



Designation: D7942 – 15 (Reapproved 2023)

Standard Specification for Thermoplastic Pavement Markings in Non Snow Plow Areas¹

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1. Scope

1.1 This specification covers a reflectorized thermoplastic-based pavement striping material of the class that is applied to the road surface in a molten state by screed/extrusion or ribbon extrusion means. Retroreflectivity of the pavement marking compound is achieved initially by surface application of retroreflective optics at the time of pavement marking application. Upon cooling to normal pavement temperature, the pavement marking material produces an adherent reflectorized stripe of specified thickness and width capable of resisting deformation by traffic. The pavement marking compound includes retroreflective optics (glass beads or composite optics, or both) that are incorporated into the material at the time of manufacture that provide retroreflective properties during the service life of the material.

1.1.1 This specification is limited to:

1.1.1.1 Longitudinal applications in non snow plow areas,

1.1.1.2 Standard (non-profile) pavement marking applications, and

1.1.1.3 Applications on smooth asphalt or concrete surfaces. Asphalt seal coat applications, which use large aggregate resulting in a very rough, open grade finish, are excluded from this specification.

1.1.2 This specification includes:

1.1.2.1 Compositional and physical property requirements of the thermoplastic pavement marking material,

1.1.2.2 Requirements for the optics that are used to reflectorize the thermoplastic pavement marking material after application,

1.1.2.3 Field performance requirements for the installed thermoplastic pavement markings, and

1.1.2.4 Material application requirements.

1.2 The values stated in inch-pounds units are to be regarded as the standard except where noted in the document.

¹ This specification is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.38 on Highway Traffic Control Materials.

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The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D36/D36M Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)

D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester

D4960 Test Method for Evaluation of Color for Thermoplastic Pavement Marking Materials

D6628 Specification for Color of Pavement Marking Materials

D7307 Practice for Sampling of Thermoplastic Pavement Marking Materials

D7308 Practice for Sample Preparation of Thermoplastic Pavement Marking Materials

D7585/D7585M Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments

D7735 Test Method for Type A Durometer Hardness Testing of Thermoplastic Pavement Marking at Elevated Temperatures

E313 Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E1710 Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer

G155 Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

2.2 *AASHTO Standards*:³

AASHTO M 247 Standard Specification for Glass Beads Used in Traffic Paints

AASHTO T 250 Standard Method of Test for Thermoplastic Traffic Line Material

3. Terminology

3.1 Definitions:

3.1.1 *binder*—mixture of rosins, synthetic resins, waxes, polymers, and plasticizers that form the continuous phase in the pavement marking compound.

3.1.2 *pavement marking compound*—a homogeneous mixture of binder, fillers, extenders, pigments, and intermixed retroreflective optics.

3.1.3 *retroreflective optics*:

3.1.3.1 *glass beads*—spherical glass manufactured for use with pavement marking materials to provide retroreflective properties to the marking, allowing them to be visible when viewed at night under automobile headlights.

(1) *small glass beads*—also referred to as standard glass beads. This can refer to a number of products of various sizes, but as defined in this document it refers to a glass bead product meeting the requirements of AASHTO M 247 Type 1 or Type 2.

(2) *large glass beads*—these glass beads meet the requirements of AASHTO M 247 Type 3, Type 4, or Type 5 as called for in the specification.

(3) *high refractive index glass beads*—these glass beads typically meet the requirements of AASHTO M 247 Type 1 or Type 2 except the refractive index of the glass bead is between 1.90 and 1.95.

3.1.3.2 *composite optics*—a multi-component retroreflective particle comprised of a pigmented core (typically white or yellow) combined with very small glass or ceramic beads having a refractive index of between 1.90 and 2.4).

3.1.3.3 *non AASHTO glass beads*—a manufacturer may provide a product outside the requirements found under 3.1.3.1 in which case the performance requirements of this specification must still be met.

3.1.4 *thermoplastic pavement markings*—a pavement marking compound brought to a molten state by heating to the manufacturer's recommended temperature under agitation and then applied to the pavement while in the molten state. Retroreflective optics are applied (dropped on) to the surface of the molten marking immediately after application to provide initial retroreflectivity.

³ Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, <http://www.transportation.org>.

4. Classification

4.1 The thermoplastic pavement markings are classified into categories with specific retroreflectivity performance levels. See 9.6.

4.2 The annex contains application recommendations for typical installations to meet each performance class.

4.3 The thermoplastic pavement markings can be provided with a contrast marking process consisting of a black thermoplastic pavement marking that improves the visual marking contrast for daytime visibility.

5. Ordering Information

5.1 The purchaser must specify the pavement marking class when ordering. In addition the purchaser has the option of requiring a contrast marking application.

6. Materials and Manufacture

6.1 The thermoplastic material shall be available in white, yellow, and black.

6.2 The thermoplastic material shall be homogeneously composed of pigment, filler, resins, and optics.

6.3 *Glass Beads General Requirements*—Glass beads shall provide the marking with good night visibility without compromising day visibility and be of a composition designed to be highly resistant to traffic wear and to the effects of weathering.

6.4 *Intermix Glass Beads*—The glass beads shall conform to the requirements of AASHTO M 247 Type 1, Type 2, or Type 3 and shall be either uncoated or have an adhesion promoting coating.

6.5 *Drop-on Glass Beads*—The drop-on beads shall meet the requirements of AASHTO M 247 as required in this specification. When a double-drop application of glass beads is required, the larger beads shall be placed on the top surface of the thermoplastic first followed by the application of the smaller beads.

6.5.1 *Specific Properties*—The AASHTO M 247 Type 3, Type 4, and Type 5 glass beads used for drop-on beads shall have an adhesion promoting coating. AASHTO M 247 Type 1 and Type 2 glass spheres used for drop-on beads shall have a coating which will provide enhanced adhesion, moisture resistance, and proper embedment in the pavement marking.

6.6 *Composite Optics*—The composite optics shall be provided according to the manufacturer's specifications.

6.7 The thermoplastic material shall not deteriorate on contact with sodium chloride, calcium chloride or other de-icing chemicals or because of oil content of paving materials or oil droppings.

6.8 *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.

6.9 *Set Time*—When applied at a temperature range of 412 ± 12 °F (211 ± 7 °C) and thickness of up to 0.125 in. (4.736 mm) the material shall set to bear traffic in not more

than 2 min when the air temperature is $50 \pm 3^\circ\text{F}$ ($10 \pm 2^\circ\text{C}$) and not more than 10 min when the air temperature is $90 \pm 3^\circ\text{F}$ ($32 \pm 2^\circ\text{C}$).

6.10 *Storage Life*—Thermoplastic material furnished in granular and block form shall meet the above requirements for a minimum period of one year. The thermoplastic must melt uniformly with no evidence of skins or unmelted particles during this one year period. Material not meeting the above requirements shall be replaced by the manufacturer.

7. Chemical Composition

7.1 *Composition of the Thermoplastic Pavement Marking Material (percent by weight)*—See Table 1.

8. Physical Properties

8.1 *Laboratory Properties:*

8.1.1 *Color*—The thermoplastic materials after heating for $4\text{ h} \pm 5\text{ min}$ at $425 \pm 3^\circ\text{F}$ ($218 \pm 2^\circ\text{C}$) under agitation shall meet the following requirements when tested according to Test Method D4960 using a CIE 2 degree standard observer and standard illuminant D65. Yellowness index shall be calculated according to Practice E313.

8.1.1.1 *White:*

- (a) Daylight Reflectance at $45^\circ/0^\circ$: 75 % minimum
- (b) Yellowness Index at $45^\circ/0^\circ$: 12 maximum

8.1.1.2 *Yellow:*

- (a) Daylight reflectance at $45^\circ/0^\circ$: 42 to 56 %
- (b) The initial daytime CIE chromaticity for yellow materials without drop-on retroreflective optics shall fall within the following coordinates:

Initial Yellow Daytime Chromaticity Coordinates (Corner Points)				
	1	2	3	4
x	0.490	0.560	0.460	0.420
y	0.510	0.440	0.400	0.440

(c) *Color Stability after Accelerated Weathering* ASTM Designation: Practice G155, Table X3.1 Cycle I, 1500 h exposure time. Prepare sample by dipping a sheet aluminum panel into the molten thermoplastic and removing it to obtain a 0.06 to 0.120 in. (1.5 to 3 mm) coating thickness of thermoplastic on the panel. Place the panel in the weathering apparatus for 1500 h. After accelerated weathering, measure the Yellow Color or Yellowness Index. Material shall meet the color stability requirements below after this exposure. This

TABLE 1 Composition of the Thermoplastic Pavement Marking Material (percent by weight)

Component	White	Yellow	Black
Binder ^B	20.0 min.	20.0 min.	20.0 min.
Intermix Retroreflective Optics ^C	40.0 min.	40.0 min.	—
Titanium Dioxide (ASTM Type II)	10.0 min.	—	—
Yellow and Black Pigments	—	A	A

^A Amount of yellow and black pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing all other requirements of this specification are met. The thermoplastic material shall comply with all applicable Federal requirements found in RCRA (Resource Conservation and Recovery Act).

^B The binder shall consist of a mixture of synthetic resins, polymers, and plasticizers. The purchaser shall have the option of requiring the binder system to be either an alkyd or a hydrocarbon based system.

^C The retroreflective optics shall consist of glass beads, composite optics or a combination thereof.

requirement is not intended to be predictive of the three to five year service life of the marking but can be used as a screening tool to identify materials that will fail.

White – Yellowness Index – 20 Maximum

Yellow Daytime Chromaticity Coordinates (after accelerated weathering)				
	1	2	3	4
x	0.490	0.560	0.460	0.420
y	0.510	0.440	0.400	0.440

8.1.2 *Cracking Resistance at Low Temperature*—The material shall show no cracks when tested in accordance to AASHTO T 250.

8.1.3 *Softening Point*—After heating the thermoplastic material for $4\text{ h} \pm 5\text{ min}$ at $425 \pm 3^\circ\text{F}$ ($218 \pm 2^\circ\text{C}$) and testing in accordance with Test Method D36/D36M, the materials shall have a softening point of $215 \pm 15^\circ\text{F}$ ($102.5 \pm 9.5^\circ\text{C}$).

8.1.4 *Indentation Resistance*—The hardness shall be between 40 and 75 units after 15 s when tested in accordance to Test Method D7735. The durometer and the sample shall be maintained at 115°F (46°C).

8.1.5 *Flash Point*—The thermoplastic material shall have a flash point of no less than 500°F (260°C) when tested in accordance with Test Method D92 COC.

9. Performance Requirements

9.1 Installed pavement markings shall meet the following service life requirements:

Traffic Volume (AADT) ^A	Minimum Years of Service Life
<5000	5
5000–15 000	4
15 000–25 000	3
>25 000	<3

^A AADT is defined as the annual average daily traffic count per traffic lane.

9.2 The service life of the installed markings shall be defined by the following field performance criteria:

9.3 *Daytime Color (during service life)*—The markings shall meet the requirements of Specification D6628 with the exception of “Y” (reflectance).

9.4 *Nighttime Color (during service life)*—The markings shall meet the requirements of Specification D6628.

9.5 *Durability*—Defined as no more than 10 % loss (visible daytime road presence) in any 1000 ft section of continuous or broken pavement markings. Any markings installed less than 6 in. from a construction joint are not covered in this specification.

9.6 *Retroreflectivity (180 days)*—The minimum dry retroreflectivity of the markings when tested 180 days or less after installation shall be as follows when tested according to Test Method E1710:

Dry Retroreflectivity (Test Method E1710) ^A	Class 1	Class 2	Class 3
White (mcd/m ² /lux)	300	450	800
Yellow (mcd/m ² /lux)	200	350	525

^A The values presented for the coefficient of retroreflected luminance (R_L) are presented in SI units, which are the accepted worldwide norm for expressing this value, rather than in inch-pound.

9.7 *Retroreflectivity (retained)*—The minimum dry retroreflectivity of the markings of all classes when tested from 181

days after installation through the end of service life of the markings shall be as follows when tested according to Test Method **E1710**:

White: 150 mcd/m²/lux

Yellow: 125 mcd/m²/lux

NOTE 1—The values presented for the coefficient of retroreflected luminance (R_L) are presented in SI units, which are the accepted worldwide norm for expressing this value, rather than in inch-pound.

9.8 In considering compliance to the performance requirements of this specification any area where the markings are tracked, contaminated by foreign material, damaged by unusual traffic patterns or natural or man-made disasters shall be excluded.

10. Installation Requirements

10.1 *Pavement Surface Requirements*—The pavement surface shall be new or meet the requirements of **A1.3** prior to thermoplastic application, or both. This specification does not cover recoating (capping) over old thermoplastic (refurbishing).

10.2 *Application Thickness*—The pavement marking materials shall be applied at a minimum thickness of 100 mils as measured above the plane of the pavement surface and shall discount the presence of the drop-on optics.

10.3 *Application Method*—The markings shall be applied by either extrude or ribbon extrude method.

10.4 *Application Temperatures*:

10.4.1 The thermoplastic material shall be applied at a minimum temperature of 400 °F (205 °C) and shall not exceed the manufacturer's recommended maximum temperature. For any deviation of this guideline (upper or lower end of the material temperature) the manufacturer should be contacted for review and approval of said deviation in order to prevent potential bonding or applications issues.

10.4.2 *Pavement and Ambient Temperatures*—The minimum ambient and pavement surface temperatures shall be 55 °F (12.8 °C) and rising for standard extrusion application and 60 °F (15.5 °C) and rising for ribbon extrusion application.

10.5 *Drop-on Optics*—The application of the drop-on optics shall be according to the pavement marking manufacturer's recommendation and shall result in installed markings that achieve the retroreflective performance requirements of this specification.

NOTE 2—Refer to **X1.1** of the appendix for typical optics applications that will yield acceptable retroreflectivity performance for each class of pavement markings identified in this specification.

10.6 *Other Installation Requirements*—For additional installation requirements refer to the annex of this document.

11. Other Requirements

11.1 The performance requirements of this specification are void if product failure occurs due to unusual or unanticipated

conditions beyond the control of the material manufacturer including, but not limited to: failure of the road surface, unusual road or traffic conditions, snowplow blade damage, studded tires, or other external forces not characteristic of normal traffic wear, and unusually severe weather, floods, or other acts of God.

11.2 Application requirements pertaining to this specification can be found in the annex.

12. Dimensions, Mass, and Permissible Variations

12.1 All markings shall be applied to the dimensions as called for in the project drawings and specifications and any variation shall be within the permissible tolerance set forth in said specifications.

12.2 The contractor who applies the markings has total responsibility of this portion of the specification and shall provide any corrective action as required by the terms of the project specification.

13. Workmanship, Finish, and Appearance

13.1 The markings shall meet the requirements for workmanship and appearance as set forth in the specific project plans of the purchasing party. The contractor who applies the markings has total responsibility for these requirements and shall provide any corrective action as required in order to meet the terms of the project specification.

14. Sampling and Sample Preparation

14.1 *For Laboratory Testing of Composition and Physical Properties*—The thermoplastic material shall be sampled according to Practice **D7307** and the samples shall be prepared for testing according to Practice **D7308**.

14.2 *For Field Testing*:

14.2.1 *Retroreflectivity*—The markings shall be tested according to the sampling and testing protocol set forth in Practice **D7585/D7585M**.

14.2.2 *Color (Daytime and Nighttime)*—The markings shall be tested according to the sampling and testing protocol set forth in Practice **D7585/D7585M**.

14.2.3 *Durability*—The markings shall be evaluated in a visual drive through during daytime conditions. Evaluations shall be conducted in approximately 1000 ft segments. Areas of failure are not to be noted if the failure occurs due to unusual or unanticipated conditions beyond the control of the material manufacturer including, but not limited to: failure of the road surface, unusual road or traffic conditions, snowplow blade damage, studded tires, or other external forces not characteristic of normal traffic wear, and unusually severe weather, floods, or other acts of God.

15. Number of Tests and Retests

15.1 Testing shall be done according to the applicable referenced standard.