~*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-~~7~~*6*.6 Application Properties: Application properties shall meet the requirements of Section 711.

971-~~7~~*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-~~8~~*7* Permanent Tape Materials for Pavement Stripes and Markings.

971-~~8~~*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 divided into two classes: Standard and High Performance. The classes are differentiated by their durability and retroreflectivity. 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-~~8~~*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-~~8~~*7*.3 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 E 303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

971-~~8~~*7*.4 Thickness: The Qualified Products List will list the specified thickness of each approved product.

971-~~8~~*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-~~8~~*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-~~8~~*7*.7 Tensile Strength: The stripes and markings shall have a minimum tensile strength of 40 psi when tested according to ASTM D 638. A rectangular test specimen 6 by 1 by 0.05 minimum thickness shall be tested at a temperature range of 40 to 80ºF using a jaw speed of 0.25 inch/min.

971-~~8~~*7*.8 Elongation: The stripes and markings shall have a minimum elongation of 25% when tested in accordance with ASTM D 638.

971-~~8~~*7*.9 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 80ºF. Rectangular test specimen size shall be 6 by 1 by 0.05 inch minimum thickness.

971-~~8~~*7*.10 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-~~8~~*7*.11 Glass Spheres: The stripes and markings shall have glass retention qualities such that, when at room temperature a 2 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-~~8~~*7*.12 Standard Markings: The preformed materials for pavement stripes and markings shall have a service life of three year. The materials shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 for white and contrast markings and not less than 250 mcd/lx·m^2, for yellow markings. The retroreflectance of the white, yellow and contrast pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m^2. 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^2.

971-~~8~~*7*.13 High Performance Markings: The preformed materials for pavement 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^2 for white and contrast markings and not less than 350 mcd/lx·m^2 for yellow markings. The pavement stripes and markings shall retain a minimum retroreflectance for two years of not less than 300 mcd/lx·m^2 for white and contrast markings and not less than 250 mcd/lx·m^2 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^2.

971-~~9~~*8* Two Reactive Component Materials For Traffic Stripes And Markings.

971-~~9~~*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-~~9~~*8*.2 Composition:

Component	Test Method	Criteria
TiO_2, Type II Rutile (white material only)	ASTM D 476	minimum 10% by weight
Volatile Organic Content, (VOC)	ASTM D 3960	maximum 150 g/L

971-~~9~~*8*.3 Physical Requirements: The material shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Adhesion to Concrete	ASTM D 4541	*Concrete Failure*~~Pass~~	-
Hardness	ASTM D 2240	75	-
~~Flexibility~~	~~Fed Spec TT-P-115D~~	~~Pass~~	~~-~~
Abrasion Resistance	971-9*8*.5~~5~~*3*.2	Pass	-

971-9*8*.3.1 Set To Bear Traffic Time: The material shall set to bear traffic in not more than two minutes.

971-9*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 220ºF for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 1.1 lb 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 0.178 ounce per plate.

971-9*8*.3.3 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 450 mcd/lx·m^2 and not less than 350 mcd/lx·m^2, respectively. The retroreflectance of the white and yellow pavement markings at the end of the ~~one~~*three* year service life shall not be less than 150 mcd/lx·m^2.

971-9*8*.4 Application Properties: Application properties shall meet the requirements of Section 709.

971-9*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-~~10~~*9* Thermoplastic Material for Audible and Vibratory Traffic Stripes.

971-~~10~~*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, glass spheres, and filler shall be well dispersed in the resin. The material shall be free from all skins, dirt and foreign objects.

971-~~10~~*9*.2 Composition:

Component	Test Method	White	Yellow
Binder		20.0% minimum	20.0% minimum
TiO_2, Type II Rutile	ASTM D 476	10.0% minimum	-
Glass Spheres	AASHTO T 250	40.0% minimum	40.0% minimum

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-~~10~~*9*.3 Glass Spheres: The glass spheres in the intermix shall be Type 1 and meet the requirements of 971-2.

971-~~10~~*9*.4 Physical Requirements: Laboratory samples shall be prepared in accordance with ASTM D 4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D 570	-	0.5%
Softening Point	ASTM D 36	210ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D 2240* Shore Durometer, A2	65	-
Impact Resistance	ASTM D 256, Method A	1.0 N·m	-
Flash Point	ASTM D 92	475ºF	-
*The durometer and panel shall be at 80ºF, but not exceeding 90ºF with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.			

971-~~10~~*9*.4.1 Set To Bear Traffic Time: The thermoplastic shall set to bear traffic in not more than 10 minutes at ambient air temperatures of 80ºF or less and in not more than 15 minutes for ambient air temperatures exceeding 80ºF.

971-~~10~~*9*.4.2 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and not less than 250 mcd/lx·m^2, 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^2.

971-~~10~~*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-~~10~~*9*.5 Application Properties: Application properties shall meet the requirements of Section 701.

971-~~10~~*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.

TRAFFIC MARKING MATERIALS.
(REV 6-25-09)

SECTION 971 (pages 922-936) is deleted and the following substituted:

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: All traffic marking materials shall be one of the products listed on the Qualified Products List. 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 μm) 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 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 stripe materials shall be characterized as non-hazardous as defined by Resource Conservation and Recovery Act (RCRA) 40 CFR 261 and the material shall not exude fumes which are hazardous, toxic or detrimental to persons or property. Provide supporting independent analytical data or product Material Safety Data Sheets (MSDS) identifying nonhazardous designations.

Additionally, traffic stripe materials shall contain no more that 5.0 ppm lead by weight when tested in accordance with the RCRA reference above. Provide supporting independent analytical data.

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 D 1155	Min: 70 % by weight
Roundness**	ASTM D 1155	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 D 1214)				
	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	95 - 100
No. 20	95 - 100	0 – 5	0 – 2		85 - 95
No. 25		0 – 2			
No. 30	75 – 95				65 - 85
No. 40					45 - 65
No. 50	15 – 35				25 - 45
No. 80					
No. 100	0 – 5				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 1 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 D 2369	minimum 75%
Pigments, by weight	ASTM D 3723	minimum 57%
Vehicle Solids % of Vehicle*		minimum 40%
TiO_2, Type II Rutile (white paint only)	ASTM D 476	minimum 1.5 lb/gal
Volatile Organic Content, (VOC)	ASTM D 3960	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 D 1475	13.5 ± 1.4 lb/gal	-
Viscosity at 77ºF	ASTM D 562	80 KU	100 KU
Fineness of Grind	ASTM D 1210	2(HS)	3(HS)
Dry Opacity at 5 mils WFT	ASTM D 2805	0.96	-
Bleed Ratio	ASTM D 969	0.95	-
Flexibility	ASTM D 522 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 220ºF 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^2 and 250 mcd/lx·m^2. 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^2.

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 Durable Waterborne Traffic Paint.

971-4.1 General: Durable waterborne 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 D 2369	75% minimum
Pigments, by weight	ASTM D 3723	57% minimum
Vehicle Solids, % of Vehicle*		40% minimum
TiO_2, Type II Rutile (white paint only)	ASTM D 476	1.5 lb/gal minimum
Volatile Organic Content, (VOC)	ASTM D 3960	150 g/L maximum

*Vehicle Solids % of Vehicle = $\frac{\text{\% total solids - \% pigment}}{\text{100 - \% pigment}}$

Vehicle solids shall be 100% acrylic emulsion polymer. Polymer shall be Fastrack HD-21 manufactured by Rohm & Haas or DT 400NA by Dow.

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

Property	Test Method	Minimum	Maximum
Density	ASTM D 1475	13.5 ± 1.4 lb/gal	N/A
Viscosityat 77ºF	ASTM D 562	80 KU	100 KU
Fineness of Grind	ASTM D 1210	2 (HS)	3(HS)
Dry Opacity at 5 mils WFT	ASTM D 2805	0.96	-
Bleed Ratio	ASTM D 969	0.95	-
Flexibility	ASTM D 522 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 ten 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 220ºF 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.

971-4.3.3 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and 250 mcd/lx·m^2, respectively. The retroreflectance of the white and yellow pavement markings at the end of the 18 month service life shall not be less than 150 mcd/lx·m^2.

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_2, Type II Rutile	ASTM D 476	10.0% minimum	-
Glass Spheres	AASHTO T 250	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 D 4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D 570	-	0.5%
Softening Point	ASTM D 36	195ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D 2240* Shore Durometer, A2	40	75
Impact Resistance	ASTM D 256, Method A	1.0 N·m	-

Property	Test Method	Minimum	Maximum
Flash Point	ASTM D 92	475ºF	-
*The durometer and panel shall be at 110ºF with a 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^2 and not less than 350 mcd/lx·m^2, 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^2.

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. The in-service luminance factor at the end of the three year service life shall not be less than 35 when measured outside the wheel paths.

971-6.5 Physical Requirements: Laboratory samples shall be prepared in accordance with ASTM D 4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Softening Point	ASTM D 36	195ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-

Property	Test Method	Minimum	Maximum
Indentation Resistance	ASTM D 2240* Shore Durometer, A2	40	75
Impact Resistance	ASTM D 256, Method A**	1.0 N·m	-

*The durometer and panel shall be at 110ºF with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.
**The test specimen for ASTM D 256 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^2. 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^2. 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^2.

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 E 303. 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 Pavement 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 divided into two classes: Standard and High Performance. The classes are differentiated by their durability and retroreflectivity. 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 (British Pendulum Number) when tested according to ASTM E 303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

971-7.4 Thickness: The Qualified Products List 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 D 638. A rectangular test specimen 6 by 1 by 0.05 minimum thickness shall be tested at a temperature range of 40 to 80ºF 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.

971-7.9 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 80ºF. Rectangular test specimen size shall be 6 by 1 by 0.05 inch minimum thickness.

971-7.10 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.

971-7.11 Glass Spheres: The stripes and markings shall have glass retention qualities such that, when at room temperature a 2 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.

971-7.12 Standard Markings: The preformed materials for pavement stripes and markings shall have a service life of three year. The materials shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 for white and contrast markings and not less than 250 mcd/lx·m^2, for yellow markings. The retroreflectance of the white, yellow and contrast pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m^2. 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^2.

971-7.13 High Performance Markings: The preformed materials for pavement 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^2 for white and contrast markings and not less than 350 mcd/lx·m^2 for yellow markings. The pavement stripes and markings shall retain a minimum retroreflectance for two years of not less than 300 mcd/lx·m^2 for white and contrast markings and not less than 250 mcd/lx·m^2 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^2.

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_2, Type II Rutile (white material only)	ASTM D 476	minimum 10% by weight
Volatile Organic Content, (VOC)	ASTM D 3960	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 D 4541	Concrete Failure	-
Hardness	ASTM D 2240	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 220ºF for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 1.1 lb 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 0.178 ounce 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^2 and not less than 350 mcd/lx·m^2, 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^2.

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, glass spheres, 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_2, Type II Rutile	ASTM D 476	10.0% minimum	-
Glass Spheres	AASHTO T 250	40.0% minimum	40.0% minimum
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 Glass Spheres: The glass spheres in the intermix shall be Type 1 and meet the requirements of 971-2.

971-9.4 Physical Requirements: Laboratory samples shall be prepared in accordance with ASTM D 4960 and shall meet the following criteria:

Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D 570	-	0.5%
Softening Point	ASTM D 36	210ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-
Specific Gravity	Water displacement	1.9	2.3
Indentation Resistance	ASTM D 2240* Shore Durometer, A2	65	-
Impact Resistance	ASTM D 256, Method A	1.0 N·m	-
Flash Point	ASTM D 92	475ºF	-
*The durometer and panel shall be at 80ºF, but not exceeding 90ºF with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.			

971-9.4.1 Set To Bear Traffic Time: The thermoplastic shall set to bear traffic in not more than 10 minutes at ambient air temperatures of 80ºF or less and in not more than 15 minutes for ambient air temperatures exceeding 80ºF.

971-9.4.2 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 300 mcd/lx·m^2 and not less than 250 mcd/lx·m^2, 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^2.

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.