

**971 TRAFFIC MARKING MATERIALS.**  
**(REV 2-15-11) (FA 2-22-11) (7-11)**

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

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

**971-1 General Requirements.**

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

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

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

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

**971-1.4 Qualified Products List:** 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  $\mu\text{m}$ ) for the vehicle component. Products may only be used for applications recommended by the manufacturer. A notation of the number of coats and the thickness of each coat at which the product passes testing may be placed on the QPL. When listed, this will be the minimum criteria for application of the traffic marking material.

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

**971-1. 6 Color:** Materials 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 than 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<br>(AASHTO) | Type 3 (FP 96) | Type 4 (FP 96) | Type 5 (FP 96) | High Index |
|---------|--------------------|----------------|----------------|----------------|------------|
| No. 8   |                    |                |                | 100            |            |
| No. 10  |                    |                | 100            | 95 – 100       |            |
| No. 12  |                    | 100            | 95 – 100       | 80 – 95        |            |
| No. 14  |                    | 95 – 100       | 80 – 95        | 10 – 40        |            |
| No. 16  | 100                | 80 – 95        | 10 – 40        | 0 – 5          | 100        |
| No. 18  |                    | 10 – 40        | 0 – 5          | 0 – 2          |            |
| No. 20  | 95 - 100           | 0 – 5          | 0 – 2          |                | 95 - 100   |
| No. 25  |                    | 0 – 2          |                |                |            |
| No. 30  | 75 – 95            |                |                |                | 55 - 85    |
| No. 40  |                    |                |                |                | 15 - 45    |
| No. 50  | 15 – 35            |                |                |                | 0 - 5      |
| No. 80  |                    |                |                |                |            |
| No. 100 | 0 – 5              |                |                |                |            |

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

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

**971-2.3.1 Sampling:** A random 50 lb sample of glass spheres shall be obtained for each 50,000 lb shipped. Upon arrival, the quantity of material will be reduced in a sample splitter to a size of approximately 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 <sub>2</sub> , 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 77°F         | 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 220°F for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

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

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

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

**971-4.1 General:** Fast dry traffic paints intended for use under this Specification shall include products that are single packaged and ready mixed. Upon curing, these materials shall produce an adherent, reflective pavement marking capable of resisting deformation by traffic. The manufacturer shall have the option of formulating the material according to his own specifications. However, the requirements delineated in this Specification and Section 710 shall apply regardless of the type of formulation used. The material shall be free from all skins, dirt and foreign objects.

#### **971-4.2 Composition:**

| Component                                            | Test Method | Criteria           |
|------------------------------------------------------|-------------|--------------------|
| Total Solids, by weight                              | ASTM D 2369 | 75% minimum        |
| Pigments, by weight                                  | ASTM D 3723 | 57% minimum        |
| Vehicle Solids, % on Vehicle*                        |             | 40% minimum        |
| TiO <sub>2</sub> , 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    |

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

| Property                  | Test Method         | Minimum            | Maximum |
|---------------------------|---------------------|--------------------|---------|
| Density                   | ASTM D 1475         | 13.5 ± 0.37 lb/gal | N/A     |
| Viscosity at 77°F         | 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 two minutes.

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

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

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

**971-4.5 Packaging and Labeling:** The traffic paint shall be placed in 55 gallon open-end steel drums with a re-usable multi-seal sponge gasket. No more than 50 gallons of material shall be placed in any drum to allow for expansion during transport and storage.

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

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

### **971-5.2 Composition:**

| Component                                            | Test Method  | White         | Yellow                     |
|------------------------------------------------------|--------------|---------------|----------------------------|
| Binder                                               |              | 20.0% minimum | 20.0% minimum              |
| TiO <sub>2</sub> , Type II Rutile                    | ASTM 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                           | 195°F   | -       |
| Low Temperature Stress Resistance                                                                                              | AASHTO T 250                        | Pass    | -       |
| Specific Gravity                                                                                                               | Water displacement                  | 1.9     | 2.3     |
| Indentation Resistance                                                                                                         | ASTM D 2240*<br>Shore Durometer, A2 | 40      | 75      |
| Impact Resistance                                                                                                              | ASTM D 256, Method A                | 1.0 N·m | -       |
| Flash Point                                                                                                                    | ASTM D 92                           | 475°F   | -       |
| *The durometer and panel shall be at 110°F 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<sup>2</sup> and not less than 350 mcd/lx·m<sup>2</sup>, respectively. The retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

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

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

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

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

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

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

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

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

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

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

\*The durometer and panel shall be at 110°F 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<sup>2</sup>. The retroreflectance of the white pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>. All pedestrian crosswalks, bike lane symbols and messages in a proposed bike lane shall attain initial retroreflectivity of not less than 275 mcd/lx·m<sup>2</sup>.

**971-6.5.2 Skid Resistance:** The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN (British Pendulum Number) when tested according to ASTM 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 80°F using a jaw speed of 0.25 inch/min.

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

**971-7.9 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 80°F. 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<sup>2</sup> for white and contrast markings and not less than 250 mcd/lx·m<sup>2</sup>, for yellow markings. The retroreflectance of the white, yellow and contrast pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>. All pedestrian crosswalks, bike lane symbols and messages in a proposed bike lane shall attain initial retroreflectivity of not less than 275 mcd/lx·m<sup>2</sup>.

**971-7.13 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<sup>2</sup> for white and contrast markings and not less than 350 mcd/lx·m<sup>2</sup> for yellow markings. The pavement stripes and markings shall retain a minimum retroreflectance for two years of not less than 300 mcd/lx·m<sup>2</sup> for white and contrast markings and not less than 250 mcd/lx·m<sup>2</sup> for yellow markings. The retroreflectance of the white, yellow and contrast pavement markings at the end of the five year service life shall not be less than 150 mcd/lx·m<sup>2</sup>.

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

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

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

| Component                                                  | Test Method | Criteria              |
|------------------------------------------------------------|-------------|-----------------------|
| TiO <sub>2</sub> , Type II Rutile<br>(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, ASTM D 7234<br>or ACI 503 | 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 220°F for 18 hours. Clean with a soft brush and weigh each sample. Abrade samples for 1,000 cycles with 500 g weights and CS-10 wheels. Clean the samples with a soft brush and weigh again. The average weight loss for the four plates shall not exceed 50 mg per plate.

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

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

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

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

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

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

| Component                                             | Test Method  | White                      | Yellow                     |
|-------------------------------------------------------|--------------|----------------------------|----------------------------|
| Binder                                                |              | 20.0% minimum              | 20.0% minimum              |
| TiO <sub>2</sub> , Type II Rutile                     | ASTM D 476   | 10.0% minimum              | -                          |
| Reflective Elements                                   | AASHTO T 250 | % minimum per manufacturer | % minimum per manufacturer |
| Yellow Pigment                                        |              | -                          | % minimum per manufacturer |
| Calcium Carbonate and Inert Filler (- 200 mesh sieve) |              | % minimum per manufacturer | % minimum per manufacturer |

Percentages are by weight.

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

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

**971-9.4 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM 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                           | 210°F   | -       |
| Low Temperature Stress Resistance | AASHTO T 250                        | Pass    | -       |
| Specific Gravity                  | Water displacement                  | 1.9     | 2.3     |
| Indentation Resistance            | ASTM D 2240*<br>Shore Durometer, A2 | 65      | -       |
| Impact Resistance                 | ASTM D 256, Method A                | 1.0 N·m | -       |
| Flash Point                       | ASTM D 92                           | 475°F   | -       |

\*The durometer and panel shall be at 80°F, but not exceeding 90°F with a 4.4 lb load applied. Instrument measurement shall be taken after 15 seconds.

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

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

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

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

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

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

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

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

**971-10.2 Composition:**

| Component                                            | Test Method  | White                      | Yellow                     |
|------------------------------------------------------|--------------|----------------------------|----------------------------|
| Binder                                               |              | 20.0% minimum              | 20.0% minimum              |
| TiO <sub>2</sub> , Type II Rutil                     | ASTM D 476   | 10.0% minimum              | N/A                        |
| Reflective Elements (intermix)                       | AASHTO T 250 | % minimum per manufacturer | % minimum per manufacturer |
| Yellow Pigment                                       |              | N/A                        | % minimum per manufacturer |
| Calcium Carbonate and Inert Filler (-200 mesh sieve) |              | % minimum per manufacturer | % minimum per manufacturer |

Percentages are by weight.

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

**971-10.4 Physical Requirements:** Laboratory samples shall be prepared in accordance with ASTM 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                           | 200°F   | -       |
| Low Temperature Stress Resistance | AASHTO T 250                        | Pass    | -       |
| Specific Gravity                  | Water displacement                  | 1.9     | 2.3     |
| Indentation Resistance            | ASTM D 2240*<br>Shore Durometer, A2 | 40      | -       |
| Impact Resistance                 | ASTM D 256, Method A                | 1.0 N·m | -       |
| Flash Point                       | ASTM D 92                           | 475°F   | -       |

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

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

**971-10.4.2 Retroreflectivity:** The white and yellow pavement markings shall attain an initial dry retroreflectivity of not less than 300 mcd/lx·m<sup>2</sup> and not less than 250 mcd/lx·m<sup>2</sup>, respectively, and also attain an initial wet recovery retroreflectivity of not less than 150 mcd/lx·m<sup>2</sup> and not less than 125 mcd/lx·m<sup>2</sup>, respectively. The dry retroreflectance of the white and yellow pavement markings at the end of the three year service life shall not be less than 150 mcd/lx·m<sup>2</sup>, and also the wet recovery retroreflectivity at the end of the service life shall not be less than 75 mcd/lx·m<sup>2</sup>. The retroreflectivity will be determined in accordance with Florida Method FM-5-541 for dry and ASTM E 2177 (Bucket Method) for wet recovery.

**971-10.4.3 Durability:** Durability is the measured percent of thermoplastic material completely removed from the pavement. The thermoplastic material line loss must not exceed 5.0% at the end of the three year service life. When an audible bump is

required, durability shall also include flattening of the profile or raised portions of the line. The flattening of the profile or raised portion of the line shall not exceed 25% at the end of the three year service life.

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

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