1. **Scope**

1.1 The purpose of this work plan is to laboratory procedures for evaluating pavement marking materials with the exception of raised and recessed pavement markers. These evaluation procedures and this document will act as the standard for evaluations of pavement marking materials performed under the auspices of the National Transportation Product Evaluation Program (NTPEP) serving the member departments of the American Association of State Highway and Transportation Officials (AASHTO).

2. **Referenced Documents**

2.1 **AASHTO Standards**
- R11 Standard Recommended Practice for Indicating Which Places of Figures Are To Be Considered Significant In Specified Limiting Values
- T 250 Standard Method of Test for Thermoplastic Traffic Line Material

2.2 **ASTM Standards**
- D 562 Standard Test Method for Consistency of Paints Using the Stormer Viscometer
- D 711 Standard Test Method for No-Pick-Up Time of Traffic Paint
- D 823 Standard Practices for Producing Films of Uniform Thickness of {Paint, Varnish, and Related Products on Test Panels
- D 869 Standard Test Method for Evaluating Degree of Settling of Paint
- D 1309 Standard Test Method of Settling Properties of Traffic Paints During Storage
- D 1475 Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products
- D 1644A Standard Test Methods for Nonvolatile Content of Varnishes
- D 1652 Standard Test Methods for Epoxy Content of Epoxy Resins
- D 2243 Standard Test Method for Freeze-Thaw Resistance of Water-Borne Coatings
- D 2369 Standard Test Methods for volatile Content of Coatings
- D 2371 Standard Test Method for Pigment Content of Solvent-Reducible Coatings
- D 2621 Standard Test Method for Infrared Identification of Vehicle solids from Solvent-Reducible Paints
- D 2698 Standard Test Method for Determination of the Pigment Content of Solvent-Reducible Paints by High-Speed Centrifuging
- D 3335 Standard Test Method for Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
- D 3723 Standard Test Method for Pigment Content of Water Emulsion Paints by Low Temperature Ashing
- D 3759 Standard Test Method for Tensile Strength and Elongation of Pressure-sensitive Tapes
- D 4505 Specification for Preformed Plastic Pavement Marking Tape for Extended Service Life
- D 4797 Standard Test Methods for Chemical and Gravimetric Analysis of White and Yellow Thermoplastic Traffic Marking Containing Lead Chromate and Titanium Dioxide
- D 5381 Standard Guide for X-Ray Fluorescence (XRF) Spectroscopy of Pigments and Extenders

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3. **Significance and Use**

3.1 This work plan will be used to fingerprint products by the use of chemical and physical laboratory analysis. Test results may be used by participants to verify that products furnished under purchase order are equivalent to the products tested according to the National Transportation Product Evaluation Program (NTPEP).

3.2 Evaluation data will be compiled into a report which will be made available to all participating states and testing companies. This report will include data and/or graphs only. No judgment as to a product’s acceptability will be made in this report. End user participants will establish individual criteria for product acceptability. User guide will provide recommendations for use.

3.3 In addition to the report, participating states may submit any sample of material to the test facility for verification testing that the material is equal to the material originally tested. The intent of this is not to eliminate production sampling and testing by the states, but is designed to aid states when questionable material is provided. States will be limited to a total of five (5) submittals per year, without charge.

3.4 All data shall be rounded and reported according to the procedures found in AASHTO R 11 unless specified differently in individual test procedures.

3.5 Manufacturers will furnish test reports showing test results for those parameters listed in Laboratory practice section for the type product being submitted. These test reports will be included with the samples and shipped to the participating laboratory test state. For non-standardized testing, the manufacturer shall submit a test range for review by AASHTO and the host state.

4. **Procedures for Solvent-Reducible Paint**

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NOTE: The testing agency will retain at least five (5) grams of pigment and one (1) quart of paint.

4.1.1 Atomic Absorption (AA)  
ASTM D3335  
For white and lead-free yellow paints, measure TiO₂.  
For lead-containing paints, measure PbCrO₄

4.1.2 Contrast Ratio (Opacity) and Reflectance  
ASTM E 1347/1349, ASTM D 823  
Per ASTM D 823, prepare a 15 mil and a 5 mil wet film thickness test specimen on a black and white hiding power chart, such as Leneta 13H or equivalent. Allow the film to dry for 24 hours. Modify ASTM E 1347/1349 as follows: For each film thickness, measure reflectance (the Y tristimulus value) of the paint over the white background and over the black background using D65 illuminant and CIE 2° observer. Obtain the Y/x/y values. Calculate the contrast ratio (opacity) as \( Y_{black}/Y_{white} \).

4.1.3 Density, as weight-per-gallon  
ASTM D1475

4.1.4 Degree of Settling  
ASTM D 869

4.1.5 Infrared spectrum  
ASTM D 2621

4.1.6 No-Pick-Up Time  
ASTM D 711,  
ASTM D 823 (Practice E)

Per ASTM D 823, prepare a 15 mil wet film thickness sample on a glass panel.

4.1.7 Pigment Content  
ASTM D 2698  
TiO₂ Content – White and lead free yellow  
ASTM D4563 (AA) / D 4764 (XRF)  
Lead Chromate – Leaded yellow  
ASTM D3335

4.1.8 Solids (Non-volatile) Content  
ASTM D 2369

4.1.9 Viscosity, Krebs  
ASTM D 562

4.1.10 X-Ray Diffraction Spectrum, on a dry film  
Qualitative analysis by ASTM C1365

5. Procedures for Water-Borne Paint and Durable Water-Borne

NOTE: The testing agency will retain at least five (5) grams of pigment and one (1) quart of paint.

5.1.1 Contrast Ratio (Opacity) and Reflectance  
ASTM E 1347/1349, ASTM D 823  
Per ASTM D 823, prepare a 15 mil and a 5 mil wet film thickness test specimen on a black and white hiding power chart, such as Leneta 13H or equivalent. Allow the film to dry for 24 hours. Modify ASTM E 1347/1349 as follows: For each film thickness, measure reflectance (the Y tristimulus value) of the paint over the white background and over the black background using D65 illuminant and CIE 2° observer. Obtain the Y/x/y values. Calculate the contrast ratio (opacity) as \( Y_{black}/Y_{white} \).

5.1.2 Density, as weight-per-gallon  
ASTM D1475

5.1.3 Degree of Settling  
ASTM D 869

5.1.4 Freeze-Thaw Resistance  
ASTM D 2243, ASTM D 562  
Modify ASTM D2243 as follows: Cycle between -10 ± 1 °C and 25± 1 °C and perform five
freeze-thaw cycles.

5.1.5 No-Pick-Up Time

AMT D 711, AMT D 823 (Practice E)

Per AMT D 823, prepare a 15 mil wet film thickness sample on a glass panel. Modify AMT D 711 as follows: Place the wet panel in a humidity chamber at 23 ± 2 °C and 50 ± 5 % RH. Test the paint for dryness to light touch at 5 minutes intervals, allowing the panel to remain in the humidity cabinet while touching. Perform the roller wheel test only after the paint film is dry to light touch. Return the test panel to the humidity cabinet between wheel rolls.

5.1.6 Pigment Content

AMT D 3723

TiO2 Content – White and lead free yellow AMT D 4563 (AA) / D 4764 (XRF)

Lead Chromate – Leaded yellow AMT D 3335

5.1.7 Rohm and Hass (RH) Dry Time

Per AMT D 823, prepare a 12.5 mil wet film thickness sample on a glass panel. Place the wet panel in a humidity chamber at 23 ± 2 °C and 90 ± 3 % RH. Test the paint for dryness to touch at 15 minutes intervals, allow the panel to remain in the humidity cabinet while touching. The film is dry when a twisting thumb touch (without pressure) does not distort the paint film.

5.1.6 Solids (Non-volatile) Content

AMT D 2369

5.1.7 Volatile Organic Content (VOC)

AMT D 3960

5.1.8 Viscosity, Krebs

AMT D 562

5.1.9 Viscosity, Heat Stability

AMT D 562

Condition a sealed, 1 pint sample at 60° ± 1°C for seven (7) days. Test viscosity - AMT D 562.

5.1.10 Water Resistance

AMT D 870, AMT D 823

Per AMT D 823, prepare a 15 mil wet film thickness sample on a glass panel, allow to dry at 25 ± 1 °C for 72 ± 1 hr. Modify AMT D 870 as follows: Perform the test with an immersion time of 18 ± 1 hours, use a water temperature of 25± 1 °C without circulation, allow the test panels to air dry for two hours before evaluation, and examine the specimens for paint softening, blistering, wrinkling, and disbondment.

5.1.11 X-Ray Diffraction Spectrum, on a dry film

Qualitative analysis by AMT C1365

6. Procedures for Thermoplastic

6.1 AASHTO T 250 will be used to test the thermoplastic for the following parameters:

6.1.1 Specific Gravity *

AASHTO T-250, sect 16

6.1.2 Flowability *

AASHTO T-250, sect 11

6.1.3 Flowability (extended heat)

AASHTO T-250, sect 17

6.1.4 Softening Point, Ring and Ball

AASHTO T-250, sect 15

6.1.5 Low Temperature Stress Resistance

AASHTO T-250, sect 12

6.1.6 Bead Content and Grading

AMT D4797 and AASHTO T250, sect 7

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6.1.7 Daylight Reflectance (Color)  
ASTM D6628 (2° Obs., D65 Ill.)

6.1.7.1 Conduct color prior/post to QUV /condensate procedure as per equipment settings per AASHTO T250, Sections 18.2.7 thru 18.2.9.

6.1.8 Hardness *  
AASHTO T-250

6.1.9 XRF analysis (lead content) *  
ASTM D5381

6.1.10 Titanium Dioxide *  
ASTM D4797

6.1.11 IR scan of binder *  
ASTM E1252/E1421

6.1.12 Alkyd identification by solubility in diacetone alcohol *  
VaDOT reference

7. Procedure for Preformed Thermoplastic

7.1 AASHTO T 250 will be used to test preformed thermoplastic for the following parameters:

7.1.1 Specific Gravity *  
AASHTO T-250, sect 16

7.1.2 Softening Point  
AASHTO T-250, sect 15

7.1.3 Low Temperature Stress Resistance  
AASHTO T-250, sect 12

7.1.4 Bead Content and Grading  
ASTM D4797 and AASHTO T250, sect 7

7.1.5 Daylight Reflectance (Color)  
ASTM D6628 (2° Obs., D65 Ill.)

7.1.5.1 Conduct color prior/post to QUV /condensate procedure as per equipment settings per AASHTO T250, Sections 18.2.7 thru 18.2.9.

7.1.6 Hardness *  
AASHTO T-250

7.1.7 XRF analysis (lead content) *  
ASTM D5381

7.1.8 Titanium Dioxide *  
ASTM D4797

7.1.9 IR scan of binder *  
ASTM E1252/E1421

7.1.10 Alkyd identification by solubility in diacetone alcohol *  
VaDOT reference

8. Procedure for Tapes

8.1 Tensile strength  
ASTM D 3759

8.2 Ultimate elongation  
ASTM D 3759

8.2 Retroreflectivity  
ASTM E 1710 ((portable equipment)

8.3 Daylight Reflectance (Color)  
ASTM D6628 (2° Obs., D65 Ill.)

8.3.1 Conduct color prior/post to QUV /condensate procedure as equipment settings per AASHTO T250, Sections 18.2.7 thru 18.2.9.

8.4 Skid resistance  
ASTM E 303

8.5 Surface IR of adhesive layer  
ASTM E1252/E1421

8.6 Surface IR of tape surface without beads  
ASTM E1252/E1421

8.7 5% Modulus  
ASTM D3759 (calculated from results)

8.8 Binder Content (without heads)  
ASTM D4797

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9. Procedures for Multi-Component Materials

9.1 Surface scan IR of reacted Film
9.2 IR scan of each component ASTMD2621
9.3 % Pigment, each component ASTMD2371 or D3723
9.4 % Total Solids, each component ASTMD1644A or D3960
9.5 Weight per gallon, each component ASTMD1475
9.6 Drying time of reacted film ASTMD711
9.7 Epoxide number* ASTMD1652
9.8 Hardness AASHTOT-250
9.9 Yellowness index ASTM E313
9.10 Daylight Reflectance (Color) ASTM D6628 (2° Obs., D65 Ill.)

9.10.1 Conduct color measurements prior/post to QUV/condensate procedure as per equipment settings as per AASHTOT-250, Sections 18.2.7 thru 18.2.9.

*Related to only epoxy based multi-component materials

10. Reports

10.1 A final report will be assembled at the end of the laboratory testing
10.2 The following minimum information shall be included:
   10.2.1 Product Name, Producer, Type of Material, Color, Testing Agency Reference Number, Date Sampled, Date Tested
   10.2.2 Test Data according to the appropriate section of the procedure
10.3 All lab test data shall be uploaded into DataMine 2.0 within two months of testing completion following internal review by testing agency and lead state.
10.4 Laboratory results shall be compared to the manufacturer data on the sample submitted. For standardized tests, precision and bias between both data sets shall be within published ranges or be subject to challenge. For non-standardized testing, the manufacturer shall submit a test range (on application) for review by AASHTO and the host state.
10.5 In the event of a legitimate challenge (as per 10.4) to a laboratory value, (during vendor review) the host lab will re-run the sample in question. The cost for the referee testing will be borne by the host or vendor depending upon the outcome. The referee sample will be the value used in the final report.