

COMMITTEE ON MATERIALS AND PAVEMENTS

Meeting (Annual)

2020 Annual COMP meeting

Date

July 28, 2020

Scheduled Time

Noon – 2:00 PM

Technical Subcommittee & Name

Markings and Coatings 4c

Chair Name and (State)

David Kuniega (Pennsylvania)

Vice Chair Name and (State)

Robert Lauzon (Connecticut)

Research Liaison Name and (State)

I. Introduction and Housekeeping

II. Call to Order and Opening Remarks

A. Brief Summary of Activities

III. Roll Call of Voting Members

Present	Member Name	State	Present	Member Name	State
<input checked="" type="checkbox"/>	Anne Holt	ON	<input checked="" type="checkbox"/>	Kelly Morse	IL
<input checked="" type="checkbox"/>	Brandi Mitchell	KY	<input checked="" type="checkbox"/>	Richard Barezinsky	KS
<input checked="" type="checkbox"/>	Temple Short	SC	<input checked="" type="checkbox"/>	Richard Douds Monica Flournoy	GA
<input checked="" type="checkbox"/>	Clement Fung	MA	<input checked="" type="checkbox"/>	Robert Lauzon	CT
<input checked="" type="checkbox"/>	Danny Lane	TN	<input checked="" type="checkbox"/>	Ron Stanevich	WV
<input checked="" type="checkbox"/>	David Kuniega	PA	<input checked="" type="checkbox"/>	Ross Metcalfe	MT
<input checked="" type="checkbox"/>	William Lawrence	UT	<input checked="" type="checkbox"/>	Steven Ingram	AL
<input checked="" type="checkbox"/>	James Welter	OH	<input type="checkbox"/>	Added during call	
<input checked="" type="checkbox"/>	Jason Davis	LA	<input checked="" type="checkbox"/>	Joe Blair (NH)	NH
<input type="checkbox"/>	John Schuler	VA	<input checked="" type="checkbox"/>	Sejal Barot MD	MD
			<input checked="" type="checkbox"/>	Russell Thielke NY	NY

Quorum Rules Met?

Annual Meeting: Simple majority of voting members (☒y/ ☐n) | Mid-Year Meeting: Voting members present (☐y/ ☐n)

A. Review of Membership

1. Replacements for NY and NH?

IV. Approval of Technical Subcommittee Minutes

Mid-Year TS 4c Minutes - Attachment A

Mistake in reconfirmation ballot items: Verbiage in M133 about the “color standard” needs to be edited to remove anything after “approved as is” b/c there are no color standards in M133

TN makes a motion to accept with revision; IL makes a second to accept. No discussion. Mid-year meeting minutes were adopted with revision above.

V. Old Business

A. Standard Actions

MP 41-19 (formerly MP PP 79) High Friction Surface Treatment for Asphalt and Concrete Pavements Using Calcined Bauxite

- Adopted as a new 'materials only' standard – Continued comments/questions which will require future TS ballot. Working with Steward on these items presently.

Technical changes that needed to be addressed are still being worked through. Danny is putting a task force together (and would like to add Kelly Morse IL) to harmonize the standard that was split. There are some changes needed to the compositional. Please contact Danny Lane if you would like to participate in this official task force.

R 94 (formerly PP 74) Determination of Size and Roundness of Glass Beads Used in Traffic Markings by Means of Computerized Optical Method

- After COMP wide ballot, to be edited and adopted as R 94

Only editorial changes. The standard will be rectified with editorial changes.

Durable Green Bike Lane Standard (DGBLS)

- Tech Ballot in 2020 produced comments and negatives. To be addressed with steward

Generated a few negative comments. Several experts from ATSSA were involved in resolving the negatives. This standard flows better having been cleaned up. The TS has found a new Steward for this standard – Charles Holzschuher (FL). Charles should reach out to other folks in the task group. Lane will stay involved but no longer be in leadership.

T-106 Determination of Heavy Metal Content of Glass Beads Using X-ray Fluorescence (XRF)

- Steward to address ILDOT comments. Possible request for future TS ballot. 1 year extension as a provisional standard by COMP wide ballot

Members and friends from ATSSA have been helping develop this standard. Is there a need to include what other states are included as heavy metals – broadening the scope of what's considered a hazardous material. Should we specifically call out elements? This will be balloted.

Calling out for XRF as a standard may not be enough since everyone isn't necessarily operating/calibrating their XRF according to the standard. Needs more details to standardize a procedure to calibrate/operate instrumentation. It's tricky to validate a calibration because of the lack of NIST traceable standards.

Terry Arnold (FHWA) has been working on determination of heavy metals in glass. If you want to use XRF (yes/no) it's easy. But it's harder to set a level. They are using some glass beads from NIST and attempting to make some standard materials with known levels of heavy metals. Terry will join the task force.

Introducing the level of standards that we're discussing is approaching C114 – word of caution was introduced to require standards that may not actually be readily available.

M-249 White and Yellow Reflective Thermoplastic Striping Material (solid form)

- Reconfirmed but comments generated new task force. Include tie-in to T-250 and subsequent discussion on 'lead -free'; Steward (LA)

Comments that generated a new task force. What is the definition of "lead free" and some color inconsistency issues. In the discussion, Terry Arnold (FHWA) developed a tech brief for XRF analysis of TiO₂

<https://www.fhwa.dot.gov/publications/research/infrastructure/pavements/20031/20031.pdf>

which can easily be used to analyze for lead as well.

MP 24-15(2018) Waterborne White and Yellow Traffic Paints

- TC wide ballot granted 1 year extension

Comments were mostly editorial.

TP 111-14 (2018) Measuring Retroreflectivity of Pavement Marking Materials Using A Mobile Retroreflectivity Unit

- TC wide ballot granted one year extension

Indicated that there may have been movement in ASTM to create standard deviations. P&B was balloted in the ASTM spec but it needed to be reballoted. David Entrekin will report back.

TP 130-18 Producing Draw Down Panels and Measuring the Coefficient of Retroreflected Luminance (RL) of Pavement Markings in a Laboratory Panel

- TC wide ballot reconfirmed 2 year extension

This would allow labs to create panels, bead them, then measure them.

M300 Inorganic Zinc Rich Primer

- Tech Ballot produced comments which have been addressed by Steward

2 biggest issues:

- 1) Concern about broadening the definition of the standard to include both organic and inorganic zinc-rich primers.
- 2) Concern about scribes. Both cuts are supposed to be in the same direction (x-cut vs parallel scribes)
- 3) Derrick Castle – **For informational purposes** Derrick discussed the various SSPC Paint standards and revisions underway. While Paint 20 is routinely referenced by DOT agencies, it has been revised and eliminated any references to performance testing/requirements. Current efforts are underway to merge Paint 20 and Paint 29 into a document that will combine both the compositional aspects of the current Paint 20 and the performance aspects of Paint 29. Paint 29 and the proposed document will include open circuit potential testing (OCP).

B. COMP Ballot Items (Include any ASTM changes/equivalencies, including ASTM standards' revision years.)

COMP Ballot #	Standard	Results (neg/affirm)	Comments/Negatives	Action
	PP 74	A	Comments and revisions post ballot	Edit and adopt as full standard
	TP106	A	Comments to be considered by Steward	Extension of provisional standard. Comments to be considered in future Tech ballot

C. Technical Subcommittee Ballots

TS Ballot #	Standard	Results (neg/affirm)	Comments/Negatives	Action
	M300	A	Comments	Addressed by steward-provided
	DGBLS	N	Comments & Negatives (IL, LA,PA)	To be addressed by steward

D. Reconfirmation Ballots

Reconf. Ballot #	Standard	Results (neg/affirm)	Comments/Negatives	Action
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	M 133	A	Comments	Reconfirmed but future TC ballot to address comments
	M 249	A	Comments	Reconfirmed but future TC ballot to address comments
	TP130	A	Comments indicating potential future harmonization with ASTM	Reconfirmed
	MP 24	A	Comments	Reconfirmed but future TC ballot to address comments
	TP 111	A	Comments indicating potential future harmonization with ASTM	Reconfirmed

E. Task Force Reports

Task Force #	Title33	Members	Status/Update
01-19	M249/ T250	LA, PA, OH, IL, Dingess	Proposed revised verbiage. <ul style="list-style-type: none"> •20 year history of issues. States it should be lead and lead chromate free. What does that mean? Does it mean Oppm or is there a limit? •Do we want to get rid of « lead free » and link to EPA docs or do we want to define something? •Action item : We should survey the states to see what agencies are looking for, including methodology and what they'd be looking for
TP106	TP 106	TN, FL, Dingess, Entrekin,Carlson	See notes in previous section on TP 106
180-1	DGBLS	LA, VA, KY, TN, Dingess, Entrekin,Carlson	FLDOT presentation (see attached presentation)
FTPMM	Friction on PMMs	FL, MD, KY, Industry	FLDOT presentation (see attached presentation)

F. AASHTO Re:source/CCRL/NTPEP (*Observations from assessments, as applicable.*)

There was a test deck slated for this year but COVID put the breaks on that. Deck will be postponed until Spring/Summer 2021.

G. Revisions/Work on Standards for Coming Year

1 Revise or Reconfirm

a M300-12 (2017) Inorganic Zinc-Rich Primer

Should move to concurrent ballot. CT moves to send to concurrent ballot; IL seconds. Moves to concurrent ballot.

b. T143-13 (2017) Sampling and Testing Calcium Chloride for Roads and Structures

Move to reconfirmation ballots

c. T333-07 (2017) Linear Coefficient of Shrinkage on Cure of Adhesive Systems

Move to reconfirmation ballot

d. T346-13 (2017) Glass Beads Used in Pavement Markings

Discussion about revising the standard. This needs to be revised to remove reference to updated PP 74. May need to consider different use of verbiage with regard to beads. This will go to TS ballot.

2 Provisional Standard Actions

- a. MP 024-15 (2020) **Waterborne White and Yellow Traffic Paints**
 - Revise or 1 yr extend (reconfirmation ballot)
- b. MP 41-19 **High Friction** MP 41-19 **High Friction Surface Treatment for Asphalt and Concrete Pavements Using Calcined Bauxite**
 - Revise or 2 yr Reconfirm review (reconfirmation ballot)
- c. TP 106-20 **Determination of Heavy Metal Content of Glass Beads Using X-ray Fluorescence (XRF)**
 - Adopt or drop MT moved to adopt as a full standard to move to COMP; WV seconds. Discussion: is there a risk that if it passes TS but then doesn't pass COMP that it would drop? Likely no - we will just work to continue revising.
- d. TP 111-14 (2018) **Measuring Retroreflectivity of Pavement Marking Materials Using A Mobile Retroreflectivity Unit**
 - Revise or 1-yr extend (reconfirmation ballot)

3 Revise existing Standards

H. Review of Stewardship List

Please be in touch with Dave and Bob if you would like to volunteer to be a steward. CA and FL will review the listing and get in touch.

I. Proposed New Standards - none

J. NCHRP Issues

Just completed a 20-07 task 427 standard practice for selecting thermometers without mercury (LIG). There are a number of standards, practices, and specs in 4c that are impacted. T250 & T333 have been highlighted and have done a draft revision to clarify those specs according to the new wording. This is something that a steward may get involved with.

K. Correspondence, Calls, Meetings

L. Proposed New Task Forces (Include list of volunteers to lead and/or join TF.)

New task force for harmonizing MP-41

M. New TS Ballots

VI. Open Discussion

The chair and VC are quickly approaching retirement and will need to be replaced. A few plans are in place to find replacements. The Vice Chair shared his appreciation to the Chair for his leadership and steadfastness.

VII. Adjourn

TS Meeting Summary

Meeting Summary		
Items Approved by the TS for Ballot <i>(Include reconfirmations.)</i>		
Standard Designation	Summary of Changes Proposed	Ballot Type
TP 106 Determination of Heavy Metal Content of Glass Beads Using X-ray Fluorescence (XRF)	This is reaching the end of its life as a provisional. Adopted by voice vote and motion to move to COMP for full adoption.	<input type="checkbox"/> TS <input checked="" type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
T346-13 (2017) Glass Beads Used in Pavement Markings	Some verbiage needs to be revised. Also reference to PP 74 needs to be removed since it was adopted as a full standard	<input checked="" type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
M300-12 (2017) Inorganic Zinc-Rich Primer	Negatives and comments received that were addressed	<input type="checkbox"/> TS <input type="checkbox"/> COMP <input checked="" type="checkbox"/> CONCURRENT
		<input type="checkbox"/> TS <input type="checkbox"/> COMP <input type="checkbox"/> CONCURRENT
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New Task Forces Formed		
Task Force Name	Summary of Task	TF Member Names and (States)
TF 4c-20-01	Harmonize MP-41 issues	Danny Lane, Kelly Morse
Research Proposals <i>(Include number/title/states interested.)</i>		
Other Action Items		
Send out a state survey about M 249/T 250 see what agencies are looking for, including methodology and what they'd be looking for as limits		

ROLE CALL: (Voting) Danny Lane, Jim Welter, John Schuler, Temple Short, William Lawrence, Clement Fung, David Kuniega, Robert Lauzon, Rich Barezinsky

Approval of minutes from Annual meeting (Aug' 2019)

Motion by TNDOT - Seconded by CTDOT – Approved unanimously

COMP Ballot Items

- PP74
 - No discussion – Edit and adopt as full standard
- TP106
 - IL is requesting the addition of barium to the standard; discussion on whether to acknowledge additional hazardous elements or allow users to define the target elements by their internal specifications since this is a test method
 - Danny Lane will review the request and get it to this Task Force
 - Edit and allow extension as a provisional standard; Additional requests will be considered for a future TS ballot

Technical Subcommittee Ballot Items

- Durable Green Bike Lane Spec
 - Pending ballot in January 2020
- M300
 - Proposed edits will go out during TS ballot in January 2020

Reconfirmation Ballot Items

- M133
 - Zero negatives, 16 affirmatives – Approved as is, however comments related on color standard/equipment change as well as measurement inconsistencies will require review and future TC ballot
- M249
 - Change to color specification – Impact includes color chip identification as well as equipment and instrumental setting requirements.
 - While standard requires a specific color standard (chip) to be met by eye, the same 'chip' will not meet the associated Yellowness Index requirement in the standard
 - Specification/testing issue: The equipment used provides a whole number, but standard calls out a decimal format
 - Need to work with the spec steward (Jason Davis) to determine where we go with this standard
 - Robert Dingess noted that TS could reach out to SAE for more information
 - Robert will reach out to SAE
 - 0 negatives, 16 affirmatives – Approved as is, however comments related to color standard/equipment change as well as measurement inconsistencies will require review and future TC ballot
- TP130
 - 0 negatives, 17 affirmatives

- Possible harmonization with ASTM in the future
- Extend status for two years w/ possible action in the future
- MP 24-15
 - 0 negative, 15 affirmatives – Extend one year
 - 2 comments
 - FL looks for materials to meet 2 minute no-track
 - Luminance factor is not consistent with E1549
 - Qd method for cap-Y measurement
 - Inconsistencies with whole number versus decimal format as in M249
- TP 111-14
 - 0 negative, 16 affirmatives – extend 1 year
 - 1 comment
 - ASTM is working on similar standard, need to consider harmonization

Task Force Reports

- Green Bike Lane
 - No further comments
 - TG-180-1 – LA, VA, KY, TN, Dingess, Entrekin, P. Carlson
- TP 106
 - FL is interested in being part of the Task Force
 - TG -TP106 – TN, FL, Dingess, Entrekin, P Carlson
- Friction Testing of Pavement Markings
 - Two devices have been tested
 - Micro-grip tester
 - *Didn't mention other device*
 - Europe has been testing this for a long time
 - Task Group will stay open
 - TG-FTPMM – FL, MD, KY, Industry
- “Lead Free” in Thermo
 - Dave Kuniega has had some discussions with LA and IL, but not much done with this so far. Meeting planned in 2020 to discuss TG position on how ‘lead-free’ is defined.
 - TG-01-19 – LA, PA, IL, OH, Industry

New Business

- Red colored bus lanes
 - There is an official approval memo from FHWA to allow interim use of red markings in bus lanes
 - Robert Dingess noted that the green bike lane would be a good template to get started with this
 - TS members should be aware that future requests from DOT traffic, municipalities, local government might provide possible rationale to develop a materials specification within TS

- Several standards still need stewards, please take a look at the spreadsheets that Dave Kuniega sent out to see if you are interested in taking on this role
- Upcoming standards presented for consideration in 2020

Adjourn



U.S. Department
of Transportation
Federal Highway
Administration

Memorandum

Subject: **INFORMATION:** MUTCD – Interim
Approval for Optional Use of Red-Colored
Pavement for Transit Lanes (IA-22)

Date: DEC 4 2019

From: Martin C. Knopp 
Associate Administrator for Operations

In Reply Refer To:
HOTO-1

To: Federal Lands Highway Division Directors
Division Administrators

Purpose: The purpose of this memorandum is to issue an Interim Approval for the optional use of red-colored pavement to enhance the conspicuity of station stops, travel lanes, or other locations in the roadway that are reserved for (1) the exclusive use by public transit vehicles or (2) multi-modal facilities where public transit is the primary mode (collectively referred to hereinafter as “transit lanes”). Interim Approval allows interim use, pending official rulemaking, of a new traffic control device, a revision to the application or manner of use of an existing traffic control device, or a provision not specifically described in the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD).

Background: Chapter 3G of the 2009 MUTCD contains provisions regarding the use of colored pavements. Paragraph 1 of Section 3G.01 describes colored pavement as consisting of differently colored road paving materials, such as colored asphalt or concrete, or paint or other marking materials applied to the surface of a road or island to simulate a colored pavement.

If colored pavement is used to regulate, warn, or guide traffic, the colored pavement is considered to be a traffic control device. Paragraph 3 of Section 3G.01 limits the use of colored pavement used as a traffic control device to the colors yellow and white. Interim Approval 14 allows for the optional use of green-colored pavement in bicycle lanes. Paragraph 2 of Section 3G.01 discusses the use of colored pavement as a purely aesthetic treatment that is not intended to regulate, warn, or guide traffic and is therefore not considered to be a traffic control device.

There have been several experiments conducted in the United States that were approved under the MUTCD with the use of red-colored pavement to provide additional conspicuity to pavement markings that communicate to road users that a portion of the roadway has been set aside for exclusive or preferential use by public transit vehicles. In some cases, taxis and bicycles have also been permitted to use these lanes. Depending on the roadway geometry, it is sometimes permissible for vehicles to enter these transit lanes as necessary to turn right or to access on-street parking. Because this colored pavement has been used to regulate,

warn, or guide traffic, it is serving as more than an aesthetic treatment and is, by definition, a traffic control device.

For more than 10 years, red has been the only color that has received official Federal Highway Administration (FHWA) approval for colored pavement experimentation with transit facilities. Experimentation with this treatment began at the request of agencies wishing to improve the performance of and compliance with their transit lanes and to improve on the existing MUTCD-compliant pavement markings. Red was selected with the early experimental cities because of its existing use for this purpose in other jurisdictions internationally.

Research on Red-Colored Pavement for Transit Lanes: Agencies across the United States are showing an increased interest in using colored pavement specifically for transit lanes, and many of them have submitted requests to the FHWA to experiment with colored pavement. The FHWA has approved experiments with red-colored pavement for a variety of State and local governmental agencies, including the following: the City of Chicago, Ill.; the City of New York, N.Y.; the District of Columbia; the City of Santa Rosa, Cal.; and San Diego County, Cal. In these experiments, red-colored pavement is being used as a traffic control device to enhance the conspicuity of locations designated for exclusive or preferential use by public transit vehicles. The experimental locations were a mix of full-time and part-time dedicated transit lanes.

FHWA Evaluation of Results: The Office of Transportation Operations has reviewed the available data and considers the experimental red-colored pavement to be satisfactorily successful for the applications that were tested. Positive operational effects have been noted in the experiments including the reduction of illegal occupancy of transit lanes by non-transit vehicles, travel time of transit vehicles, and illegal parking in transit lanes. While not all of these effects were observed at all experimental sites, the majority of sites observed showed at least one of these positive operational effects from the installation of red-colored pavement. Experimental results also showed that the red-colored pavement did not induce drivers of private vehicles to make turns from the incorrect lane.

In one experimental location, the experimenting agency heard concerns from business owners that the red-colored pavement might confuse drivers into believing they could not access the businesses on the right side of the roadway. It is recommended that agencies consider public information when red-colored pavement is installed and, if warranted, install appropriate signing where potential concerns with business access are identified.

The design of red-colored pavement for transit lanes is not proprietary and can be used by any jurisdiction that obtains approval from the FHWA to use red-colored pavement. Experimentation has shown that red-colored pavement has a low risk of safety or operational concerns when used in transit lanes in compliance with the terms of this Interim Approval.

This Interim Approval does not create a new mandate compelling the use of red-colored pavement, but will allow agencies to install red-colored pavement in transit lanes, pending official MUTCD rulemaking, to enhance the conspicuity of the transit lane where such a need has been determined.

Conditions of Interim Approval: The FHWA will grant Interim Approval for the optional use of red-colored pavement in designated locations, station stops, or travel lanes in the roadway reserved exclusively for public transit vehicles or multi-modal facilities where public transit is the primary mode, to any jurisdiction that submits a written request to the FHWA Office of Transportation Operations. A State may request Interim Approval for all jurisdictions in that State. Jurisdictions using red-colored pavement under this Interim Approval must agree to comply with the technical conditions detailed herein, to maintain an inventory list of all locations where red-colored pavement is installed, and to comply with Item D in Paragraph 18 of Section 1A.10 of the 2009 MUTCD, which requires:

An agreement to restore the site(s) of the Interim Approval to a condition that complies with the provisions in this Manual within 3 months following the issuance of a Final Rule on this traffic control device; and terminate use of the device or application installed under the interim approval at any time that it determines significant safety concerns are directly or indirectly attributable to the device or application. The FHWA's Office of Transportation Operations has the right to terminate the interim approval at any time if there is an indication of safety concerns.

1. General Conditions:

The use of red-colored pavement is optional. However, if an agency opts to use red-colored pavement under this Interim Approval, the following design and installation requirements shall apply.

2. Allowable Uses:

Red-colored pavement may be used to enhance the conspicuity of locations, station stops, or travel lanes in the roadway reserved for (1) the exclusive use by public transit vehicles or (2) multi-modal facilities where public transit is the primary mode (collectively referred to herein as transit lanes). This includes travel lanes that are dedicated for such use on a part-time basis.

The use of red-colored pavement under this Interim Approval is limited to the following applications:

- a. Red-colored pavement may be installed within transit lanes only as a supplement to the standard pavement markings that are required for the designation of a preferential lane as provided in Chapter 3D of the 2009 MUTCD. Red-colored pavement shall not be used in lieu of those pavement markings that are required to designate a preferential lane.
- b. Where used, red-colored pavement shall be installed for the entire width of the transit lane and for the entire length of the transit lane, except where non-transit vehicles are permitted to enter the transit lane in advance of a turning movement or for other authorized purposes. Red-colored pavement should be used in a broken pattern where non-transit vehicles are permitted to enter the transit lane under these conditions.

- c. If lane extension markings are used to extend a transit lane across an intersection (see Section 3B.08 of the 2009 MUTCD), red-colored pavement may be installed between these lines as a supplement to the lines. Red-colored pavement shall not be used instead of dotted lane extension markings to extend a transit lane across an intersection. Red-colored pavement may be installed for the entire length of the transit lane extension or for only a portion (or portions) of the transit lane extension. If used between dotted lane extension lines through an intersection, the pattern of the red-colored pavement shall be dotted in a manner that matches the pattern of the dotted lines, thus filling in only the areas that are directly between a pair of dotted line segments that are on opposite sides of the transit lane extension.

3. Design of Red-Colored Pavement:

- a. The daytime chromaticity coordinates for the color used for red-colored pavement shall be as follows:

1		2		3		4	
x	y	x	y	x	y	x	y
0.420	0.330	0.450	0.380	0.560	0.370	0.540	0.320

- b. There is no nighttime chromaticity requirement for red-colored pavement.
 - c. Red-colored pavement may be retroreflective, but there is no requirement or recommendation that it be retroreflective.
 - d. If red paint or other marking materials applied to the roadway surface are used to provide red coloring, consideration should be given to selecting pavement marking materials that will minimize loss of traction for pedestrians, bicycles, and motorcycles where such users are expected to use or cross the facility (see Paragraph 4 of Section 3A.04 of the 2009 MUTCD).
- ### 4. Other:

Except as otherwise provided herein, all other provisions of the MUTCD that are applicable to colored pavements shall apply to red-colored pavement.

Please direct any questions concerning this Interim Approval to Mr. David Kirschner at david.kirschner@dot.gov.

cc:

Associate Administrators
 Chief Counsel
 Chief Financial Officer
 Directors of Field Services
 Director of Technical Services

Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form)

AASHTO Designation: M 249-12 (2020)

Technical Subcommittee: 4c, Markings and Coatings

Release: Group 2 (June)



**American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, D.C. 20004**

Standard Specification for

White and Yellow Reflective Thermoplastic Striping Material (Solid Form)

AASHTO Designation: M 249-12 (2020)



Technical Subcommittee: 4c, Markings and Coatings

Release: Group 2 (June)

1. SCOPE

- 1.1. This specification covers a reflectorized thermoplastic pavement striping material that is applied to the road surface in a molten state by mechanical means with surface application of glass beads at a rate specified by the purchaser or the manufacturer. Upon cooling to normal pavement temperature, the applied thermoplastic produces an adherent retroreflective stripe of specified color, thickness, and width capable of resisting deformation by traffic.
- 1.2. The values stated in SI units are to be regarded as the standard.

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
 - M 247, Glass Beads Used in Pavement Markings
 - T 250, Thermoplastic Traffic Line Material
- 2.2. *ASTM Standards:*
 - D36/D36M, Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
 - E1710, Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
- 2.3. *Federal Standards:*
 - Fed. Std. No. 141, Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling and Testing
 - Fed. Std. No. 595b, Colors Used in Government Procurement

3. MATERIALS

- 3.1. The thermoplastic material shall be homogeneously composed of pigment, filler, resins, and glass reflectorizing spheres.
 - 3.1.1. The thermoplastic material shall be available in both white and yellow.
 - 3.1.2. The resin shall be alkyd or hydrocarbon as specified by the purchaser.

- 3.1.3. The vendor shall have the option of formulating the material according to his or her own specifications. However, the physical and chemical properties contained in this specification shall apply regardless of the type of formulation used.
- 3.1.4. *Glass Beads (Pre-Mix)*—The beads shall be uncoated and conform to AASHTO M 247, Type I.
- 3.1.5. Yellow pigment shall be lead and lead-chromate free.

4. REQUIREMENTS

- 4.1. *Specific Gravity*—The specific gravity of the white and yellow thermoplastic traffic line material shall not exceed 2.15.
- 4.2. *Composition*—The pigment, beads, and filler shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt, and foreign objects and shall comply with requirements according to Table 1.

Table 1—Composition (percent by weight)

Component	White	Yellow
Binder	18.0 min	18.0 min
Glass beads	30–40	30–40
Titanium dioxide	10.0 min	—
Calcium carbonate and inert fillers	42.0 max	See Note 1
Yellow pigments	—	—

Note 1—Amount of yellow pigment, calcium carbonate, and inert fillers shall be at the option of the manufacturer, providing all other requirements of this specification are met.

- 4.2.1. The material shall be provided in either granular or block form as specified by the purchaser.
- 4.3. *Physical Characteristics:*
- 4.3.1. *Color*—The thermoplastic material after heating for 240 ± 5 min at $218 \pm 2^\circ\text{C}$ ($425 \pm 3^\circ\text{F}$) and cooled to $25 \pm 2^\circ\text{C}$ ($77 \pm 3^\circ\text{F}$) shall meet the following:
- White:* Daytime Luminance factor, Y (%) at $45^\circ/0^\circ$ —geometry and illuminant D65 using the 1931 CIE 2° standard observer ≥ 75 . For highway use, the color shall match Federal Test Standard No. 595b, Color 17886.
- Yellow:* Daytime Luminance factor, Y (%) at $45^\circ/0^\circ$ —geometry and illuminant D65 using the 1931 CIE 2° standard observer ≥ 45 .
- For highway use, the color shall match Federal Test Standard No. 595b—Color 13538.
 - For airport use, the color shall comply with the requirements established by the FAA. The chromaticity and luminance factors shall be within the limits in Table 2 when determined under standard conditions:
 - a) angle of illumination: 45 degrees;
 - b) direction of view: perpendicular to surface (0 degrees);
 - c) illuminant: CIE standard illuminant D65; and
 - d) standard observer: 1931 CIE 2 degrees.

Note 2—The chromaticity and luminance factors of ordinary colors and colors of retroreflecting materials shall be determined under the following standard conditions:

- a) angle of illumination: 45 degrees;
- b) direction of view: perpendicular to surface (0 degrees);

- c) illuminant: CIE standard illuminant D65; and
- d) standard observer: 1931 CIE 2 degrees.

Table 2—CIE Equations

Yellow	
Orange boundary	$y = 0.130 + 0.636x$
White boundary	$y = 0.910 - x$
Green boundary	$y = 1.35x - 0.093$
Luminance factor	$\beta = 0.27$ (mnm)
White	
Purple boundary	$y = x$
Blue boundary	$y = 0.610 - x$
Green boundary	$y = 0.040 + x$
Yellow boundary	$y = 0.710 - x$
Luminance factor	$\beta = 0.35$ (mnm)

- 4.3.2. *Drying Time*—When applied at a temperature range of $211 \pm 7^{\circ}\text{C}$ ($412.5 \pm 12.5^{\circ}\text{F}$) and thickness of 3.2 to 4.8 mm (125 to 188 mils), the material shall set to bear traffic in not more than 2 min when the air temperature is $10 \pm 2^{\circ}\text{C}$ ($50 \pm 3^{\circ}\text{F}$) and not more than 10 min when the air temperature is $32 \pm 2^{\circ}\text{C}$ ($90 \pm 3^{\circ}\text{F}$).
- 4.3.3. *Cracking Resistance at Low Temperature*—After heating the thermoplastic material for 240 ± 5 min at $218 \pm 2^{\circ}\text{C}$ ($425 \pm 3^{\circ}\text{F}$), applying to concrete blocks, and cooling $-9.4 \pm 1.7^{\circ}\text{C}$ ($15 \pm 3^{\circ}\text{F}$), the material shall show no cracks.
- 4.3.4. *Impact Resistance*—After heating the thermoplastic material for 240 ± 5 min at $218 \pm 2^{\circ}\text{C}$ ($425 \pm 3^{\circ}\text{F}$) and forming test specimens, the impact resistance shall be a minimum of 1.13 J (10 in.-lb).
- 4.3.5. *Softening Point*—After heating the thermoplastic material for 240 ± 5 min at $218 \pm 2^{\circ}\text{C}$ ($425 \pm 3^{\circ}\text{F}$) and testing in accordance with ASTM D36/D36M the materials shall have a softening point of $102.5 \pm 9.5^{\circ}\text{C}$ ($215 \pm 15^{\circ}\text{F}$).
- 4.3.6. *Flowability*—After heating the thermoplastic material for 240 ± 5 min at $218 \pm 2^{\circ}\text{C}$ ($425 \pm 3^{\circ}\text{F}$) and testing for flowability, the white thermoplastic shall have a maximum percent residue of 18 and the yellow thermoplastic shall have a maximum percent residue of 21.
- 4.3.7. *Yellowness Index*—The white thermoplastic material shall not exceed a yellowness index of 0.12.
- 4.3.8. *Flowability—Extended Heating*—After heating the thermoplastic material 8.0 ± 0.5 h at $218 \pm 2^{\circ}\text{C}$ ($425 \pm 3^{\circ}\text{F}$), with stirring the last 6 h, and tested for flowability, the thermoplastic shall have a maximum percent residue of 28.
- 4.4. *Storage Life*—Thermoplastic material shall meet the above requirements and melt uniformly with no evidence of skins or unmelted particles for a period of 1 year. Any material not meeting the above requirements shall be replaced by the manufacturer.

5. PREQUALIFICATION REQUIREMENTS

- 5.1. The in-place marking material evaluated on a test deck not exposed to snow plowing administered or performed by an authorized testing facility as approved by the National Transportation Product Evaluation Program (NTPEP) shall be capable of maintaining the following minimum

retroreflectance value through 180 days of exposure when tested in accordance with ASTM E1710:

- | | |
|----------|----------------------------|
| ■ White | 325 mcd/lux/m ² |
| ■ Yellow | 200 mcd/lux/m ² |

Note 3—Values are based upon using a double drop bead application.

Note 4—DISCLAIMER: Prequalification is intended to determine the acceptability of thermoplastic material based upon field evaluation of the material installed under ideal conditions and exposed to traffic on a controlled field test deck. The user may experience variable performance in actual striping applications due to improper installation practices, modification of the product, or a defect in the reflective glass beads. Actual performance may also vary dependent upon traffic volume and type of vehicle exposure along with road maintenance procedures associated with deicing and snow removal.

Note 5—For the purpose of inspection and acceptance, the specifying agency may set a contract minimum retroreflectance value at the time of installation as part of the construction specification.

6. APPLICATION PROPERTIES

- 6.1. The thermoplastic material shall be capable of being applied by spraying, screed extrusion, or ribbon extrusion, as specified by the purchaser, at temperatures of $211 \pm 7^{\circ}\text{C}$ ($412 \pm 12.5^{\circ}\text{F}$) from approved equipment, to produce a line 3.2 to 4.8 mm (125 to 188 mils) thick, which shall be continuous and uniform in shape, having clear and sharp dimensions, particularly when extruded.
- 6.2. The material shall not exude fumes that are toxic or injurious to persons or property when it is heated during applications.
- 6.3. The application of additional surface applied glass beads shall be accomplished by means of a pressurized bead dispenser or by drop-on methods at a rate specified by the purchaser or manufacturer and agreed to by the applicator.

7. PACKAGING AND MARKING

- 7.1. Thermoplastic supplied in granular form shall be in white or yellow plastic bags of a suitable size to contain approximately 23 kg (50 lb) and shall be made of a material that, when introduced into the mix hopper of the application equipment, will become a part of the mix without any adverse effect to the performance of the thermoplastic material.
- 7.2. Thermoplastic material supplied in block form shall be approximately 300 by 915 by 51 mm (12 by 36 by 2 in.) and shall have a mass of approximately 23 kg (50 lb). Block thermoplastic shall be packaged in suitable containers to which it will not adhere during shipment and storage.
- 7.3. Each container label shall designate the color, manufacturer's name, batch number, and date of manufacture. Each batch manufactured shall have its own separate number. The label shall specify that the material shall be heated to $211 \pm 7^{\circ}\text{C}$ ($412 \pm 12.5^{\circ}\text{F}$) during application.
- 7.4. The contractor shall assume all cost resulting from the use of patented materials, equipment, devices, or processes used on or incorporated in the work, and agrees to indemnify and save harmless the purchaser and the purchaser's duly authorized representatives from all suits at law, or action of every nature for or on account of the use of any patented materials, equipment, devices, or processes.

8. SAMPLING

- 8.1. The minimum batch size of thermoplastic traffic striping material sampled and tested shall not be less than 1360 kg (3000 lb) unless the total order is less than this amount. Any manufacturer not familiar with the technique of making this material should consult the purchaser. A small trial batch should be made prior to making the thermoplastic traffic striping material in large quantities, to make certain the finished product will comply with all the requirements of this specification.

9. TESTING

- 9.1. The material shall be tested in accordance with T 250 or with the appropriate method in Federal Standard No. 141 or ASTM designation.

10. KEYWORDS

- 10.1. Glass beads; retroreflective stripe; thermoplastic pavement striping.

Agency	Individual Name	Email Address	Status	Item No. 1 - Item #1 M-300 Zinc-rich Primer ; Revisions proposed 2019; Approved by 4c for Tech Section ballot at 2019 Annual Meeting		
				Decision	Comments	Response Attachments
Alabama Department of Transportation	Steven Ingram	ingrams@dot.state.al.us	Submitted	Affirmative		
Connecticut Department of Transportation	Robert G Lauzon	robert.lauzon@ct.gov	Submitted	Affirmative		
Florida Department of Transportation	Awilda Merced-Fernandez	awilda.merced@dot.state.fl.us	Submitted	No Vote	Coatings(M-300 Zinc-rich primer) Section 5.5.5.1 - Surface Profile. Comment: FDOT supports the revision. AASHTO R31 has a testing range for slip critical connections from 50 – 90 µm (1.96 – 3.5 mils). The paint systems currently being used on slip critical connections may have been tested w/ a surface profile of 3.5 mils. FDOT Supports this change. Section 5.5.5.4 – Scribing. Comment: FDOT supports adding the option of two parallel lines but does not recommend the removal of the "X" option. Based on available research, either option seems enough if the cut reaches the metallic surface. Recommend specifying "either a single "X" or two parallel lines."	
Georgia Department of Transportation	Richard Douds	rdouds@dot.ga.gov	Submitted	Affirmative		
Illinois Department of Transportation	Kelly L. Morse	kelly.morse@illinois.gov	Submitted	Affirmative	No comment	
Kansas Department of Transportation	Richard A Barezinsky	rick.barezinsky@ks.gov	Submitted	Affirmative		
Louisiana Department of Transportation and Development	Jason Davis	jason.davis@la.gov	Submitted	Affirmative	Section 5.5.5.1*150 micromhos/cm", should the unit be "microhms / cm" for conductivity?	
Massachusetts Department of Transportation	Clement Fung	clement.fung@dot.state.ma.us	Submitted	Affirmative		
Montana Department of Transportation	Ross Oak Metcalfe	rmetcalfe@mt.gov	Submitted	Affirmative		
Ontario Ministry Of Transportation	Becca Lane	Becca.Lane@ontario.ca	Submitted	Affirmative	1.1 Steel is iron with carbon and/or other metals which form an alloy. Iron is never used in it's pure form. 3.1.1 Solvent-based 3.1.2 Water Based 4.1.2 Vehicle shall be a curable organic polymer thermoset consisting of two parts – the resin and the cure. The resin part shall contain water or organic solvents to lower the viscosity and aid in spray application as well as inorganic filler and other additives to enhance the coating performance. The cure may contain a mixture of reactive and non-reactive components to achieve the desired pot life, stoichiometric mix ratio and cure time. 4.1.4 Replace "basically" with mainly. 5.2.1 x-ray diffraction (XRD) is typically used for identification and qualitative analysis. of crystalline compounds. A quantitative approach would be to use x-ray fluorescence spectroscopy (XRF). Other, more direct analysis methods commonly used for inorganic determinations are Inductively Coupled Plasma Optical Emission Spectroscopy (ICP) and Atomic Absorption Spectroscopy (AA). 5.5.8 Rust creepage measurement would be a	
Pennsylvania Department of Transportation	David H. Kuniega	Dkuniega@pa.gov	Submitted	Affirmative		

Tennessee Department of Transportation	Danny L Lane	danny.lane@tn.gov	Submitted	Affirmative		
Utah Department of Transportation	William J Lawrence	BillLawrence@utah.gov	Submitted	Affirmative		
Virginia Department of Transportation	John Schuler	john.schuler@vdot.virginia.gov	Submitted	Affirmative		
3M	Gene H Carlson	ghcarlson1@mmm.com	Not Submitted	No Vote		
AASHTO Consultants	Mark Edward Felag	mfelag@hotmail.com	Not Submitted	No Vote		
AASHTO re:source	Maria Knake	mknake@ashtoresource.org	Not Submitted	No Vote		
AASHTO re:source	Robert Lutz	rlutz@ashtoresource.org	Not Submitted	No Vote		
AASHTO re:source	Steven Lenker	slenker@ashtoresource.org	Not Submitted	No Vote		
American Association of State Highway and Transportation Officials	Katheryn Malusky	kmalusky@ashto.org	Not Submitted	No Vote		
American Association of State Highway and Transportation Officials	Casey Soneira	csoneira@ashto.org	Not Submitted	No Vote		
Connecticut Department of Transportation	Jonathan T Boardman	jonathan.boardman@ct.gov	Not Submitted	No Vote		
DBI Services	Richard John Baker	rbaker@dbiservices.com	Not Submitted	No Vote		
Dow Chemical Company	Eric C Greyson	egreyson@dow.com	Not Submitted	No Vote		
Future Labs LLC	David S. Entekin	david@futurelabsllc.com	Not Submitted	No Vote		
GGfGA Engineering, LLC	Georgene M Geary	ggeary@ggfga.com	Not Submitted	No Vote		
Holcim (US) Inc.	Al Innis	al.innis@holcim.com	Not Submitted	No Vote		
Interplastic Corporation	Jason David Schiro	jschiro@interplastic.com	Not Submitted	No Vote		
Kentucky Transportation Cabinet	Brandi Ramona Mitchell	brandi.mitchell@ky.gov	Not Submitted	No Vote		
Kwik Bond Polymers	Gregg Freeman	gregg@kwikbondpolymers.com	Not Submitted	No Vote		
Mercer Strategic Alliance	Robert N Dingess	rdingess@mercerstrategic.com	Not Submitted	No Vote		
Ohio Department of Transportation	James Norbert Weller	jim.weller@dot.ohio.gov	Not Submitted	No Vote		
Ohio Department of Transportation	Patrick Bierl	patrick.bierl@dot.ohio.gov	Not Submitted	No Vote		
Ontario Ministry Of Transportation	Anne Lee Holt	anne.holt@ontario.ca	Not Submitted	No Vote		
Ontario Ministry Of Transportation	Grant Ridley	grant.ridley@ontario.ca	Not Submitted	No Vote		
Ontario Ministry Of Transportation	Winston Chand	winston.chand@ontario.ca	Not Submitted	No Vote		
Pennsylvania Department of Transportation	Timothy Ramirez	tramirez@pa.gov	Not Submitted	No Vote		
Potters Beads	Andy Andersen	andy.andersen@pottersbeads.com	Not Submitted	No Vote		
RII	Paul J Carlson	PCarlson@roadinfrastructureinc.com	Not Submitted	No Vote		
South Carolina Department of Transportation	Temple Short	shorttk@scdot.org	Not Submitted	No Vote		
Treated Wood Council	Jeff Miller	jeff_miller@treated-wood.org	Not Submitted	No Vote		
Utah Department of Transportation	Scott S Andrus	scottandrus@utah.gov	Not Submitted	No Vote		
West Virginia Department of Transportation	Ron Stanevich	Ron.L.Stanevich@wv.gov	Not Submitted	No Vote		

Standard Specification for Inorganic Zinc-Rich Primer

AASHTO Designation: M 300-03 (20~~17~~20)

Technical Subcommittee: 4c, Markings and Coatings

Release: Group 2 (June)

American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001

Standard Specification for

Inorganic Zinc-Rich Primer

AASHTO Designation: M 300-03 (2017)



Technical Subcommittee: 4c, Markings and Coatings

Release: Group 2 (June)

1. SCOPE

- 1.1. This specification covers self-curing, inorganic zinc-rich primers for use on ~~iron and steel~~ surfaces.
- 1.2. *Intended Use of the Primers:*
 - 1.2.1. Types I and II are intended for use on bridges, similar structural steel, and other ferrous metal surfaces subject to corrosive atmospheric environments such as marine, industrial, and high humidity.
- 1.3. The values stated in SI units are to be regarded as the standard.

Commented [WJ1]: Becca Lane of Ontario Ministry of Transportation commented, "Steel is iron with carbon and/or other metals which form an alloy. Iron is never used in it's pure form".

2. REFERENCED DOCUMENTS

- 2.1. Reference to standard specifications, testing procedures, and other standard procedures contained in this document shall be the latest edition of the published document at the date of this specification.
 - 2.1.1. *AASHTO Standard:*
 - *Standard Specifications for Highway Bridges*
 - 2.1.2. *ASTM Standards:*
 - A36/A36M, Standard Specification for Carbon Structural Steel
 - B117, Standard Practice for Operating Salt Spray (Fog) Apparatus
 - D185, Standard Test Methods for Coarse Particles in Pigments
 - D512, Standard Test Methods for Chloride Ion In Water
 - D520, Standard Specification for Zinc Dust Pigment
 - D521, Standard Test Methods for Chemical Analysis of Zinc Dust (Metallic Zinc Powder)
 - D562, Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
 - D610, Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
 - D1475, Standard Test Method For Density of Liquid Coatings, Inks, and Related Products
 - D1640, Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings
 - D1654, Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

- D1735, Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
- D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
- D2369, Standard Test Method for Volatile Content of Coatings
- D2371, Standard Test Method for Pigment Content of Solvent-Reducible Paints ([withdrawn 2019](#))
- D3363, Standard Test Method for Film Hardness by Pencil Test
- D4417, Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
- D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- D4752, Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub
- D4940, Standard Test Method for Conductimetric Analysis of Water Soluble Ionic Contamination of Blast Cleaning Abrasives
- D5894, Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
- D6580, Standard Test Method for the Determination of Metallic Zinc Content in Both Zinc Dust Pigment and in Cured Films of Zinc-Rich Coatings

2.1.3.

Federal Standards:

- Fed. Std. No. 141, Paint, Varnish, Lacquer, and Related Materials: Methods of Inspection, Sampling and Testing
- Fed. Std. No. 29, CFR 1910.1200 OSHA Hazard Communication Standard
- Fed. Std. No. 40, CFR, Part 59, Subpart D, Section 59.400 Through 59.413 National Volatile Organic Compound Emission Standards for Architectural Coatings

2.1.4.

ANSI Standard:

- AB 3, Abrasive Specification Number 3, Newly Manufactured or Re-Manufactured Steel Abrasive
- SP 5, White Metal Blast Cleaning

Commented [WJ2]: American National Standards Institute (ANSI) B94.50, Style E, Basic Nomenclature and Definitions for Single Point Cutting Tools, provided by ASME, WITHDRAWN BY ASME

[2.1.7-2.1.5.](#)

Other Document:

- Commercial Item Description (CID) A-A-1689B; Tape, Pressure-Sensitive Adhesive, Plastic Film²

3.

CLASSIFICATION

3.1.

Types—Inorganic zinc-rich primers covered by this specification shall be furnished in the following types, as specified in the invitation for bids, contract, or order.

3.1.1.

Type I—~~Inorganic zinc-rich primer~~ Solvent-base multiple components.

3.1.2.

Type II—~~Inorganic zinc-rich primer~~ ~~Water~~-base multiple component system.

Commented [WJ3]: Becca Lane of Ontario Ministry of Transportation commented, "3.1.1 Solvent-based 3.1.2 Water Based".
Redundant

4.

MATERIALS

4.1.

The materials used in the manufacture of the primer shall conform to the requirements of the following specifications.

- 4.1.1. *Zinc Dust*—ASTM D520, Type II
- 4.1.2. Vehicle shall be either a ~~post-cured or self-cured inorganic waterborne alkali silicate, such as sodium, potassium, ammonium or lithium silicate, or a self-cured hydrolyzed organic solvent silicate, such as ethyl silicate, with additives such as agents, hardeners, or activators that can improve film durability, adhesion, and other properties.~~ *Vehicle shall be either a post-cured or self-cured inorganic waterborne alkali silicate, such as sodium, potassium, ammonium or lithium silicate, or a self-cured hydrolyzed organic solvent silicate, such as ethyl silicate, with additives such as agents, hardeners, or activators that can improve film durability, adhesion, and other properties.*
- 4.1.3. The Volatile Organic Compound (VOC) content shall be stated by the manufacturer in accordance with Section 6.2.
- 4.1.4. *Pigment*—The pigment used in the formulation shall be ~~basically~~ *mainly* zinc dust. Small amounts of color and extender pigments may be used if the quantitative requirements of the complete paint are met.

5. REQUIREMENTS

- 5.1. *Color*—The color of the inorganic zinc primer shall be as mutually agreed on and such that a definite contrast between it and the color of blasted steel is readily apparent.
- 5.2. *Pigment*—The extracted pigment on analysis shall conform to the minimum quantitative requirements specified in Table 1, and shall not vary more than a –2 percent or +3 percent metallic zinc content from the initially approved primer.
- 5.2.1. The x-ray diffraction (XRD) pattern ~~analysis of the zinc dust in of~~ the extracted pigment, ~~which can differentiate Metallic Zinc content and Zinc Oxide content within Total Zinc content,~~ shall be obtained for the initially approved primer. ~~X-ray fluorescence (XRF) can be used to determine Total Zinc content and ASTM D521 to determine Metallic Zinc content as mentioned in Table 1.~~
- 5.3. *Primer Quantitative Requirements*—The mixed primer shall meet the quantitative requirements specified in Table 1. Primer must meet applicable VOC content limitations for its intended use categories (shop or field application) as defined by Federal and local regulations. Primers for field coating shall comply with the requirements of 40 CFR, Part 59, Subpart D, Section 59.400 through 59.413. If thinning is necessary for application, the maximum amount of solvent added shall be such that the final product still complies with all the requirements of this section, including the VOC requirements.

Table 1—Requirements

Characteristics	Minimum Requirement	Test Method
Total solids, % by mass of paint	78	ASTM D2369
Pigment, % by mass of total solids	85	ASTM D2371
Metallic zinc, % by mass of pigment	85	ASTM D521
Metallic zinc, % by mass of total solids	72	ASTM D6580 or ASTM D521

- 5.4. *Physical Properties*—The mixed primer shall meet the physical requirements of Table 2.

Commented [WJ4]: Becca Lane of Ontario Ministry of Transportation commented, "4.1.2 Vehicle shall be a curable organic polymer thermoset consisting of two parts – the resin and the cure. The resin part shall contain water or organic solvents to lower the viscosity and aid in spray application as well as inorganic filler and other additives to enhance the coating performance. The cure may contain a mixture of reactive and non-reactive components to achieve the desired pot life, stoichiometric mix ratio and cure time." Derrick Castle said, The title and historical significance of M300 is to provide a stringent performance based evaluation of Inorganic Zinc Rich Primers, in which only very well formulated IOZ's can pass. The suggested change opens the standard up to confusion of scope and applicability. Section 3 Classification, states Inorganic Zinc, the suggestion would change Section 4.1.2 Vehicle from silicate dispersions (what makes IOZ an Inorganic Zinc) to organic compounds and introduce terminology, resin and cure, which is typically associated with organic zinc rich primers. In my opinion this suggestion would lead people to believe the standard is applicable to Organic Zinc Rich Primers. This would be very problematic, as most OZ's will likely not pass M300 testing. Jim Welter proposes to Define the Inorganic Zinc vehicle like it is described in SSPC Paint 20, with language concerning additives.

Commented [WJ5]: Becca Lane of Ontario Ministry of Transportation commented, "Replace "basically" with mainly."

Commented [WJ6]: Becca Lane of Ontario Ministry of Transportation commented, "x-ray diffraction (XRD) is typically used for identification and qualitative analysis. of crystalline compounds. A quantitative approach would be to use x-ray fluorescence spectroscopy (XRF). Other, more direct analysis methods commonly used for inorganic determinations are Inductively Coupled Plasma Optical Emission Spectroscopy (ICP) and Atomic Absorption Spectroscopy (AA)" Derrick Castle said, It is true that XRD (Diffraction) is used for crystalline analysis. However, XRD will facilitate rapid instrumental analysis of zinc dust that can differentiate Metallic Zinc content and Zinc Oxide content within Total Zinc content. Whereas, XRF (Fluorescence) is a rapid instrumental analysis that will only give you Total Zinc content. Most states that I am aware of that still do significant sampling and testing have XRF, some have both XRF and XRD. If considering moving to or adding XRF – I would suggest including ASTM D521 as a test for Metallic Zinc. XRF will allow agencies to monitor Total Zinc, but not Metallic Zinc, without performing additional testing – ASTM D521. For clarification – agencies that specify or monitor zinc in the dried film, should be using metallic zinc content for this calculation. Jim Welter proposes the final revisions.

Table 2—Properties of Mixed Paint

Characteristics	Minimum Requirement	Maximum Requirement	Test Method
Density, kg/m ³ (lb/gal)	2217 (18.5)		ASTM D1475
Viscosity, KU @ 25°C (77°F)	Manufacturer's recommendation		ASTM D562
Set to touch, minutes @25°C (77°F) wet film thickness of 75 to 100 µm (3 to 4 mils)	—	30	ASTM D1640
Dry hard, h @ 25°C (77°F) wet film thickness of 75 to 100 µm (3 to 4 mils)	—	24	ASTM D1640
Pot life @ 25°C (77°F), h	8		Section 5.5.4.1

5.5. *Primer Qualitative Requirements*—The primer shall meet the following qualitative requirements.

5.5.1. *Mixing*—The raw materials of the liquid portion of the inorganic primer shall be mixed and dispersed as required to produce a product that is uniform, stable, free from grit, and conforms to the requirements of this specification.

5.5.2. The pigment portion of multicomponent paints, prior to mixing, shall be dry and loosely packed. After mixing, all types of coarse particles and skins as residue retained on a standard 250-µm (60-mesh) screen shall be no more than 0.5 percent by mass of total paint, regardless of type, in accordance with ASTM D185.

5.5.3. *Storage Life*—The vehicle component shall not show thickening, curdling, gelling, gassing, or hard caking after being stored unmixed for 9 months from date of manufacture in a tightly covered, unopened container at a temperature of 10 to 32°C (50 to 90°F).

5.5.4. *Working Properties*—The mixed paint shall spray easily, and shall show no streaking, running, sagging, or other objectionable features when tested in accordance with Federal Standard No. 141, Methods 4331, and ~~4541~~.

5.5.4.1. *Pot Life*—After mixing, the pot life shall be determined by placing 350 to 400 mL of the mixed paint into a 500 mL (1 pt) double-friction, top-round paint can and sealing the lid. Place the sealed can into a water bath maintained at a temperature of 25°C (77°F). After 8 h the mixed paint shall not show curdling, gelling, gassing, hard caking, or a change in viscosity greater than ±5 KU from the initial viscosity of the sample when determined in accordance with ASTM D562.

5.5.5. *Test Panel Preparation*—Steel test panels (ASTM A36 hot-rolled steel, or equivalent), measuring 100 by 150 by 1.5 mm (4 by 6 by 1/16 in.) unless otherwise designated shall be blast cleaned and coated with the zinc-rich primer. The panels shall be cleaned and coated on both sides and all edges.

5.5.5.1. The panels shall be cleaned in accordance with SSPC-SP 5 using recyclable metallic abrasives in accordance with SSPC-AB 3. The abrasives shall have a maximum chloride content of 15 ppm determined in accordance with ASTM D512 and a maximum conductivity of 150 ~~microhm~~ohms/cm determined in accordance with ASTM D4940. The abrasive mixture shall be approximately 60 percent SAE shot number S230 and 40 percent SAE grit number G40. Both the shot and grit shall have a Rockwell hardness of C45 ± 3. The surface profile of the cleaned panels shall be 40 to ~~65~~90 µm (1.5 to ~~2.3~~5 mils) when determined in accordance with ASTM D4417, Method C. The profile shall be clean, sharp, and free of embedded friable material, with adequate roughness to ensure effective adhesion of the primer.

5.5.5.2. The primer shall be applied to the cleaned test panels using airless spray equipment except when the paint manufacturer's application information specifically states only other methods of

Commented [WJ7]: Federal Standard No.141 Method 4541 Working Properties and Appearance of Dried Film, CANCELLED WITH NO REPLACEMENT

Commented [WJ8]: Jason Davis if LADOT, commented, ""150 micromhos/cm", should be "microohms / cm" for conductivity"

Commented [WJ9]: Proposed by Derrick Castle, decided to Kept lower limit at 1.5 mils and adjusted upper limit to 3.5 mils Awilda Merced of FDOT supports the revision.

application are to be used. All primers shall be applied to panels mounted vertically at a distance of 530 mm (21 in.) from the tip of the spray gun. The equipment shall be capable of developing sufficient pressure to properly atomize the primer. The orifice size, application pressure, pump type and ratio, hose size and length, and any atypical application requirements shall be reported. If the pressure used varies by more than 10 percent from the suggested pressure listed in the manufacturer's application data information, the actual pressure used and a statement explaining the deviation shall be reported.

- 5.5.5.3. The dry film thickness shall be 65 to 90 μm (2.5 to 3.5 mils) unless otherwise designated. Before any exposure tests, all panels shall be aged 14 days at 24 to 26°C (75 to 79°F) and 45 to 55 percent relative humidity. After aging of the test panels to be evaluated for salt fog resistance, cyclic weathering resistance, bullet hole immersion, and humidity tests, the panels shall have the edges sealed and protected by applying vinyl tape around the outside edges. The vinyl tape shall extend 5 mm ($\frac{3}{16}$ in.) onto the coated surface from the edge of the panel. The vinyl tape shall be in accordance with CID A-A-1689B and have an approximate vinyl thickness of 110 μm (4.3 mils) with an approximate neoprene adhesive thickness of 25 μm (1 mil).
- 5.5.5.4. The test panels for salt fog resistance and cyclic weathering resistance shall be scribed in accordance with ASTM D1654. The scribe shall be a ~~single "X"~~ two parallel lines centered on the test panel with rectangular dimensions of 50-mm (2-in.) top width and 100-mm (4-in.) height. To ensure proper positioning, cleanliness, and depth of the scribe, a template and a scribe-cutting tool shall be used. The scribe-cutting tool shall be a straight shank tungsten-carbide tip, having a 60° included angle, the cutting tool in accordance with ANSI B94.50, Style E. See Figures 1 and 2. ~~The operator shall beard down hard and go over each arm of the scribe twice to ensure a clean scribe of sufficient depth to remove any zinc particles from the scribe and to expose clean steel. The exposed steel in the cut of the scribe shall be verified with a microscope.~~
- 5.5.6. *Mudcracking*—The coating, when applied in accordance with Sections 5.5.5 through 5.5.5.3 to a 125- to 150- μm (5- to 6-mil) dry film thickness, shall show no mudcracking that is visible to the unaided eye.
- 5.5.7. *Adhesion*—The coating, when applied and hardened in accordance with Sections 5.5.5 through 5.5.5.3, shall be tested for adhesion in accordance with ASTM D4541, using apparatus under Appendix A4. The adhesive used to perform this test shall be a two-compound epoxy, containing no solvents (e.g., 100 percent solids). A minimum of four tests shall be performed on each panel. The average of the tests shall be a minimum pull-off adhesion value of 2-43.5 MPa (~~3500~~ psi).
- 5.5.8. *Salt Fog Resistance*—~~This is an optional test, as determined by the purchaser. The coating, when applied, hardened/cured, and scribed in accordance with Sections 5.5.5 through 5.5.5.4, shall pass 5000-h minimum exposure to salt fog (ASTM B117) without any blistering or rusting of the coated portion, with no undercutting from the scribe. (Slight rusting in the scribe mark will be permissible and resulting staining should be ignored.) Strips 6 mm ($\frac{1}{4}$ in.) wide along the edges of the panel may be ignored. Testing shall be done in triplicate.~~
- 5.5.9. *Cyclic Weathering Resistance Test*—Suitably sized panels shall be prepared in accordance with Sections 5.5.5 through 5.5.5.4 and tested in accordance with ASTM D5894, Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet). The coating shall pass fifteen 336-h cycles without any blistering or rusting of the coated portion, with no undercutting from the scribe. (Slight rusting in the scribe mark will be permissible and resulting staining should be ignored.) Strips 6-mm ($\frac{1}{4}$ -in.) wide along the edges of the panel may be ignored. Testing shall be done in triplicate.
- 5.5.10. *Bullet Hole Immersion Test*—The coating shall be applied in accordance with Sections 5.5.5 through 5.5.5.3 at a dry film thickness of 75 to 90 μm (3.0 to 3.5 mils) except for the panel size, which shall be 75 by 150 by 1.5 mm (3 by 6 by $\frac{1}{16}$ in.). A circular area of 38.1 mm (1.5 in.) in

Commented [WJ10]: Recommended by Derrick Castle. Awilda Merced of FDOT commented, "FDOT supports adding the option of two parallel lines but does not recommend the removal of the "X" option. Based on available research, either option seems enough if the cut reaches the metallic surface. Recommend specifying "either a single "X" or two parallel lines."

Derrick Castle said I am not in favor of leaving the X-cut as an option. NTPEP moved away from the X to parallel scribes over a decade ago because of issues of measuring scribe creep approaching the vertices. Additionally, I am not aware of anyone who routinely uses a X scribe for testing. Nathan Paykoff said According to D1654 both cuts must be in the same direction. Technically I don't think this is achievable if scribing an X. ANSI B94.50 Style E, WITHDRAWN BY ASME

Commented [WJ11]: Derrick Castle, "I think 600 psi is a reasonable minimum." Jim Welter Adjusted Pull Off Adhesion Value to 500 psi

Commented [WJ12]: Becca Lane of Ontario Ministry of Transportation commented, "Rust creepage measurement would be a more quantitative method of determining conformance. A maximum average rust creepage (all panels) of 4.0mm and 5.0mm in any individual panel is the suggested criteria limit. (reference OPSS 1704-2014). Blistering can be evaluated according to ASTM D714." Nathan Paykoff said, Evaluation of rust creepage is part of ASTM D1654 referenced in the scribing section above. D1654 also references D714 for evaluation of blistering in procedure B

Commented [WJ13]: Derrick Castle suggests cured in lieu of hardened

diameter, in the middle of each panel, shall be left uncoated. A small magnet may be used to hold a circular template in place for this purpose. Coat only the face of the panel with the primer being tested. The backside shall be coated with an electrochemically inert barrier-type coating such as a vinyl or epoxy barrier coating. After curing in accordance with Section 5.5.5.3, each panel shall be immersed in a 1-L (1-qt) jar containing a 5.0 percent solution of sodium chloride. The jars must be tightly covered to prevent evaporation of water. The 5.0 percent salt water must be changed weekly. After immersion at $23 \pm 3^{\circ}\text{C}$ ($75 \pm 5^{\circ}\text{F}$), for 650 h, no rusting or corrosion as determined by ASTM D 610 shall have occurred either within the circular bare area or over the zinc-rich painted surface.

- 5.5.11. *Humidity Test*—The coating when applied and hardened in accordance with Sections 5.5.5 through 5.5.5.4 shall show no rust, blistering, or loss of adhesion after 4000 h of exposure using ASTM D1735.
- 5.6. *Primer Field Performance Requirements*—Documented information detailing the past history and experience with the coating in terms of service life under specific conditions shall be required. It must be shown that less than 1 percent rust has occurred after 3 years of service in a coastal or marine environment. All details relative to surface preparation and application of the coatings shall be supplied. Sufficient identifiable characteristics shall be provided to permit laboratory test verification of coating identity. These characteristics shall include formulation information readily verifiable in a laboratory, including the general nature of the vehicle, pigment and volatile portions, the density, the percent solids by mass and volume, an infrared spectrum (2.5 to 15 microns) of the vehicle component of each coat, and other procedures used for the quality control during manufacture of the coating.
 - 5.6.1. New products that do not have three-year field performance information can be accepted on an experimental basis.

Note 1—Manufacturers must specify a minimum cure before topcoating. Either ASTM D4752 or D3363 shall be used to determine cure.
- 5.7. Primers having a slip coefficient requirement shall meet the AASHTO Class B slip coefficient of not less than 0.5 as defined by the AASHTO *Standard Specifications for Highway Bridges*.
- 5.8. *Material Quality Assurance:*
 - 5.8.1. In order to determine the acceptability of a lot or batch of a qualified product, the paint shall meet the requirements of Sections 5.2 through 5.4.
 - 5.8.2. Viscosity of the mixed paint shall be determined in accordance with ASTM D562. Variance shall be within ± 10 Krebs units or equivalent units of another viscometer of the viscosity of the initially approved primer.
 - 5.8.3. Density of the mixed paint shall be determined in accordance with ASTM D1475. Variance shall be within 48 kg/m^3 (0.4 lb/gal) of the density of the initially approved primer.
 - 5.8.4. Solids percent by mass of the mixed paint shall be determined in accordance with ASTM D2369. The percent solids by mass shall be no less than that specified in Table 1. Variance shall be within ± 2 percent of the percent solids by mass of the initially approved primer.
 - 5.8.5. The infrared spectrum (2.5 to 15 μm) of the vehicle component shall agree with the infrared spectrum of the vehicle component from the paints used in Sections 5.5 through 5.5.11. Agreement shall be both in peak position and relative intensity of the peaks, or by other analytical procedure.

5.8.6. The x-ray diffraction pattern of the extracted pigment shall match that of the initially approved primer. This test shall be performed at the discretion of the purchaser. The total zinc content of the pigment can be determined by X-ray fluorescence (XRF).

Commented [WJ14]: As mentioned in Section 5.2.1.

5.8.7. The solids percent by mass of the vehicle component shall not vary more than ± 2 percent of the solids content of the vehicle component from the initially approved primer. The solids content shall be determined in accordance with ASTM D2369.

6. PACKAGING AND MARKING

6.1. The primer shall be delivered in such containers as may be specified in the contract. Each container shall bear a label with the following information shown thereon: name and address of manufacturer, trademark or trade name, kind of paint, date of manufacture and lot number, mixing instructions, and equipment cleanup instructions. The label on the containers must also contain all appropriate health and physical hazard warnings as described in 29 CFR 1910.1200 OSHA Hazard Communication Standard.

6.2. The VOC content shall be stated on the label, and/or product data sheet, and/or Material Safety Data Sheet, or all three.

7. RECOATABILITY

7.1. *The primer shall show adequate recoatability when tested in accordance with the following method:*

7.1.1. Panels primed in accordance with Sections 5.5.5 through 5.5.5.3 shall be placed into humidity cabinet per Section 5.5.11. Panels are then cleaned in accordance with the manufacturer's recommendation and recoated and cured in accordance with Sections 5.5.5 through 5.5.5.3. Adhesion testing shall be performed in accordance with ASTM D4541, using apparatus under Appendix A4. The adhesive shall be in accordance with Section 5.5.7. A minimum of four tests shall be performed on each panel. The average of the tests shall be a minimum pull-off adhesion value of 2-43.5 MPa (500 psi).

Commented [WJ15]: Recommended by Derrick Castle. Jim Welter Adjusted Pull Off Adhesion Value to 500 psi

8. TOPCOATABILITY

8.1. *Topcoats shall show adequate adhesion when tested in accordance with the following method:*

8.1.1. Panels primed in accordance with Sections 5.5.5 through 5.5.5.3 shall be placed into humidity cabinet per Section 5.5.11. The panels shall then be cleaned and the topcoat for the system shall be applied in accordance with the manufacturer's requirements. The topcoated panels shall then be aged in accordance with Section 5.5.5.3. Aged panels shall be exposed for 30 days in accordance with ASTM D2247. After exposure, adhesion testing shall be performed in accordance with ASTM D4541, using apparatus under Appendix A4. The adhesive and resulting adhesion shall be in accordance with Section 5.5.7. A minimum of four tests shall be performed on each panel. The average of the tests shall be a minimum pull-off adhesion value of 2-43.5 MPa (500 psi).

Commented [WJ16]: Recommended by Derrick Castle. Jim Welter Adjusted Pull Off Adhesion Value to 500 psi

9. METHODS OF SAMPLING AND TESTING

- 9.1. The primer shall be sampled by lot for testing. The material can be sampled either at the manufacturer or after reaching its destination.

10. KEYWORDS

- 10.1. Inorganic zinc-rich primers; iron and steel surfaces; self-curing; self-curing coatings.

¹ Available from The Society for Protective Coatings, Building 40, 24th Street, Pittsburgh, PA 15222-4645.

² Available from GSA Specification Department, Federal Supply Services, Specification Section, 470 East L'Enfant Plaza, S.W., Suite 8100, Washington, DC 20407.

Figure 1- Scribe Tool (from ANSI B.94.50-1975 Withdrawn by ASME)

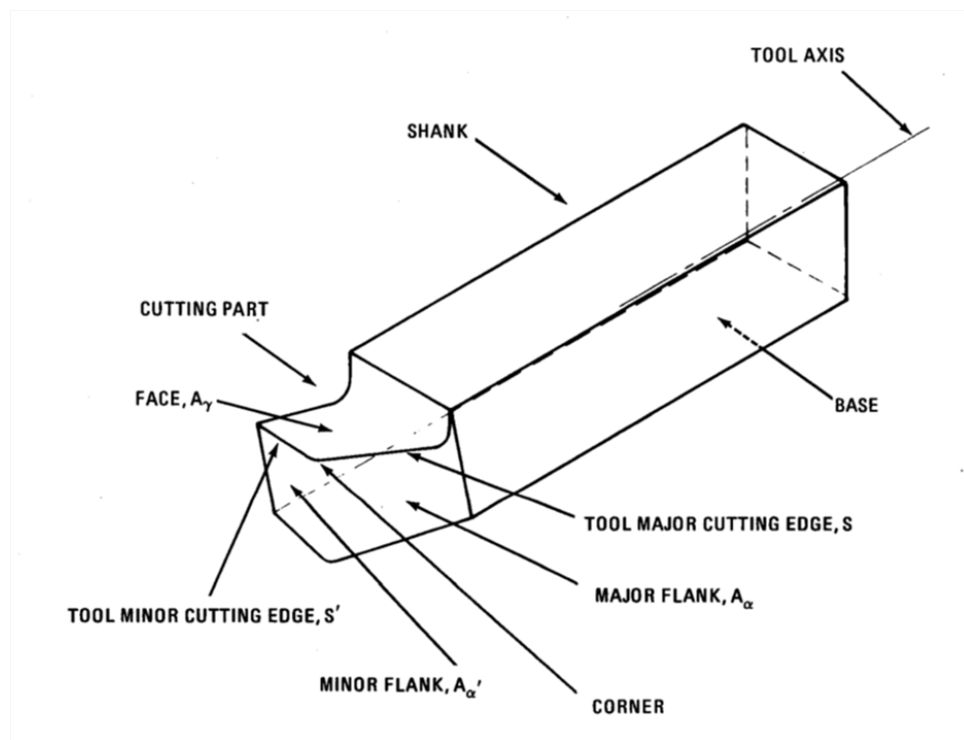
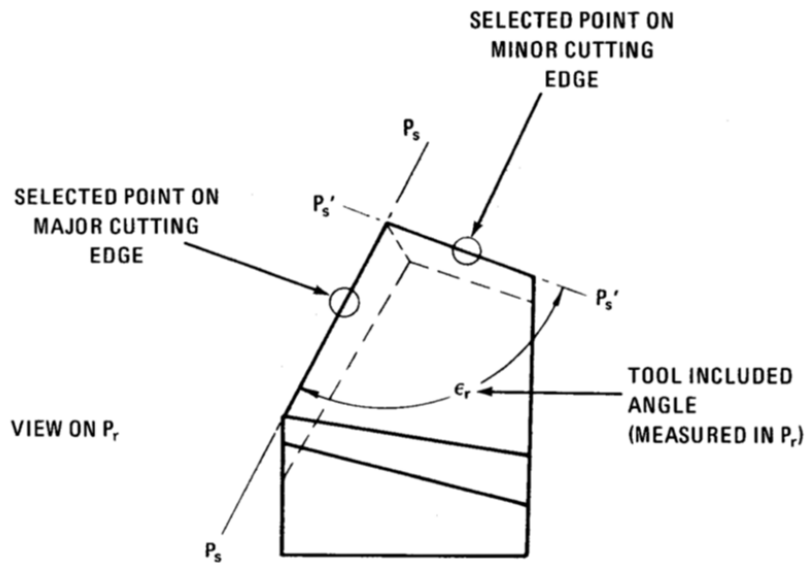


Figure 2- Included Angle (from ANSI B.94.50-1975 Withdrawn by ASME)

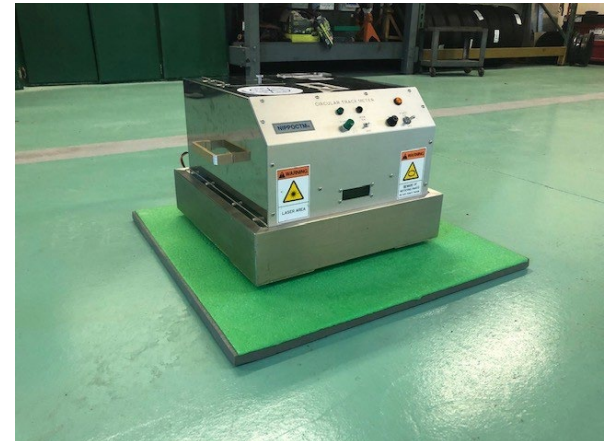
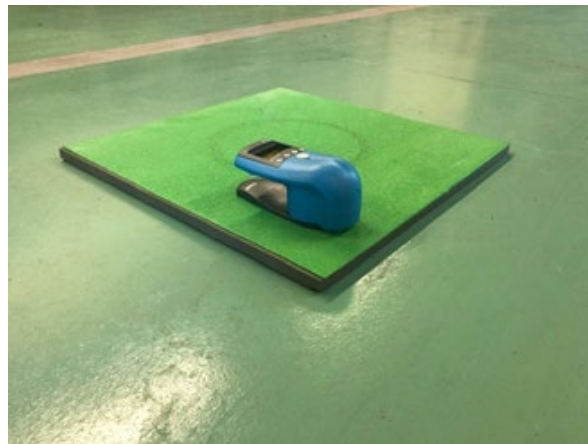
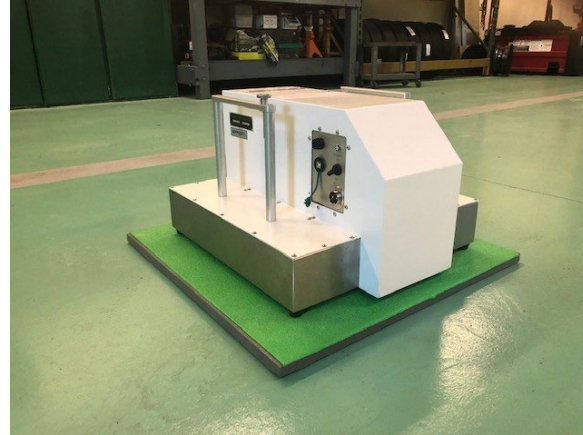




Accelerated Testing of Green Colored Bicycle Materials in Florida

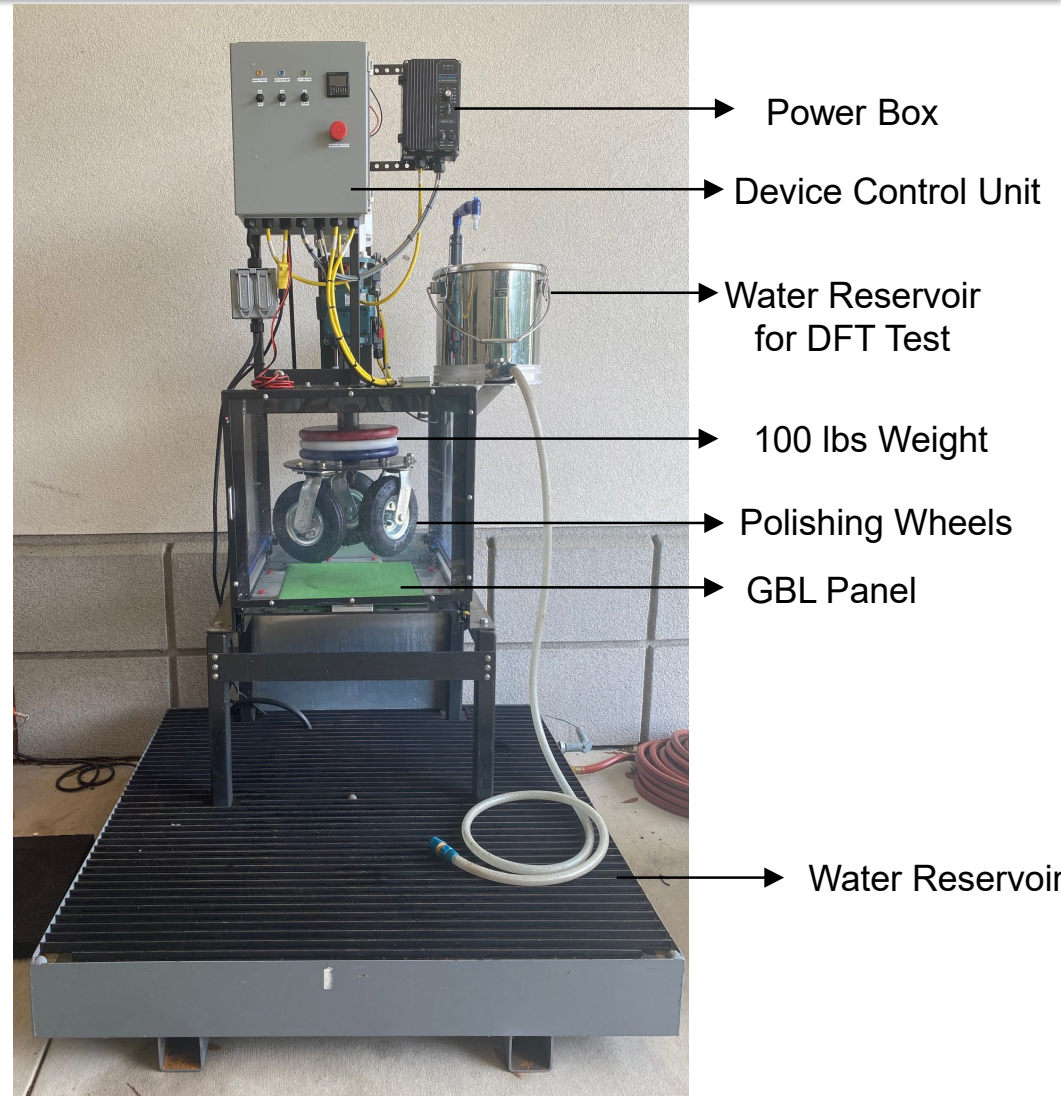
Accelerated Pavement Marking Testing

- Ability to test pavement marking materials in a laboratory environment
- Reduce 3-year wear testing
- Evaluate:
 - Friction
 - Color
 - Texture
 - Retro



Three Wheel Polish Tester (GBL Testing)

- NCAT's Three Wheel Polishing Device
- GBL Panel (19 ¾" x 15 ¾")
- Wet Test
- 0, 50,000, 100,000, 150,000 Cycles
- Color, Friction and Texture values collected after every polishing interval.



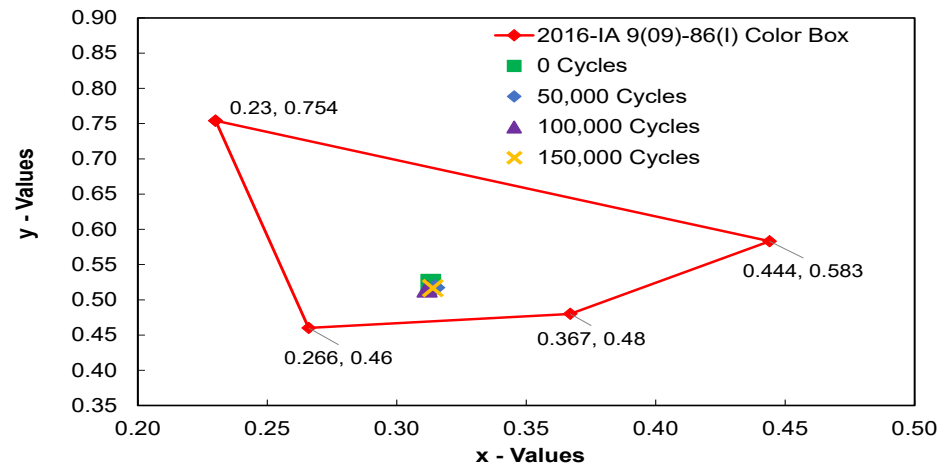
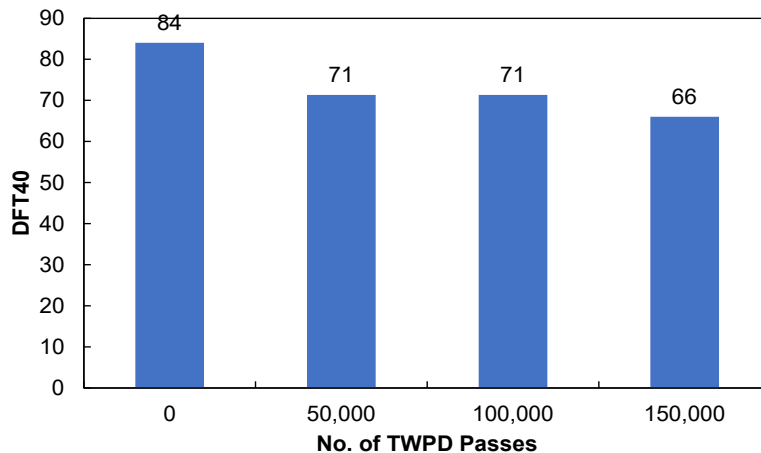
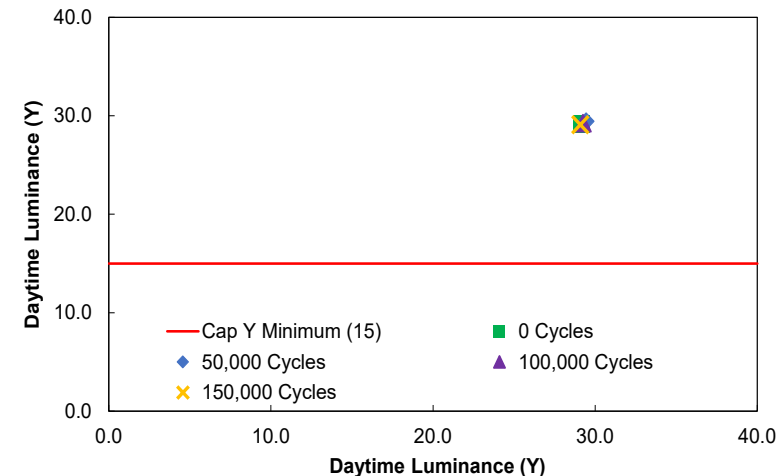
Test Equipment – Dynamic Friction Tester (DFT)

- ASTM E1911
 - Standard Test Method for Measuring Paved Surface Frictional Properties using the Dynamic Friction Tester
- Continuous Friction at speeds 0 to 55 mph
- Correlation with Locked Wheel Tester (LWT)



GBL Specification Requirements

- Guided by FDOT Dev. Spec 976 and Test Method FM5-622
- Requirements:
 - Panel Friction – Minimum coeff. of friction of 0.5 as obtained from DFT40 (40 mph)
 - Panel Color
 - Chromaticity (x,y) – Should lie within color box
 - Daytime Luminance (Y) – Min. value of 15



“The pigments used for the yellow thermoplastic compound shall not contain any hazardous materials listed in the Environmental Protection Agency Code of Federal Regulations (CFR) 40, Section 261.24, Table 1. The total of each RCRA listed heavy metal shall be analyzed by X-ray fluorescence spectroscopy (ASTM X-XXXX). **The manufacturer shall provide the purchasing agency certified test results from an acceptable laboratory at a minimum interval of 12 months to document the material complies with the above requirements. The purchasing agency may verify the above requirements at any time.**”



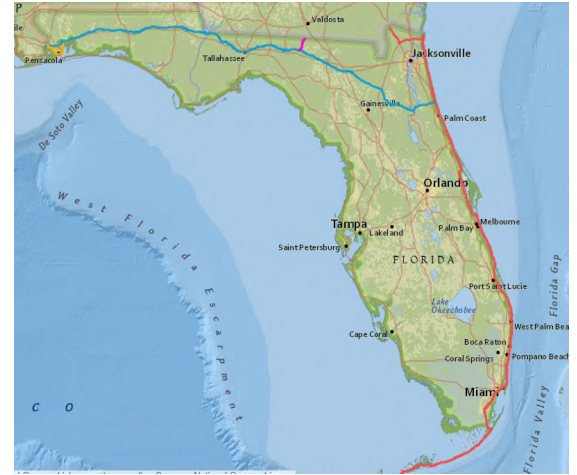
Florida Department of
TRANSPORTATION



Assessment of Green Colored Bicycle Lanes in Florida

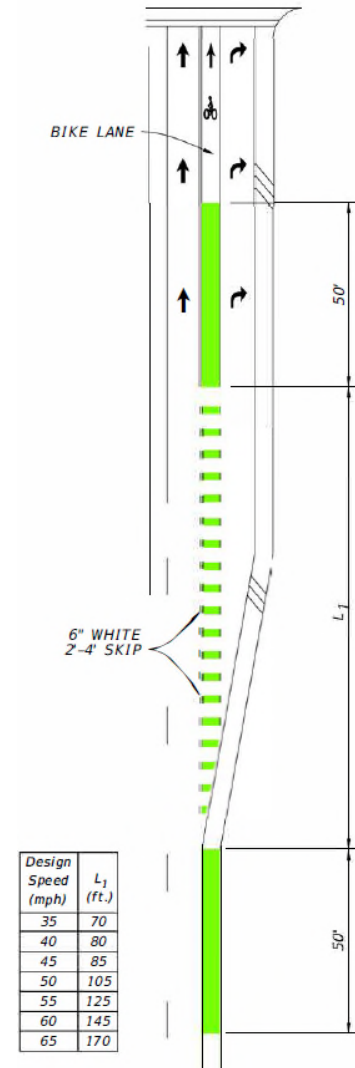
Background

- Highway System (FDOT Maintained)
 - 44,310 total lane miles
- 6,442 miles of bicycle lanes
- Interest in colored treatment on bicycle lanes and crossings has been growing in the US
- In 2011, FHWA issued interim approval for the optional use of green colored treatment on marked bicycle facilities
 - Several State and Local Governmental agencies has been granted approval by FHWA to experiment the use of green colored pavement for bike lanes



Background

- FDOT requested and received permission from FHWA for use of the green colored pavement for bicycle lanes
- Green-colored material is applied on bicycle lanes at bicycle-vehicular conflict areas
 - When bicycle lane crosses a vehicular right turn lane
 - Where a channelized right turn lane crosses a bike lane
 - Bicycle lane adjacent to a dedicated bus bay
- FDOT Developmental Specification 714/976, Green Colored Pavement Marking Materials
 - Test method (FM5-622) for evaluating friction color, and wear on green bike lane materials.

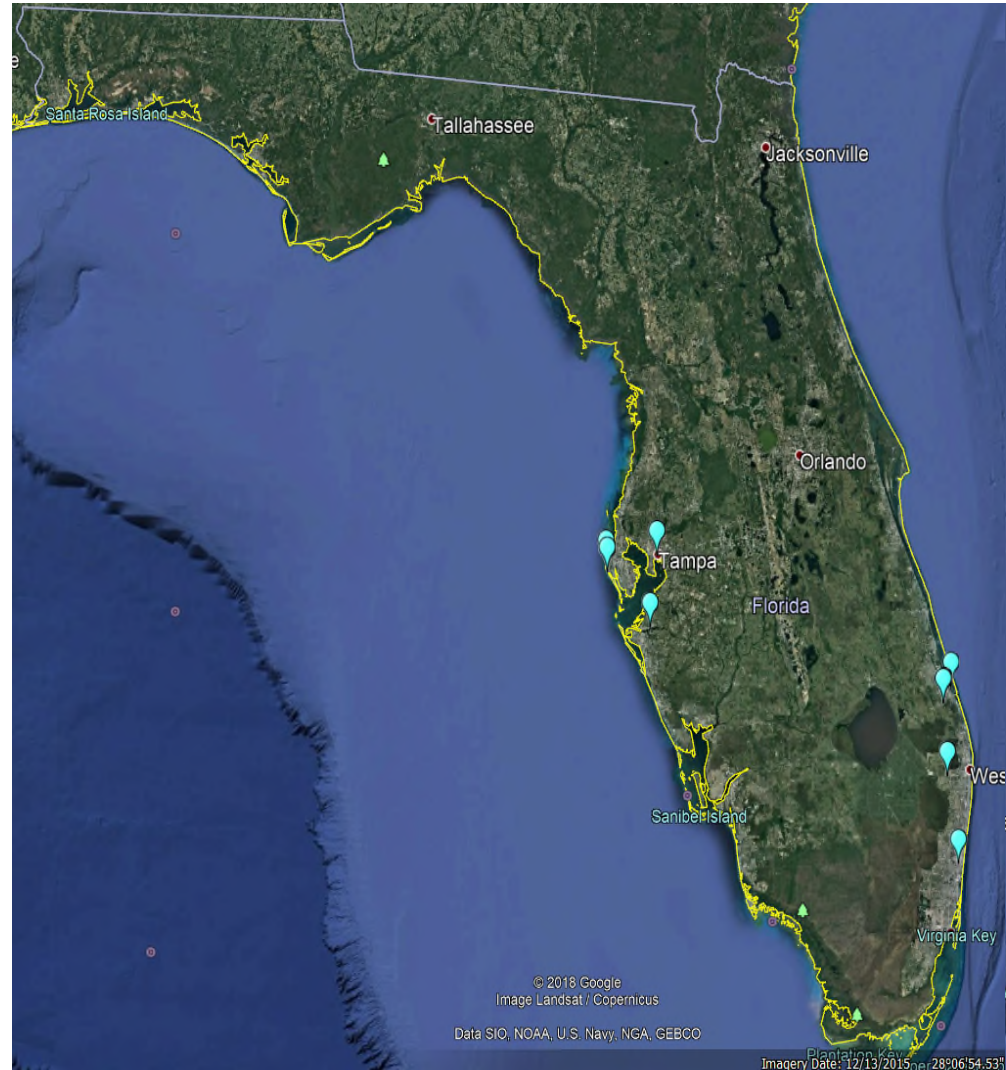


Studies Taken Up

- There have been three studies taken up pertaining to evaluation of Green Bike Lane Materials
 - FDOT GBL M-Team Site Reviews
 - 5 Year Long Term Performance Study
 - GBL Panel Testing Using Polish Tester

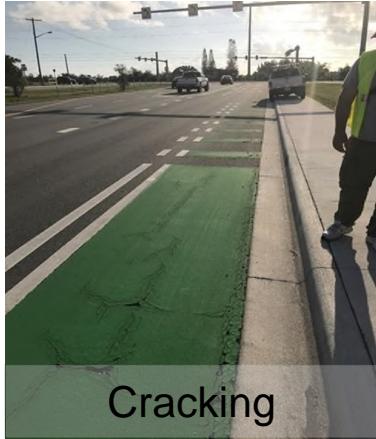
M-Team Reviews - Field Locations

- Districts 4, 5, & 7
- 23 projects
- 11 Epoxy
- 12 Thermoplastic
- Evaluated the projects for color, wear and any visible distresses.

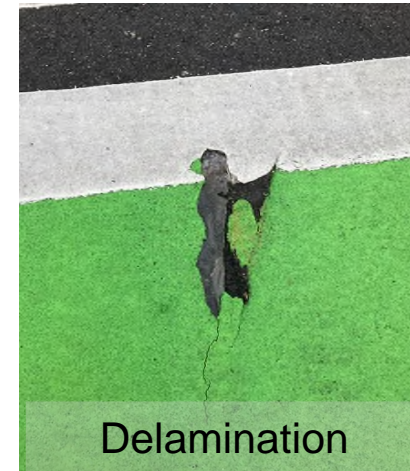
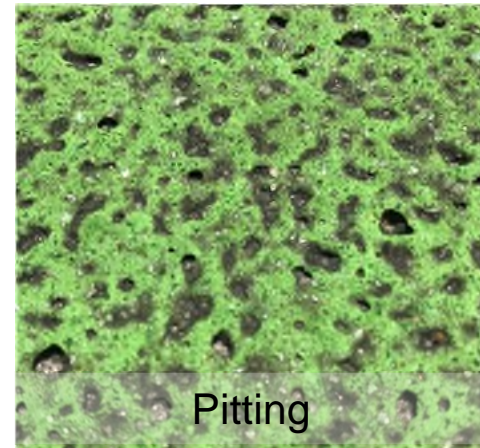
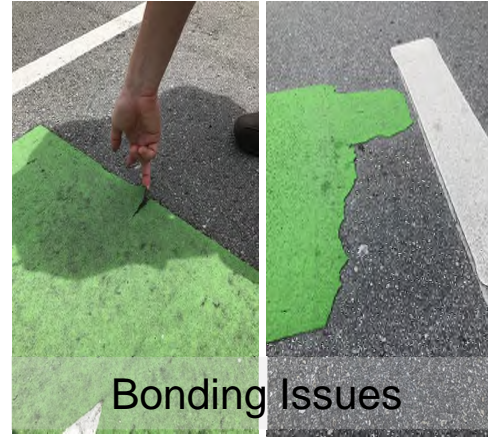


M-Team Reviews – Wear/Distresses

Epoxy

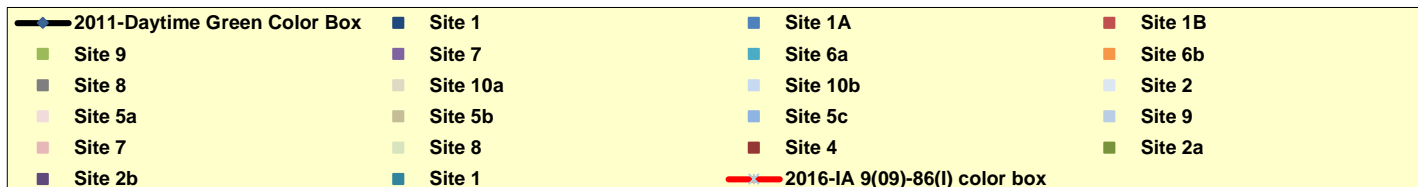
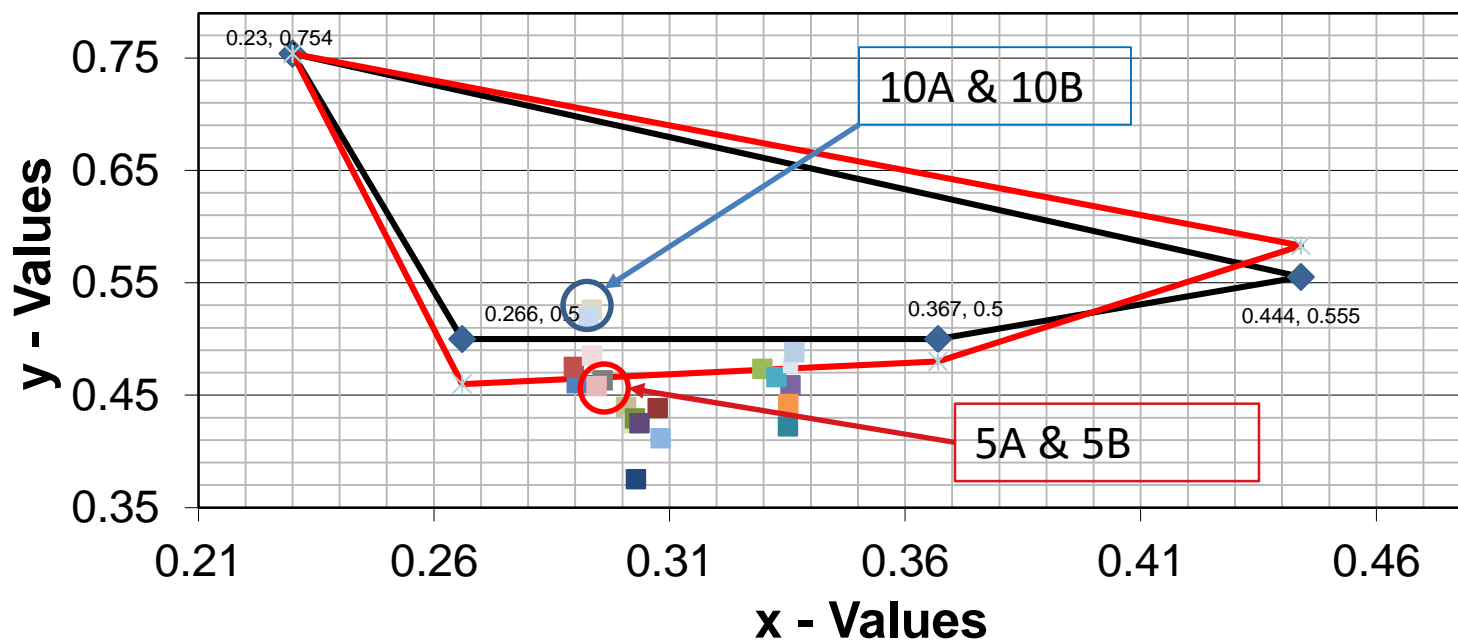


Thermoplastic



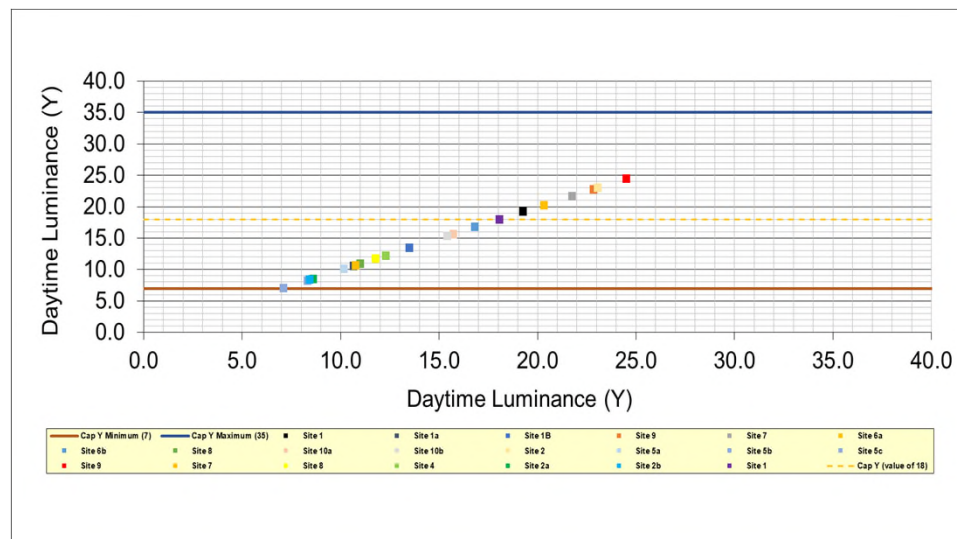
M-Team Reviews - Chromaticity (Color xy)

MUTCD Bike Lane Green Color Box Daytime Color Box

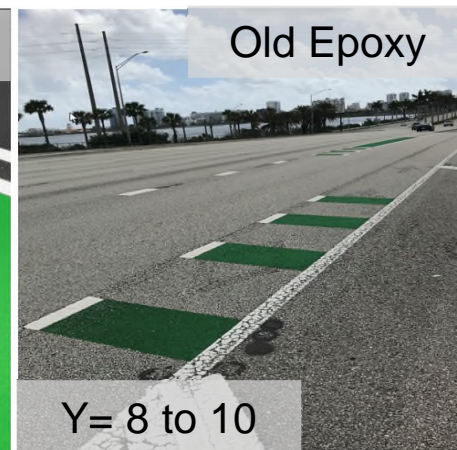


M-Team Reviews - Daytime Luminance (Y)

- Daytime Luminance (Y) 7 – 35
 - Lower Number is darker
 - Higher Number is lighter
- All 22 Samples met
- Samples greater than 18 were all thermoplastic

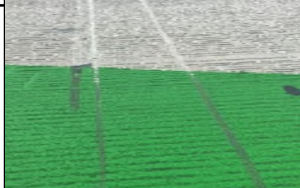


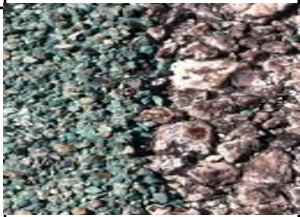



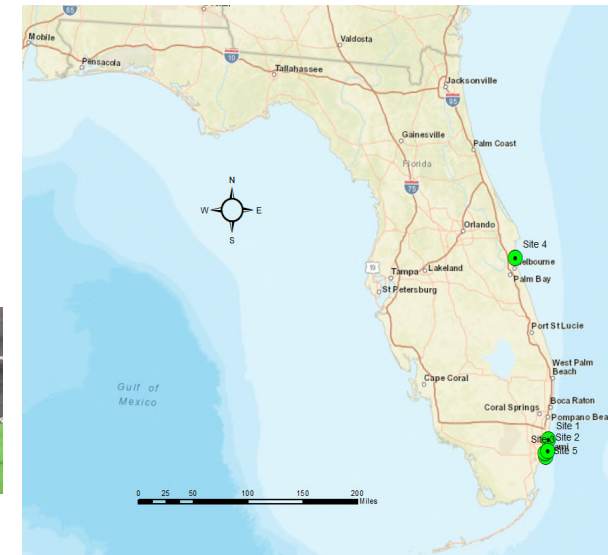
(a)



(b)

5 Year Long Term Performance Study

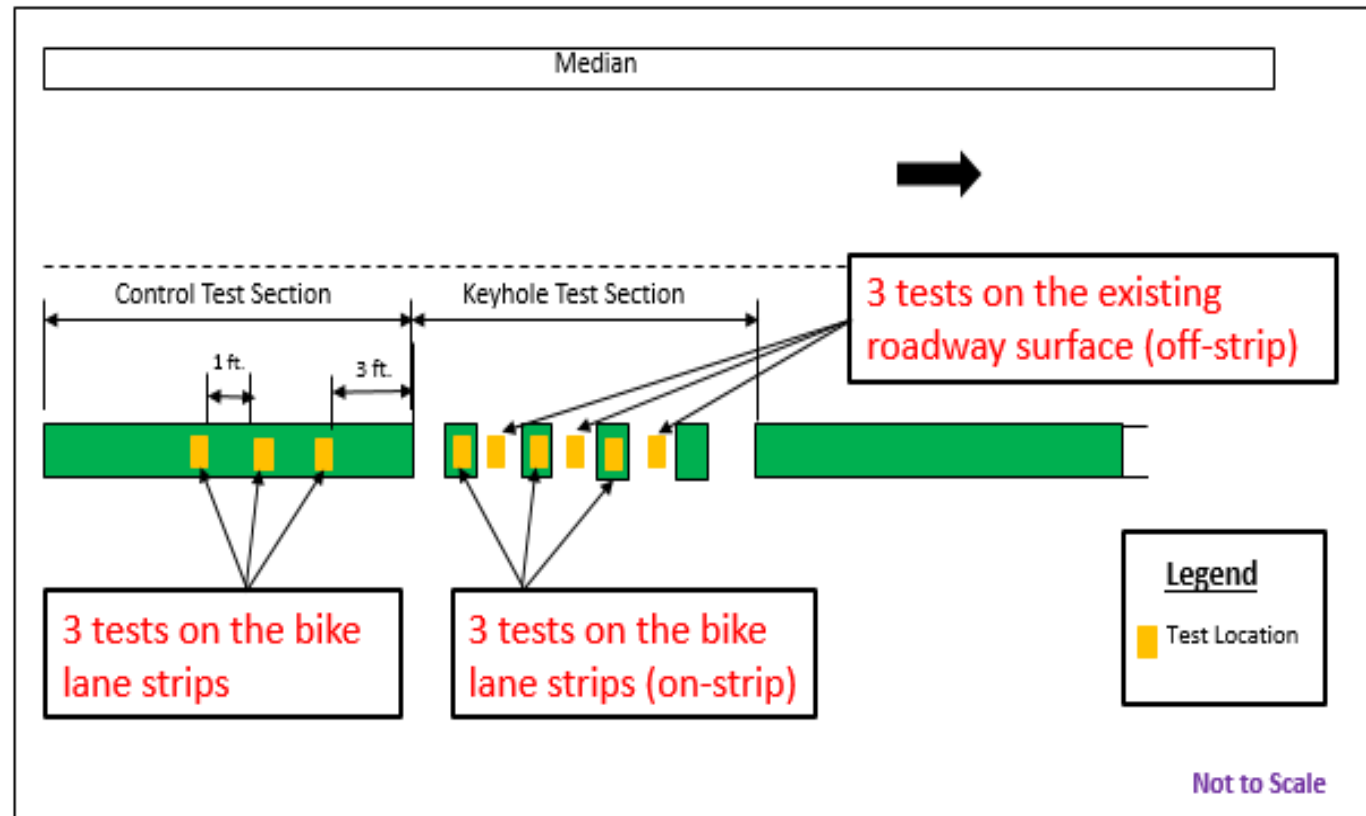
Test Location	Substrate Type	Treatment Type	Field Photos
Site 1	Rigid Pavement, Transverse Grooved	Epoxy Modified Coating	
Site 2	Dense Graded AC	Epoxy Modified Coating	
Site 3	Dense Graded AC	Thermoplastic	
Site 4	Open Graded AC	High Friction Surface Treatment (HFST)	
Site 5	Open Graded AC	Epoxy Modified Coating	



Long Term Study – Test Plan

Two Test Sections:

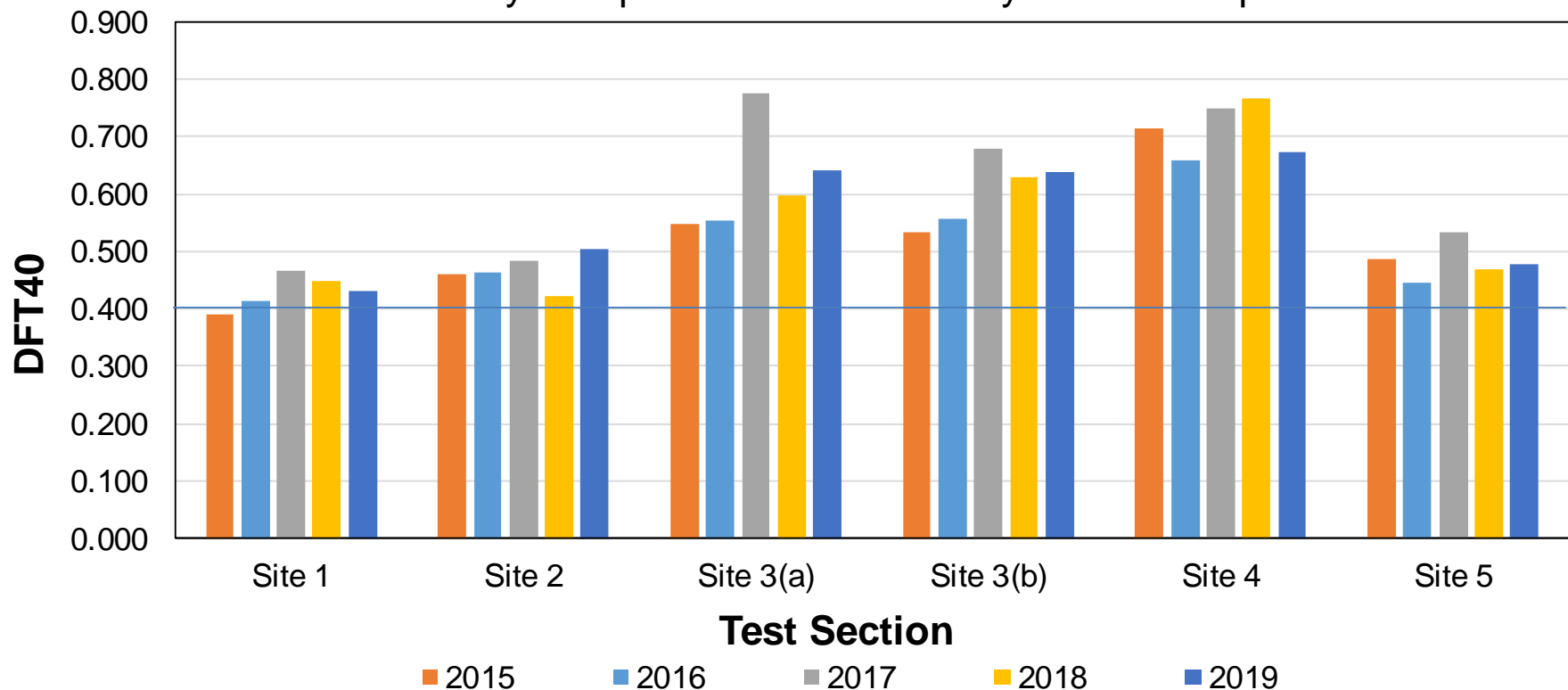
- Control
- Keyhole
 - Off-Stripe
 - On-Stripe



Friction Comparison

- Five-year friction measurement for each site

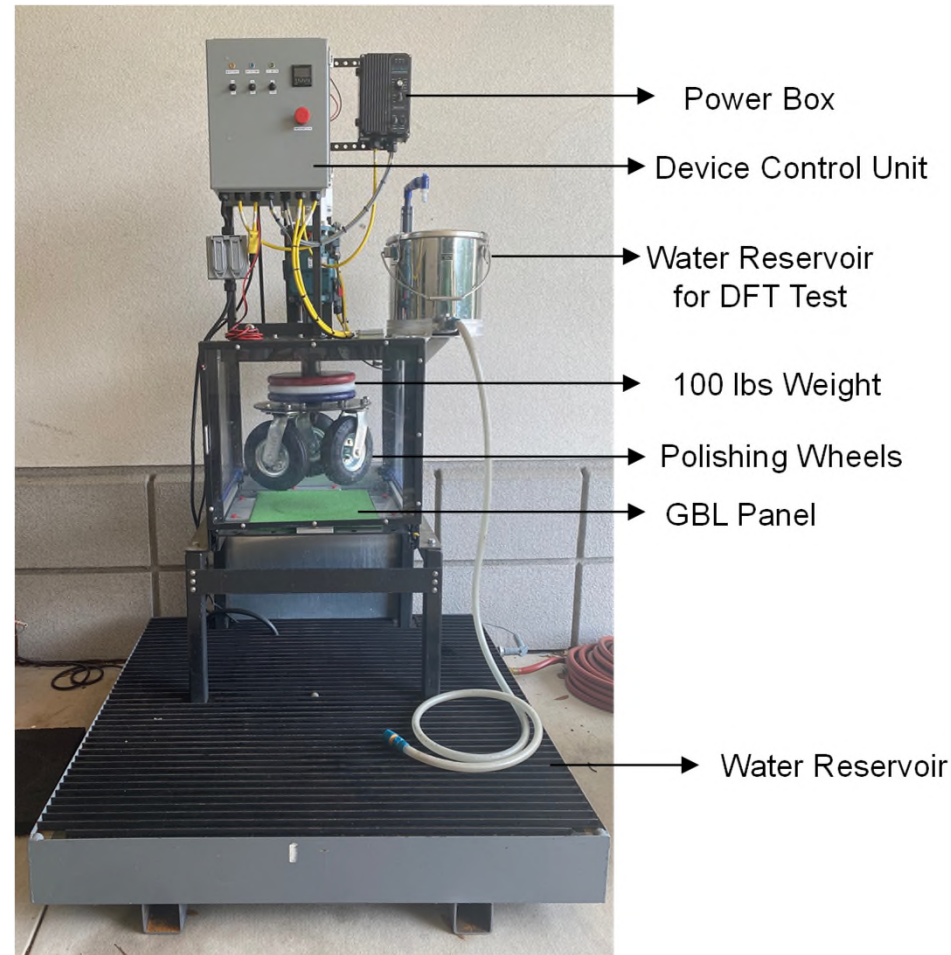
Yearly Comparison of DFT on Keyhole On-Stripe



Site 1 – Rigid + Epoxy; Site 2 – DGAC + Epoxy; Site 3: DGAC + Thermoplastic; Site 4: OGAC + HFST; Site 5: OGAC + Epoxy

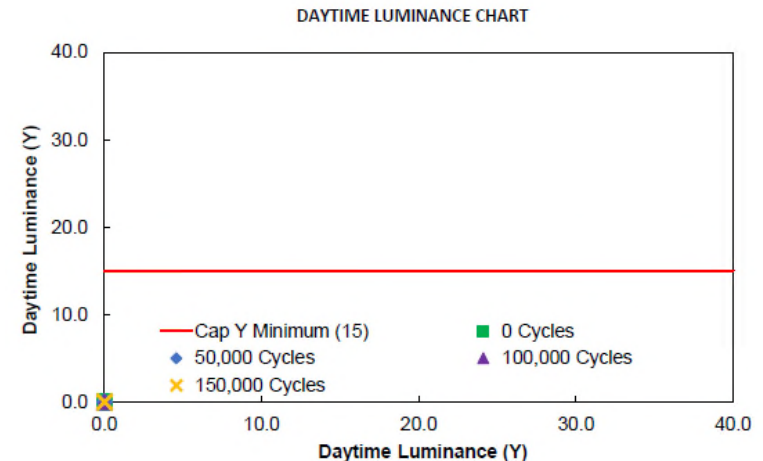
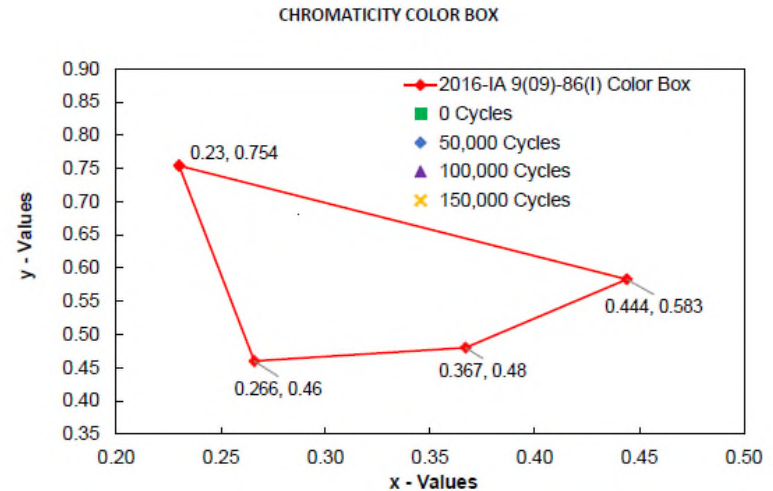
Panel Testing Using Polish Tester

- Being used to qualify the manufacturer's product for field application
- Mimics NCAT's Three Wheel Polishing Device
- GBL Panel (19 $\frac{3}{4}$ " x 15 $\frac{3}{4}$ ")
- Wet Test
- 0, 50,000, 100,000, 150,000 Cycles
- Color, Friction and Texture values collected after every polishing interval.
- Test method finalized recently

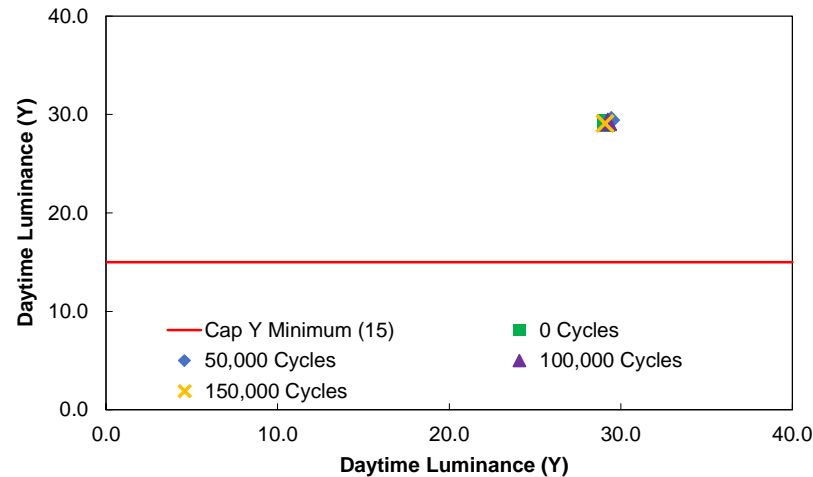
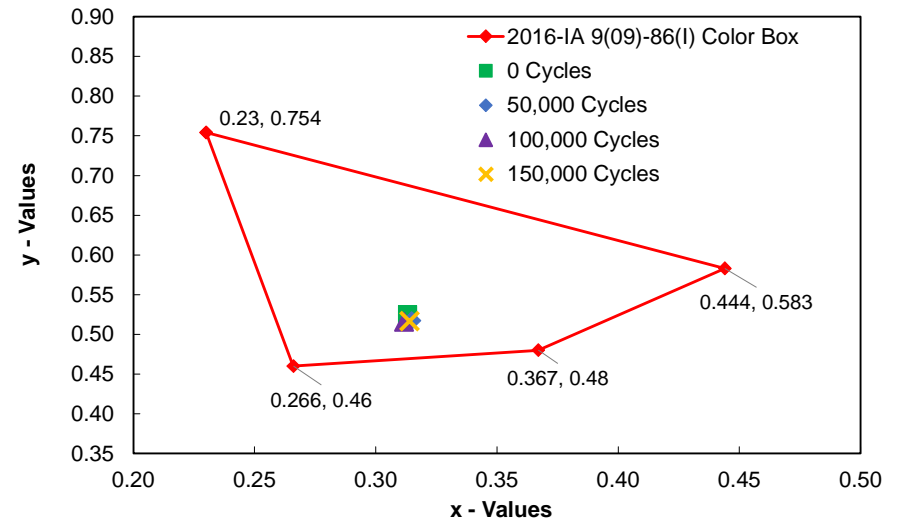
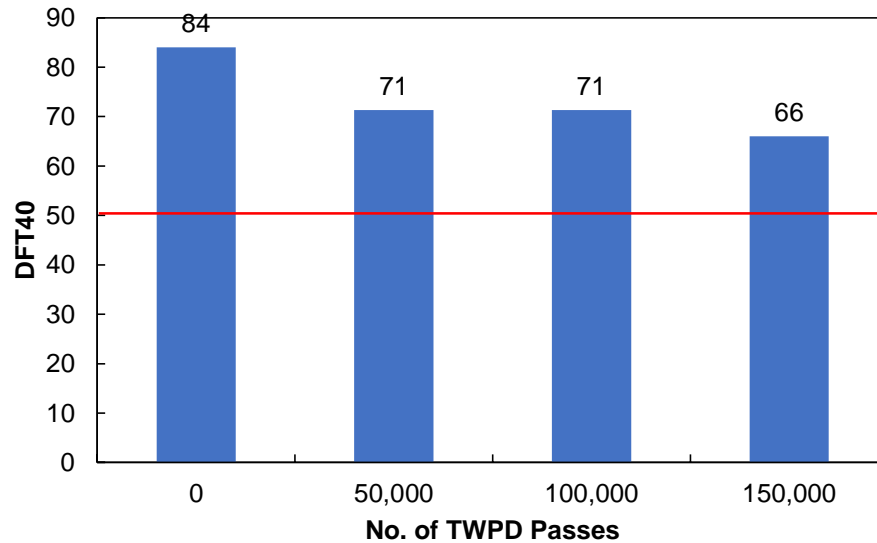


Specification Requirements

- Guided by FDOT Dev. Spec 976 and Test Method FM5-622
- At anytime during testing on TWPD, the following should be met
- Panel Friction – Minimum coeff. of friction of 0.5 as obtained from DFT at 40 mph
- Panel Color
 - Chromaticity (x,y) – Should lie within color box
 - Daytime Luminance (Y) – Min. value of 15
- For in-service green bike lanes
 - For 3 years after application, min. coeff. of friction (DFT40) of 0.4 should be maintained
 - Traffic wear should not expose more than 15% of underlying pavement surface



Example Panel Testing - Results



Standard Method of Test for

Thermoplastic Traffic Line Material

AASHTO Designation: T 250-05 (2019)

Technical Subcommittee: 4c, Markings and Coatings

Release: Group 2 (June)



**American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, D.C. 20004**

Standard Method of Test for

Thermoplastic Traffic Line Material

AASHTO Designation: T 250-05 (2019)

Technical Subcommittee: 4c, Markings and Coatings

Release: Group 2 (June)



1. SCOPE

- 1.1. The procedures used for testing thermoplastic traffic line material are described in this method. This includes the method for obtaining a representative test sample, preparation of the test specimens, and performing the specified tests. The material is a mixture of resins, fillers, pigments, and reflective spheres. These materials are combined by heating to obtain a product with the desired properties suitable for traffic line striping.
- 1.2. *This test method is divided into the following parts:*
- 1.2.1. Section 3, Sampling of Thermoplastic Material;
 - 1.2.2. Section 4, Sample Meltdown and Preparation;
 - 1.2.3. Section 5, Binder Content;
 - 1.2.4. Section 6, Glass Bead Content;
 - 1.2.5. Section 7, Glass Bead Grading Analysis;
 - 1.2.6. Section 8, Reflectance, Color, and Yellowness Index;
 - 1.2.7. Section 9, Titanium Dioxide Determination;
 - 1.2.8. Section 10, Lead Chromate Determination;
 - 1.2.9. Section 11, Flowability (Percent Residue);
 - 1.2.10. Section 12, Low Temperature Stress Resistance;
 - 1.2.11. Section 13, Bond Strength;
 - 1.2.12. Section 14, Impact Resistance;
 - 1.2.13. Section 15, Ring-and-Ball Softening Point;
 - 1.2.14. Section 16, Specific Gravity;
 - 1.2.15. Section 17, Flowability (Percent Residue) Extended Heating;

1.2.16. Section 18, Ultraviolet Light and Condensate Exposure;

1.2.17. Section 19, Hardness; and

1.2.18. Section 20, Flash Point.

1.3. The values stated in SI units are to be regarded as the standard.

Note 1—Warning: Due to the elevated temperatures used in these tests and the nature of the material, extreme care should be used when working with the thermoplastic materials. Use heat-resistant gloves and safety glasses or face shield when handling in the fluid state. Severe burns can result from spilled thermoplastics or mishandled equipment. Should melted thermoplastic come in contact with the skin, do not attempt to wipe off. Immediately hold or submerge the affected area under cold water. Inform someone in the immediate vicinity that an accident has occurred. Seek proper medical attention.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards:*

- M 231, Weighing Devices Used in the Testing of Materials
- M 247, Glass Beads Used in Pavement Markings
- M 249, White and Yellow Reflective Thermoplastic Striping Material (Solid Form)

2.2. *ASTM Standards:*

- D36/D36M, Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
- D92, Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
- D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
- D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D2240, Standard Test Method for Rubber Property—Durometer Hardness
- D4764, Standard Test Method for Determination by X-ray Fluorescence Spectroscopy of Titanium Dioxide Content in Paint
- D4796, Standard Test Method for Bond Strength of Thermoplastic Traffic Marking Materials
- D4797, Standard Test Methods for Gravimetric Analysis of White and Yellow Thermoplastic Pavement Marking
- D4960, Standard Test Method for Evaluation of Color for Thermoplastic Traffic Marking Materials
- E11, Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
- E313, Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates
- E1349, Standard Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry
- G154, Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

2.3. *Federal Standard:*

- Federal Standard No. 141, Paint, Varnish, Lacquer and Related Materials

3. SAMPLING OF THERMOPLASTIC MATERIAL

3.1. It is important to obtain a truly representative sample of the thermoplastic material for testing. This can be difficult due to the wide ranges of sizes, shapes, and densities of the particular raw materials that are used in the material formulation. The following three methods provide a way to obtain representative samples from a production lot of thermoplastic pavement marking material for testing.

3.2. *Quartering Method:*

3.2.1. *Apparatus and Materials:*

3.2.1.1. 1.2-by-1.2-m (4-by-4-ft) section of cardboard, smooth wood, or metal;

3.2.1.2. Metal scooping pan;

3.2.1.3. Metal splitting device;

3.2.1.4. Three 22-kg (50-lb) bags of thermoplastic (randomly selected); and

3.2.1.5. Unlined 3.8-L (1-gal) cans.

3.2.2. *Procedure:*

3.2.2.1. Randomly select three 22-kg (50-lb) bags from the lot to be sampled [up to 22 000 kg (50,000 lb)].

3.2.2.2. Place the selection of cardboard, wood, or metal on a level section of floor.

3.2.2.3. Empty the contents of one of the 22-kg (50-lb) bags onto the sample area. Using the metal scoop, mix the material, breaking up any large lumps. Shape the pile of thermoplastic into as high a pile as possible, forming a symmetrical inverted cone.

3.2.2.4. Take the metal splitting device and center it over the apex of the thermoplastic. Lower the device onto the material, thus splitting it into four quarter sections.

3.2.2.5. Take the material from any two opposing quarters and return it to the thermoplastic bag. The two remaining quarters are to be mixed and split in the same manner as explained above, rotating between the two quarters that are retained at the end of each step. Repeat the process for a total of four times. Retain the final two opposing quarters as a part of the composite sample and place in the unlined 3.8-L (1-gal) can.

3.2.2.6. Perform the same procedure as outlined using the two remaining bags. When the final quarters are taken from the two bags, the sum of the three bags should fill the 3.8-L (1-gal) sample container and should weigh between 4 and 4.5 kg (9 and 10 lb).

3.2.2.7. Label the outside of the 3.8-L (1-gal) sample can with adequate identification markings including: manufacturer, product number, batch number, date of manufacture, color, and specification.

3.2.2.8. The entire composite sample should be melted for the preparation of test samples as called for in Section 4, Sample Meltdown and Preparation.

3.3. *Splitter Method:*

3.3.1. *Apparatus and Material:*

- 3.3.1.1. 1:1 Splitter with pans;
- 3.3.1.2. Three 22-kg (50-lb) bags of thermoplastic (randomly selected); and
- 3.3.1.3. Unlined 3.8-L (1-gal) can.
- 3.3.2. *Procedure:*
 - 3.3.2.1. Randomly select three 22-kg (50-lb) bags of thermoplastic from the lot to be tested (up to 22 000 kg (50,000 lb)).
 - 3.3.2.2. Empty the contents of one of the bags into one of the pans and place on top of the 1:1 splitter.
 - 3.3.2.3. Place a pan underneath each of the two discharge sections of the splitter.
 - 3.3.2.4. Empty the contents in the top pan such that the material passes through the splitter.
 - 3.3.2.5. Take each half and split individually to form quarters. Return two opposing pans, or quarters, to the bag. Split the two remaining pans individually to form quarters. Repeat the above procedure by splitting the two opposing pans while returning the others to the bag. This splitting procedure is performed four times before placing the final quarters into the sample container.
 - 3.3.2.6. Perform the same procedure on the two remaining bags of thermoplastic. When the final quarters are taken from the two bags, the sum of the three bags should fill the 3.8-L (1-gal) sample container and should weigh between 4 and 4.5 kg (9 and 10 lb).
 - 3.3.2.7. Label the outside of the 3.8-L (1-gal) sample can with adequate identification markings including: manufacturer, product number, batch number, date of manufacture, color, and specification.
 - 3.3.2.8. The entire composite sample should be melted for the preparation of test samples as called for in Section 4, Sample Meltdown and Preparation.
- 3.4. *Thieving Method:*
 - 3.4.1. *Apparatus and Materials:*
 - 3.4.1.1. 5-cm (2-in.) ID metal pipe approximately 1 m (3 ft) long;
 - 3.4.1.2. Three 22-kg (50-lb) bags of thermoplastic (randomly selected); and
 - 3.4.1.3. Unlined 3.8-L (1-gal) cans.
 - 3.4.2. *Procedure:*
 - 3.4.2.1. Randomly select three 22-kg (50-lb) bags of thermoplastic from the lot to be sampled (up to 22 000 kg (50,000 lb)).
 - 3.4.2.2. Place the bag on a flat surface.
 - 3.4.2.3. Carefully cut the bag at the top or bottom to allow the pipe to be inserted into the bag.
 - 3.4.2.4. Insert the sample pipe into the bag and push through the thermoplastic material through the entire length of the bag.

- 3.4.2.5. Carefully remove the pipe and empty the thermoplastic material that is retained in the pipe into the unlined 3.8-L (1-gal) can.
- 3.4.2.6. Repeat the process, pushing the pipe through a different area of the 22-kg (50-lb) bag. Continue with the process until an approximate 1.5-kg (3-lb) sample has been obtained from the 22-kg (50-lb) bag.
- 3.4.2.7. Repeat steps in Sections 3.4.2.2 through 3.4.2.6 with the other two 22-kg (50-lb) bags that were selected for testing. The final sample size should weigh between 4 and 5.5 kg (9 and 12 lb).
- 3.4.2.8. Label the outside of the 3.8-L (1-gal) sample can with adequate identification markings, including: manufacturer, product number, batch number, date of manufacture, color, and specification. The entire composite sample should be melted for the preparation of test samples as called for in Section 4, Sample Meltdown and Preparation.

4. SAMPLE MELTDOWN AND PREPARATION

- 4.1. This procedure covers the melting of thermoplastic road striping materials using a heating mantle and an air stirrer. This procedure simulates the actual melting process and equipment found in the field.
- 4.2. *Apparatus and Materials:*
 - 4.2.1. A stainless steel 4000-mL beaker, 15-cm (6-in.) diameter by 23 cm (9 in.) high, such as a Volrath No. 84000 or equivalent such as an unlined metal 3.8-L (1-gal) can.
 - 4.2.2. Suitable heating mantle, such as a Glas-Col heating mantle, Model TM620 or equivalent.
 - 4.2.3. Temperature indicator-controller, such as an Omega Engineering Model 400JF or equivalent.
 - 4.2.4. Thermocouple, such as an Omega Engineering No. TJ36-ICSS-116G-12 with 1.6-mm ($1/16$ -in.) 304SS sheath, or equivalent.
 - 4.2.5. Air powered variable speed mixer, such as a Lightning Model 30 with two Lightning A310 stainless steel impellers or similar equipment.
 - 4.2.6. Aluminum lid to cover the top of the stainless steel 4000-mL beaker with slot to clear the air motor agitator shaft and thermocouple.
 - 4.2.7. Stainless steel ladle with pouring spout, 60-mL (2-oz) capacity.
 - 4.2.8. Tachometer to measure shaft speed of mixer.
 - 4.2.9. Copper or stainless steel tubing approximately 3 mm ($1/8$ in.) and 25 cm (10 in.) long.
 - 4.2.10. Porcelain dish, 150 mL.
 - 4.2.11. Crucibles, 30 mL.
 - 4.2.12. Glass beaker, 2 L.

4.3. *Procedure:*

- 4.3.1. Set up the apparatus as shown in Figure 1. Wire the heating mantle power cord to the temperature indicator controller according to manufacturer's instructions. Mount the controller-indicators in a panel that can be wall mounted to keep the unit away from heat, dirt, and vibrations. When the unit is ready for operation, make a test melt in order to set the proportional band and other adjustments to give a controlled temperature of $218 \pm 1^{\circ}\text{C}$ ($425 \pm 2^{\circ}\text{F}$).
- 4.3.2. Change about one-half the granular sample into the appropriate container and place in the heating mantle and attach the stirring shaft. Turn on the power to the mantle and controller. As the thermoplastic melts down, add the remainder of the sample. Start the variable-speed air agitator when plastic has softened sufficiently to mix. Continue to mix and heat until the temperature reaches 218°C (425°F) and the sample is homogeneous, and maintain temperature at $218 \pm 1^{\circ}\text{C}$ ($245 \pm 2^{\circ}\text{F}$).
- 4.3.3. Remove the thermoplastic sample using a 60-mL (2-oz) ladle and prepare samples or run tests as required.

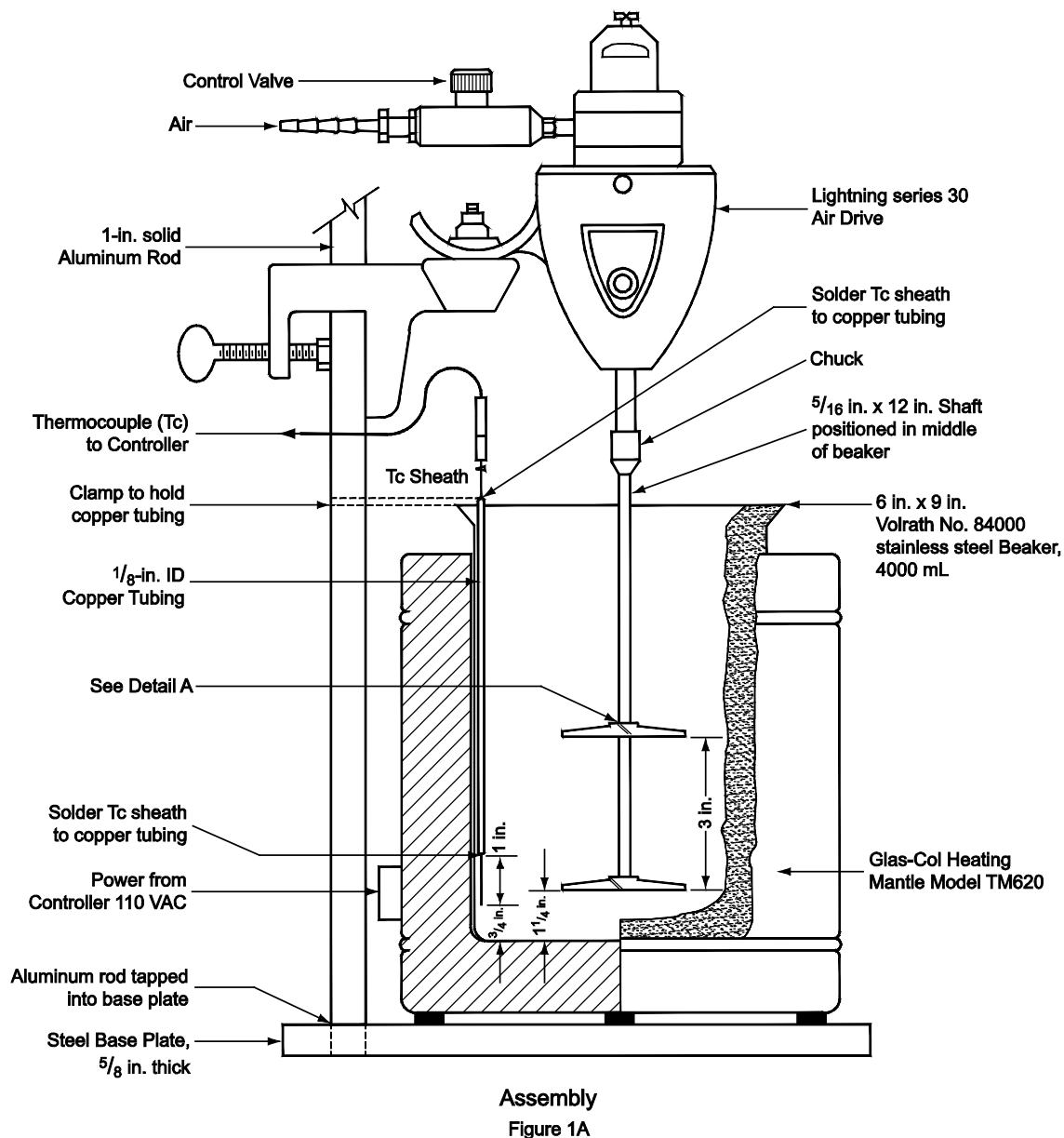


Figure 1—Thermoplastic Melter Apparatus

5. BINDER CONTENT

- 5.1. Using a 60-mL (2-oz) ladle, remove a portion of the molten thermoplastic from the sample during the first hour of the heating period (after the entire sample becomes molten). Run the binder content as specified in ASTM D4797 with the exception of using a 50-g sample of thermoplastic marking material and a 150-mL (5-oz) porcelain dish in lieu of a 30-mL crucible.

6. GLASS BEAD CONTENT

- 6.1. Using the same sample obtained for the determination of binder content, determine the intermix bead content as specified in ASTM D4797 utilizing a 2-L beaker in lieu of the 400-mL beaker and increasing the quantities of the HCl solution and water used in the rinses by a factor of five (5).

7. GLASS BEAD GRADING ANALYSIS

- 7.1. Grade the beads according to M 247 using the appropriate sieves. Determine the mass of fractions to the nearest 0.01 g.
- 7.2. Perform a visual inspection of the material larger than 100 mesh to determine that the sample is composed of glass beads only. Any material other than glass beads that are insoluble in the acid wash will appear irregular and opaque. Presence of this type of material in sizes larger than 100 mesh constitutes a failure to comply with the specification or inadequate HCl digestion.
- Note 2**—All other bead analysis testing should be performed according to M 247.

8. REFLECTANCE, COLOR, AND YELLOWNESS INDEX

- 8.1. Using a 60-mL (2-oz) ladle, remove a portion of the molten thermoplastic from the sample after the material has completed the 4-h heating period. Cast an approximate 8-cm (3-in.) diameter disk on a tin plate, can lid, or on some other nonstick surface. After the material has reached room temperature, remove and test according to the requirements of ASTM D4960. Make color measurement according to ASTM E1349 using 2-degree observer and Illuminant D 65. Calculate the Yellowness Index in accordance with ASTM E313.

9. TITANIUM DIOXIDE DETERMINATION

- 9.1. *X-Ray Fluorescence Spectroscopy Method:*
- 9.1.1. Perform the test in accordance with the requirements of ASTM D4764.
- 9.2. Jones Reduction Method (Referee Method): as noted in ASTM D4797.

10. LEAD CHROMATE DETERMINATION

- 10.1. Calculate the lead chromate pigment content according to ASTM D4797. X-ray fluorescence spectroscopy may also be used following the general requirements of ASTM D4764.

11. FLOWABILITY (PERCENT RESIDUE)

11.1. *Apparatus and Materials:*

- 11.1.1. Round, unlined steel 475-mL (1-pt) can with rim removed from inside the cans.
- 11.1.2. *Balance*, having sufficient capacity and conforming to M 231, Class G 1.
- 11.1.3. *Holder for cans*, allowing suspension of cans at a 45-degree angle with point contact.
- 11.1.4. *Electric hotplate*, capable of heating material to 218°C (425°F).
- 11.1.5. *Glass stem thermometer*, having a maximum temperature range of at least 218°C (450°F).

11.2. *Procedure:*

- 11.2.1. From the 3.8-L (1-gal) sample of molten thermoplastic material, weigh 400.0 ± 0.1 g of the material into the tared 475-mL can. This sample should be taken after the 4-h heating period has elapsed.
- 11.2.2. Using a glass stem thermometer as a stirring rod, place the sample onto a hotplate that has been set on the maximum temperature setting, and stir until the material reaches a temperature of $218 \pm 1^\circ\text{C}$ ($425 \pm 2^\circ\text{F}$). Avoid as much as possible splashing material on the inside of the can.
- 11.2.3. Remove the can from the hotplate and scrape the material from the thermometer on the rim of the can.
- 11.2.4. Immediately suspend the can at a 45-degree angle in a holder with point contact. Allow the material to flow over the rim where the thermometer was scraped until flow ceases.
- 11.2.5. Record the mass of each can plus residue.
- 11.2.6. Calculate the flowability (percent residue) as follows:

$$\text{Flowability (percent residue)} = \frac{(A - B) \times 100}{400} \quad (1)$$

where:

A = mass of can plus residue, and

B = mass of can.

Note 3—Precision and bias data are not available at this time for the flowability test.

12. LOW TEMPERATURE STRESS RESISTANCE

12.1. *Apparatus and Materials:*

- 12.1.1. *Concrete blocks*, 305 by 305 by 76 mm (12 by 12 by 3 in.), primed with primer recommended for use by the thermoplastic manufacturer.
- 12.1.2. 1.9-L (0.5-gal) cans with rims removed.
- 12.1.3. *Spatula*.
- 12.1.4. *Drawdown blade*, 10 cm (4 in.) by 125 mL.

- 12.1.5. *Cold box or freezer*, capable of maintaining a temperature of $-9.4 \pm 2.0^{\circ}\text{C}$ ($15 \pm 3.6^{\circ}\text{F}$) for 24 h.
- 12.2. *Procedure:*
- 12.2.1. Prepare sample in accordance with Section 4, Sample Meltdown and Preparation. Heat the drawdown blade at 218°C (425°F) for one-half hour.
- 12.2.2. After heating for 4 h at 218°C (425°F), quickly pour the thermoplastic into the heated drawdown blade and draw down a 10-cm (4-in.) wide line on the concrete block at room temperature.
- 12.2.3. When the test specimen has cooled to room temperature, place it in the cold box or freezer for 24 h at $-9.4 \pm 2.0^{\circ}\text{C}$ ($15 \pm 3.6^{\circ}\text{F}$).
- 12.2.4. At the end of 24 h, remove and immediately inspect the specimen for cracking. Inspect the specimen from a distance of 305 mm (12 in.) under diffuse lighting.
- 12.2.5. Any cracking shall constitute failure of the test.

13. BOND STRENGTH

- 13.1. Using material from the molten sample of thermoplastic after the 4-h heating period, prepare and test in accordance to ASTM D4796.

14. IMPACT RESISTANCE

- 14.1. *Apparatus and Materials:*
- 14.1.1. *Molds*, 25 by 25 by 150 mm (1 by 1 by 6 in.), for casting impact specimens.
- 14.1.2. Izod-type impact test apparatus with 0 to 2.82 J (0 to 25 in.-lb) scale.
- 14.2. *Procedure:*
- 14.2.1. Preheat the specimen molds for approximately 1 h at 218°C (425°F).
- 14.2.2. Using the 60-mL (2-oz) ladle, quickly fill the heated molds with the thermoplastic material. This material should be taken from the molten thermoplastic sample after the 4-h heating period.
- 14.2.3. After cooling, carefully disassemble the molds and remove the solidified material. Cut each sample into approximately 76-mm (3-in.) long sections.
- 14.2.4. Determine the impact resistance using the Izod-type impact apparatus following the procedures for use of this apparatus as outlined generally in ASTM D256, Method A. Do not use a notched specimen. Use the 0 to 2.82 J (0 to 25 in.-lb) scale with the appropriate load on the striker. Average the results of two or more breaks.

15. RING-AND-BALL SOFTENING POINT

- 15.1. *Apparatus and Materials:*
- 15.1.1. Ring-and-ball apparatus, refer to ASTM D36/D36M.

- 15.2. *Procedure:*
- 15.2.1. Perform the test according to ASTM D36/D36M. Using the 60-mL (2-oz) ladle, obtain a sample from the 4-h heated molten thermoplastic material and carefully fill the rings and level the surface to the top of the rings. Allow to cool and proceed.
- 15.2.2. Average the results of two or more tests.

16. SPECIFIC GRAVITY

- 16.1. Determine the specific gravity of the white and yellow materials according to ASTM D792, Method A. The sample shall be taken from the sample of molten thermoplastic material following the 4-h heating period.

17. FLOWABILITY (PERCENT RESIDUE) EXTENDED HEATING

- 17.1. *Apparatus and Materials:*
- 17.1.1. Round, unlined steel 475-mL (1-pt) can with rim removed from inside the cans.
- 17.1.2. *Balance*—The balance shall have sufficient capacity and conform to M 231, Class G 1.
- 17.1.3. *Holder for cans*, allowing suspension of cans at a 45-degree angle with point contact.
- 17.1.4. *Electric hotplate*, capable of heating material to 218°C (425°F).
- 17.1.5. *Glass stem thermometer*, having a maximum temperature range of at least 232°C (450°F).
- 17.2. *Procedure:*
- 17.2.1. From the initial 3.8-L (1-gal) sample melt, weigh 400.0 ± 0.1 g of material into the tared 475-mL (1-pt) can. This sample should be taken after the sample has been heated under constant agitation for a period of 8 h. The time required for meltdown and reaching the application temperature of 218°C (425°F) is included as part of the 8-h heating period.
- 17.2.2. Using the glass stem thermometer as a stirring rod, place the sample onto the hotplate that has been set on a temperature setting of high, and stir until the material reaches a temperature of $218 \pm 1^\circ\text{C}$ ($425 \pm 2^\circ\text{F}$). Avoid as much as possible splashing material on the inside of the can.
- 17.2.3. Remove the can from the hotplate and scrape the material from the thermometer rim of the can.
- 17.2.4. Immediately suspend the can at a 45-degree angle in a holder with point contact. Allow the material to flow over the rim where the thermometer was scraped until the flow ceases.
- 17.2.5. Record the mass of each can plus residue and calculate flowability (percent residue) as follows:

$$\text{flowability, extended heating} = \frac{(A - B) \times 100}{400} \quad (2)$$

where:

A = mass of can plus residue; and

B = mass of can.

Note 4—Precision and bias data are not available at this time for the extended heating flowability test.

18. ULTRAVIOLET LIGHT AND CONDENSATE EXPOSURE

18.1. Apparatus:

- 18.1.1. QUV Accelerated Weathering Tester, as described in ASTM G154.
 - 18.1.2. 7.5-by-15-cm (3-by-6-in.) aluminum Q panels, Type A or equivalent.
 - 18.1.3. 5-cm (2-in.) wide duct tape.
 - 18.1.4. Steel screed box with inside dimensions of 6 by 10 cm (2.5 by 4.0 in.) with a 6-mm (0.125-in.) opening across the entire length of one of the 6-cm (2.5-in.) sides.
 - 18.1.5. Oven, capable of maintaining 218°C (425°F).
 - 18.1.6. Masking tape, 1 cm ($\frac{1}{2}$ in.) wide.
- ### **18.2. Procedure:**
- 18.2.1. One-half hour before test, place a screed box in the 218°C (425°F) oven.
 - 18.2.2. Tape the 7.5-by-15-cm (3-by-6-in.) aluminum panel to the bench surface with masking tape to hold the panel firmly to the bench.
 - 18.2.3. Remove the screed box from the oven and position at the right angles to the 15-cm (6-in.) length of the aluminum panel and in the middle of the panel.
 - 18.2.4. With the 60-mL (2-oz) ladle, remove a sample from the molten thermoplastic sample and quickly draw down the sample across the aluminum panel.
 - 18.2.5. While hot, trim off excess plastic from the edge of the aluminum panel.
 - 18.2.6. When cool, wrap top and bottom edges of the plastic sample with duct tape to keep the sample in position on the aluminum panel. Lap the edges of the plastic with no more than 6 mm ($\frac{1}{4}$ in.) with duct tape.
 - 18.2.7. For the white thermoplastic, measure the color of the samples as outlined in Section 8, Reflectance, Color, and Yellowness Index.
 - 18.2.8. Expose the sample for 300 h in the QUV apparatus utilizing UVA-340 lamps. Set the QUV for cycles of 4 h of UV exposure at 60°C (140°F) and 4 h of condensate exposure at 40°C (104°F).
 - 18.2.9. Remove the samples from the QUV and allow them to dry at room temperature. Test the color as outlined in Section 8, Reflectance, Color, and Yellowness Index.

19. HARDNESS (ASTM D2240 TEST METHOD FOR RUBBER PROPERTY—DUROMETER HARDNESS)

19.1. Apparatus:

- 19.1.1. Shore Durometer Hardness Tester Type A-2 with attached weights so that the total weight of the unit is 2002 g.

- 19.1.2. Incubator oven with the glass inner door, capable of maintaining $46 \pm 1^{\circ}\text{C}$ ($115 \pm 2^{\circ}\text{F}$).
- 19.1.3. Stopwatch.
- 19.1.4. Aluminum disposable weighing dish, approximately 63 mm (2.5 in.) in diameter and 17.5 mm (0.7 in.) deep.
- 19.1.5. Mold release.
- 19.2. *Procedure:*
- 19.2.1. With the 60-mL (2-oz) ladle, fill the aluminum dish with hot thermoplastic material taken from the 3.8-L (1-gal) molten sample.
- 19.2.2. Allow the dish to cool to room temperature and strip the aluminum from the sample.
- 19.2.3. Place the sample on a metal 0.9-L (1-qt) can lid previously coated with mold release to prevent sticking and place in the 46°C (115°F) oven for 3 h. At the same time, place the durometer in the oven.
- 19.2.4. After 3 h, place the durometer on top of sample, immediately start stopwatch, and close inner glass door.
- 19.2.5. After 15 s contact, read durometer, open inner glass door, turn sample over, and repeat durometer reading.
- 19.2.6. Report the average of readings made on top and bottom of the sample.

20. FLASH POINT

- 20.1. Using a 60-mL (2-oz) ladle, remove a portion of the molten thermoplastic from the sample during the first hour of the heating period (after the entire sample becomes molten). Run the flash point as specified in ASTM D92.

21. KEYWORDS

- 21.1. Thermoplastic traffic line striping.