ORIGINATION FORM
Proposed Revisions to the Specifications
(Please provide all information - incomplete forms will be returned)

Date: 6/30/23

Office: State Materials Office

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Article/Subarticle: 971-1.4, 971-1.6,971-1.7,971-

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Associated Section(s) Revisions: 701, 709, 710, 711, 713

Will the proposed revision require changes to the following Publications:

Publication	Yes	No	Office Staff Contacted	Date
Standard Plans Index	○	●	Rick Jenkins/Joshua Turley	7/7/23
Traffic Engineering Manual	○	●	Mariano Amicarelli	7/7/23
FDOT Design Manual	●	○	DeWayne Carver	6/27/23
Construction Project Administration Manual	●	○	Patrick Overton	7/7/23
Basis of Estimate/Pay Items	●	○	Ryan Gray	7/7/23
Structures Design Guidelines	○	●	Ben Goldsberry	7/7/23
Approved Product List	●	○	Karen Byram	6/26/23
Materials Manual	○	●	Susan Musselman/Brad Pearson	7/7/23
Maintenance Specs	●	○	Deanna Hutchison	7/6/23

Will this revision necessitate any of the following:

Design Bulletin ☐ **Construction (DCE Memo)** ☐ **Estimates Bulletin** ☐ **Materials Bulletin** ☐

Have all references to internal and external publications in this Section been verified for accuracy? YES

Synopsis: Summarize the changes:

1. Added Table 971-1 listing the documentation required for pavement markings to be listed on the APL and re-numbered subsequent tables.
2. Editorial changes to improve specification language.
3. Reviewed and made necessary updates to test methods.
4. Corrected the unit of retroreflectivity from mcd/lux/m2 to mcd/m2/l

Justification: Why does the existing language need to be changed?

1.Table was added to be consistent with other specification formats.
2. Added language to make the specification clear.
3. Some of the test methods are no longer in use or wrongly stated. Referenced AASHTO T 250 since it is more appropriate for DOTs.
4.Unit of retroreflectivity was corrected to be consistent with the standard procedures and specifications.

Do the changes affect either of the following types of specifications (Hover over type to go to site.):

Special Provisions ☐ **Developmental Specifications** ☑

List Specifications Affected: (ex. SP3270301, Dev330TL, Dev334TL etc.)

Dev709,Dev712IMP, Dev971IMP, Dev971WSP

Contact the State Specifications Office for assistance completing this form.

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1. Are changes in line with promoting and making meaningful progress on improving safety, enhancing mobility, inspiring innovation, and fostering talent; explain how?

Changes are mainly editorial and improves the language in the specifications.

2. What financial impact does the change have; project costs, pay item structure, or consultant fees?

No financial impact is anticipated.

3. What impacts does the change have on production or construction schedules?

No schedule impact anticipated.

4. How does this change improve efficiency or quality?

Generally, improved specification language to bring clarity and made corrections.

5. Which FDOT offices does the change impact?

Design, Construction, State Material Office, APL, Maintenance.

6. What is the impact to districts with this change?

Positive impact as it corrects unit of measuring retroreflectivity to reflect federal, state and industry standards.Removing the Hot-Applied High Friction Thermoplastic markings does not affect the Districts as it was alternative to Preformed thermoplastics and was not in used in project.

7. Does the change shift risk and to who?

No

8. Provide summary and resolution of any outstanding comments from the districts or industry.

Comments and Responses are available on the Track the Status of Revisions hyperlink located on the Specifications landing page: https://www.fdot.gov/programmanagement/Specs.shtm

9. What is the communication plan?

Through the established specification revision process (e.g., Internal and Industry Review)

10. What is the schedule for implementation?

The Standard Specifications eBook and Workbook are effective July 1st every year.

PAVEMENT MARKING MATERIALS.
(REV 6-30-23)

SECTION 971 is deleted and the following substituted:

971-1 General Requirements.

971-1.1 Packaging and Labeling: The name and address of the manufacturer shall be shown on the label. The label must also show the color, date of manufacturer, lot number and APL number. The label shall warn the user of any special handling or precautions of the material, as recommended by the manufacturer. Any packaging and labeling not so marked will not be accepted.

971-1.2 Storage: All materials must have a container storage life of one year from date of manufacture. Any pavement marking materials, which although inspected and approved at the point of manufacture, hardens or livers in the containers 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. Thinners shall not be used under any circumstances.

971-1.4 Approved Product List (APL): All pavement marking materials shall be one of the products listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 and include the documentation identified in the Table 971-1. ~~and the infrared identification curve (2.5 to 15 µm) for the vehicle component.~~

Table 971-1

Documentation	Requirements
Product Photo	Displays the significant features of the product.
Technical Data Sheet	Uniquely identifies the product and includes product specifications, storage instructions, and recommended installation materials and equipment as applicable. Include the following information as applicable: 1. Use on concrete surfaces 2. Use on asphalt surfaces (dense graded, open graded, HFST, etc) 3. Primers or sealers, friction elements, glass spheres, retroreflective elements
Product Label	For each component of the product system. Label shall meet the requirements in 971-1.1.

Safety Data Sheet (SDS)	Pavement 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 (SDS) identifying any components listed in Table 1 of 40 CFR 261.24.
AASHTO Product Evaluation & Audit Solutions Field Test Report	For standard paint, durable paint, two reactive component material, and permanent tape, manufacturers shall provide AASHTO Product Evaluation & Audit Solutions field test data meeting FDOT Specification requirements.
Independent Laboratory Test Report	Submit independent laboratory test results meeting the requirements in 971.
Installation Instructions	Surface preparation and installation procedures for different substrates. Include the following information as applicable: 1. ~~1.~~ Sealer/primer application instructions when required 2. Application thickness ~~1.~~3. Application rates of glass spheres/retroreflective elements/ friction elements
Product Sample	Submit upon request from the Department. If the product is a system, a sample of each component must be submitted.

The Department will test hot-applied standard thermoplastic and profiled thermoplastic pavement marking materials in accordance with FM 5-541, Part B. The Department will test preformed thermoplastic and hot-applied high friction thermoplastic pavement marking materials in accordance with FM 5-622, Part A. ~~For standard paint, durable paint, two reactive component material, and permanent tape, manufacturers shall provide National Transportation Product Evaluation Program (NTPEP) field test data meeting FDOT Specification requirements~~. A notation of the number of coats and the thickness of each coat at which the product passes testing may be placed on the APL. When listed, this will be the minimum criteria for application of the pavement 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: Pavement markings shall meet color requirements when tested according to ASTM E2367 and E1349. 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:

Table 971-2~~1~~

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:

Table 971-32				
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: ~~Pavement 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 (SDS) identifying any components listed in Table 1 of 40 CFR 261.24.~~

R~~Additionally, r~~etroreflective 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 retroreflective surface, 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. Glass spheres ~~Beads~~ used in the intermix of materials are not required to be coated.

The following physical requirements apply:

Table 971-43		
Property	Test Method	Specification
Roundness*	AASHTO R 98	Min: 70% by weight
Roundness**	AASHTO R 98	Min: 80% by weight
Refractive Index*	ASTM C1648 -Becke Line Method (25+/-5C)	1.5 minimum
Refractive Index**	ASTM C1648-Becke Line Method (25+/-5C)	1.9 minimum
*Type 1, 3, 4 and 5 beads **High Index beads		

Table 971-54					
Sieve Size	Percent by Mass Passing Designated Sieve (AASHTO R 98)				
	Grading Designation				
	Type 1*	Type 3*	Type 4*	Type 5*	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 - 75
No. 40					15 - 35
No. 50	15 - 35				0 - 5
No. 80					
No. 100	0 - 5				
*AASHTO M247 ** Federal Specification TT-B-1325D17					

971-2.3 Sampling: A random 50-pound sample of glass spheres shall be obtained for each 50,000 pounds shipped. Send each 50-pound sample to the State Materials Office.

971-2.4 Containers: The spheres shall be furnished in new 50-pound moisture-proof bags or 2,000-pound triwall boxes. All containers shall meet Interstate Commerce Commission requirements for strength and type.

971-3 Standard Paint.

971-3.1 General: Standard paints shall include water reducible products that are single packaged and ready mixed. The paint shall have the capability of being cleaned and flushed from the pavement marking machines using regular tap water and any required rust inhibitors. The manufacturer shall have the option of formulating the paint 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 paint shall be free from all skins, dirt, and foreign objects.

971-3.2 Composition:

Table 971-65		
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_2, Type II Rutile (white paint only)	ASTM D476	minimum 1.0 lb/gal
Volatile Organic ~~Content~~ Compound, (VOC)	ASTM D3960	maximum 150 g/L
*Vehicle Solids % of Vehicle = $\frac{\text{(\% total solids - \% pigment)}}{\text{(100 - \% pigment)}}$		

971-3.3 Physical Requirements: ~~Test laboratory samples in accordance with ASTM E811 and E1349 and also meet the following criteria:~~

Table 971-76			
Property	Test Method	Minimum	Maximum
Density	ASTM D1475	13.5 ± 1.4 lb/gal	-
Viscosity at 77ºF	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 D868	0.95	-
Flexibility	ASTM D522 Method B	Pass	-
Abrasion Resistance	ASTM D4060	Pass	-

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

971-3.3.2 Abrasion Resistance: Test four samples using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 20 mils. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with a combined load of 500 g (arm plus auxiliary weight) on each arm 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 75 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/m^2/lx ~~mcd/lx·m^2~~ and 250 ~~mcd/lx·m^2~~ mcd/m^2/lx, respectively. Black pavement markings shall have a retroreflectance of less than 20 ~~mcd/lx·m^2~~ mcd/m^2/lx. The retroreflectance of the white and yellow pavement markings at the end of the six-month period shall not be less than 150 ~~mcd/lx·m^2~~ mcd/m^2/lx.

971-3.4 Application Properties: Meet the requirements of Section 710 for application properties.

971-3.5 Packaging and Labeling: The paint shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket or 275 gallon Intermediate Bulk Container (IBC). No more than 50 gallons of paint shall be placed in any drum or 250 gallons in any IBC to allow for expansion during transport and storage. Clearly mark the containers with the weight in pounds per gallon, the volume of materials in units of gallons.

971-4 Durable Paint.

971-4.1 General: Durable paints shall include water reducible products that are single packaged and ready mixed. The paint shall have the capability of being cleaned and flushed from the pavement marking 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 paint shall be free from all skins, dirt and foreign objects. The manufacturer shall provide the recommended thickness prior to installation.

971-4.2 Composition:

Table 971-8~~7~~

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_2, Type II Rutile (white paint only)	ASTM D476	1.0 lb/gal minimum
Volatile Organic ~~Content~~ Compound, (VOC)	ASTM D3960	150 g/L maximum

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

Vehicle solids shall be 100% acrylic emulsion polymer.

971-4.3 Physical Requirements: ~~Test laboratory samples in accordance with ASTM E811 and E1349. Samples shall meet the following criteria:~~

Table 971-9~~8~~

Property	Test Method	Minimum	Maximum
Density	ASTM D1475	13.5 ± 1.4 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 D868	0.95	-
Flexibility	ASTM D522 Method B	Pass	-
Abrasion Resistance	ASTM D4060	Pass	-

971-4.3.1 Set to Bear Traffic Time: The paint shall set to bear traffic in not more than ten minutes.

971-4.3.2 Abrasion Resistance: Test four samples using a Taber Abrader. The paint shall be applied to specimen plates using a drawdown blade having a clearance of 20 mils. Air dry each sample until fully cured based on the manufacturer's product recommendation. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with a combined load of 500 g (arm plus auxiliary weight) on each arm 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 75 mg per plate.

971-4.3.3 Retroreflectivity: The white and yellow pavement markings shall attain an initial retroreflectance of not less than 450 ~~mcd/lx·m²~~ mcd/m²/lx and 300 ~~mcd/lx·m²~~ mcd/m²/lx, respectively. The retroreflectance of the white and yellow pavement markings at the end of the 18 month period shall not be less than 150 ~~mcd/lx·m²~~ mcd/m²/lx.

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

971-4.5 Packaging and Labeling: The paint shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket or 275 gallon Intermediate Bulk Container (IBC). No more than 50 gallons of paint shall be placed in any drum or 250 gallons in any IBC to allow for expansion during transport and storage. Clearly mark the containers with the weight in pounds per gallon, the volume of materials in units of gallons.

971-5 Hot-Applied Standard Thermoplastic Material.

971-5.1 General: 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.

971-5.2 Composition:

Table 971-10~~9~~

Component	Test Method	White	Yellow
Binder	ASTM D4797	20% minimum	20% minimum
TiO_2, Type II Rutile	ASTM D476	10% minimum	-
Glass Spheres	ASTM D4797	40% minimum	40% minimum
Yellow Pigment		-	% minimum per manufacturer
Calcium Carbonate and Inert Filler (-200 mesh sieve)		30% maximum	37% 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 and meeting the requirements of this Section.

971-5.4 Sharp Silica Sand: Sharp silica sand shall meet the following gradation requirements:

Table 971-11~~0~~

Sieve Size	Percent by Mass Passing Designated Sieve (ASTM D1214)
20	100
50	0 to 10

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

Table 971-121			
Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D570	-	0.5%
Softening Point	AASHTO T 250 ~~STM D36~~	195ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-
Specific Gravity	AASHTO T 250~~Water displacement~~	1.9	2.3
Indentation Resistance	ASTM D7735* Type A Durometer	40	75
Impact Resistance	AASHTO T 250~~STM D256~~, ~~Method A~~	1.0 N·m	-
Flash Point	AASHTO T 250~~STM D92~~	475ºF	-
* The durometer and panel shall be at 115ºF with a 1,000 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^2~~ mcd/m^2/lx and not less than 350 ~~mcd/lx·m^2~~ mcd/m^2/lx, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three-year APL testing period shall not be less than 250 ~~mcd/lx·m^2~~ mcd/m^2/lx.

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 pounds. The label shall also warn the user that the material shall be heated in the range as recommended by the manufacturer.

971-6 Preformed Thermoplastic Material.

971-6.1 General: 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, friction elements, glass spheres, and filler shall be well dispersed in the resin.

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

971-6.3 Color: Materials shall meet the performance requirements specified in 971--1.6 and the following additional requirements. The initial luminance factor, Cap Y, for white preformed shall not be less than 55.

971-6.4 Physical Requirements: ~~Laboratory samples shall be tested in accordance with ASTM D4960 and shall meet the following criteria:~~

Table 971-132			
Property	Test Method	Minimum	Maximum
Softening Point	ASTM D36	195ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-
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 115ºF with a 1,000 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.			

971-6.4.1 Retroreflectivity: The white pavement markings shall attain an initial retroreflectance of not less than 200 ~~mcd/lx·m²~~ mcd/m²/lx. Black pavement markings shall have a retroreflectance of less than 20 ~~mcd/lx·m²~~ mcd/m²/lx. The retroreflectance of the white pavement markings at the end of the three-year period shall not be less than 150 ~~mcd/lx·m²~~ mcd/m²/lx.

971-6.4.2 Friction Resistance: Initial performance of pavement markings shall provide a minimum Dynamic Friction Tester (DFT40) value of 45 or greater in accordance with FM 5-622, Part A. In-service pavement markings shall maintain a DFT40 value of 40 or greater for a three-year period as tested per FM 5-622, Part B.

971-6.5 Application Properties: Application properties shall meet the requirements of Section 711.

971-6.6 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. Clearly mark each container with the thickness of the preformed material in units of inches.

971-7 Permanent Tape Materials.

971-7.1 General: The materials for permanent tape pavement markings shall consist of white or yellow weather-resistant retroreflective film as specified herein. 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.

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

971-7.3 Thickness: The APL will list the specified thickness of each approved product.

971-7.4 Durability and Wear Resistance: The film shall be weather resistant and, through normal wear, shall show no significant tearing, rollback or other signs of poor adhesion.

971-7.5 Conformability and Resealing: The pavement 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.

971-7.6 Tensile Strength: The pavement 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 80ºF using a jaw speed of 0.25 inch/min.

971-7.7 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 pavement markings. Test laboratory samples in accordance with ASTM E811 and E1349.

971-7.8 Glass Spheres: The pavement 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.

971-7.9 Retroreflectivity: The materials shall attain an initial retroreflectance of not less than 450 ~~mcd/lx·m²~~ mcd/m²/lx for white markings and not less than 350 ~~mcd/lx·m²~~ mcd/m²/lx for yellow markings. The pavement markings shall retain a minimum retroreflectance for two years of not less than 300 ~~mcd/lx·m²~~ mcd/m²/lx for white markings and not less than 250 ~~mcd/lx·m²~~ mcd/m²/lx for yellow markings. The retroreflectance of the white, yellow and contrast pavement markings at the end of the three~~five~~-year ~~APL testing~~ period shall not be less than 150 ~~mcd/lx·m²~~ mcd/m²/lx.

971-7.10 Packaging and Labeling: Ship all permanent tape materials in containers which will not adhere to the product during shipment and storage. Clearly mark each container with the thickness of the preformed material in units of inches.

971-8 Two Reactive Component Material.

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. 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:

Table 971-14~~3~~

Component	Test Method	Criteria
TiO_2, Type II Rutile (white material only)	ASTM D476	minimum 10% by weight
Volatile Organic ~~Content~~ Compound, (VOC)	ASTM D3960	maximum 150 g/L

971-8.3 Physical Requirements: ~~Test laboratory samples in accordance with ASTM and also meet the following criteria:~~

Table 971-154			
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	ASTM D4060	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 using a Taber Abrader. The material shall be applied to specimen plates using a drawdown blade having a clearance of 15 mils. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with a combined load of 500 g (arm plus auxiliary weight) on each arm 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 60 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^2~~ mcd/m^2/lx and not less than 350 ~~mcd/lx·m^2~~ mcd/m^2/lx, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three-year period shall not be less than 150 ~~mcd/lx·m^2~~ mcd/m^2/lx.

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 or 275 gallon Intermediate Bulk Container (IBC). No more than 50 gallons of material shall be placed in any drum or 250 gallons in any IBC to allow for expansion during transport and storage. Clearly mark the containers with the volume of materials in units of gallons and the product name.

971-9 Profiled Thermoplastic Material.

971-9.1 General: 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, retroreflective elements, and filler shall be well dispersed in the resin.

971-9.2 Composition:

Table 971-165			
Component	Test Method	White	Yellow
Binder	ASTM D4797	20% minimum	20% minimum
TiO_2, Type II Rutile	ASTM D476	10% minimum	-
Retroreflective Elements	ASTM D4797	% 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
Note: 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 retroreflective elements in the intermix shall be determined by the manufacturer and identified for the APL.

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

Table 971-1~~6~~			
Property	Test Method	Minimum	Maximum
Water Absorption	ASTM D570	-	0.5%
Softening Point	~~ASTM D36~~AASHTO T 250	210ºF	-
Low Temperature Stress Resistance	AASHTO T 250	Pass	-
Specific Gravity	~~Water displacement~~AASHTO T 250	1.9	2.3
Indentation Resistance	ASTM D7735* Type A Durometer	65	-
Impact Resistance	~~ASTM D256, Method A~~AASHTO T 250	1.0 N·m	-
Flash Point	AASHTO T 250~~STM D92~~	475ºF	-
*The durometer and panel shall be at 80ºF, with a 1,000 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 bumps 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·m²~~ mcd/m^2/lx and not less than 250 ~~mcd/lx·m²~~ mcd/m^2/lx, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three-year period shall not be less than 150 ~~mcd/lx·m²~~ mcd/m^2/lx.

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 period.

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

971-10 Hot-Applied High Friction Thermoplastic Material.

971-10.1 General: The manufacturer shall utilize alkyd based materials only and have the option of formulating the material according to his own specifications. However, the requirements of this Specification shall apply regardless of the formulation used. The pigment, retroreflective elements, and filler shall be well dispersed in the resin.

971-10.2 Composition:

Table 971-17		
Component	Test Method	White
Binder	ASTM D4797	18% minimum
TiO_2, Type II Rutile	ASTM D476	10% minimum
Note: Percentages are by weight.		

The alkyd/maleic binder shall 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.

971-10.3 Retroreflectiveand Friction Elements: The retroreflective and friction elements in the intermix shall be determined by the manufacturer and identified on the APL.

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

Table 971-18			
Property	Test Method	Minimum	Maximum
Softening Point	AASHTO T 250 STM D36	195°F	-
Hardness of Friction Elements	Moh's Scale	9	-
Indentation Resistance	ASTM D7735* Type A Durometer	55	85
Impact Resistance	AASHTO T 250 ASTM D256, Method A	1.0 N·m	-
Flash Point	AASHTO T 250STM D92	475°F	-
*The durometer and panel shall be at 115°F, with a 1,000 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 thicknesses specified by Section 711, the material shall set to bear traffic in not more than two minutes.

971-10.4.2 Retroreflectivity: The white pavement markings shall attain an initial retroreflectance of not less than 200 mcd/lx·m^2. The retroreflectance of the white pavement markings at the end of the three-year period shall not be less than 150 mcd/lx·m^2.

971-10.4.3 Friction Resistance: Initial performance of the pavement markings shall provide a minimum Dynamic Friction Tester (DFT40) value of 45 or greater in accordance with FM 5-622 – Part A. In-service pavement markings shall maintain a DFT40 value of 40 or greater for a three-year period as tested per FM 5-622 – Part B.

971-10.4.4 Color: The initial luminance factor, Cap Y, shall not be less than 55.

~~**971-10.5 Application Properties:** Application properties shall meet the requirements of Section 711.~~

~~**971-10.6 Packaging 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 pounds. The label shall warn the user that the material is to be heated in the range as recommended by the manufacturer.~~