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Standard Guide for Selection of Tests for Traffic Paints[1]

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1. Scope

1.1 This guide covers the selection and use of procedures for testing traffic paints in the laboratory and in the field.

1.2 This guide covers the testing of ready-mixed solvent base and waterborne paint products of sprayable consistency that shall be suitable for use as a reflecting traffic guide on paved roadways.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C219 Terminology Relating to Hydraulic Cement
D8 Terminology Relating to Materials for Roads and Pavements
D16 Terminology for Paint, Related Coatings, Materials, and Applications
D154 Guide for Testing Varnishes
D185 Test Methods for Coarse Particles in Pigments
D522/D522M Test Methods for Mandrel Bend Test of Attached Organic Coatings
D562 Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
D711 Test Method for No-Pick-Up Time of Traffic Paint
D713 Practice for Conducting Road Service Tests on Fluid Traffic Marking Materials
D868 Practice for Determination of Degree of Bleeding of Traffic Paint
D869 Test Method for Evaluating Degree of Settling of Paint
D870 Practice for Testing Water Resistance of Coatings Using Water Immersion
D913 Practice for Evaluating Degree of Traffic Marking Line Wear
D1210 Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage
D1309 Test Method for Settling Properties of Traffic Paints During Storage
D1475 Test Method For Density of Liquid Coatings, Inks, and Related Products
D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
D2244 Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
D2369 Test Method for Volatile Content of Coatings
D2371 Test Method for Pigment Content of Solvent-Reducible Paints
D2372 Practice for Separation of Vehicle From Solvent-Reducible Paints
D2698 Test Method for Determination of the Pigment Content of Solvent-Reducible Paints by High-Speed Centrifuging
D2805 Test Method for Hiding Power of Paints by Reflectometry
D3723 Test Method for Pigment Content of Water-Emulsion Paints by Low-Temperature Ashing
D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
D6628 Specification for Color of Pavement Marking Materials
D7377 Practice for Evaluating the Water Wash-Off Resistance of Traffic Paints using a Water Faucet
D7538 Practice for Evaluating the Water Wash-Off Resistance of Traffic Paints Using an Atomizing Spray Device
E179 Guide for Selection of Geometric Conditions for Measurement of Reflection and Transmission Properties of Materials
E308 Practice for Computing the Colors of Objects by Using the CIE System

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[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.

E1164 Practice for Obtaining Spectrometric Data for Object-Color Evaluation
E1347 Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry
E1349 Test Method for Reflectance Factor and Color by Spectrophotometry Using Bidirectional (45°:0° or 0°:45°) Geometry
E1710 Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
E2367 Test Method for Measurement of Nighttime Chromaticity of Pavement Marking Materials Using a Portable Retroreflection Colorimeter

3. Terminology

3.1 *Definitions*—For definitions used in this guide, refer to Terminology C219, D8, and D16.

3.2 *retroreflective optics, n*—a particle 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.

3.2.1 *composite optics, n*—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.)

3.2.2 *glass beads, n*—round spheres manufactured from glass of a specific refractive index and size distribution.

4. Summary of Guide

4.1 This guide consists of the following tests that, although not exhaustive, cover the areas normally of concern in traffic paint testing:

	Sections
Liquid Paint Properties	6 through 11
Application and Appearance Properties	12 through 17
Properties of the Dried Film	18 through 20
Analysis of Paint	21 through 24
Field Evaluations	25 through 29
Field Sampling	30

5. Conditions Affecting Traffic Paint

5.1 Practical requirements for traffic paint may vary with:

5.1.1 Substrate type, such as portland cement and asphaltic concretes, and the various coarse aggregates used therein.

5.1.2 Climatic conditions, both generally and specifically, at the time of paint application.

5.1.3 Service density, such as heavy traffic areas in cities versus lightly traveled rural highways and parking lots.

5.1.4 Traffic type, whether light passenger cars or heavy trucks and airplanes.

5.1.5 Presence of foreign matter on the road surface, such as oil, old paint, skid marks, sand, salt, concrete curing compound, etc.

5.2 New portland cement concrete surfaces have a greater degree of moisture and alkalinity than older surfaces and thereby adversely affect paint adhesion. Paint adhesion is also affected by the ratio of cement to fine aggregate, coarse aggregate, and mixing water, as well as by the surface character of the aggregate that can range from impervious smooth quartz to irregular, porous slag.

LIQUID PAINT PROPERTIES

6. Skinning

6.1 Paints containing a binder that dries by oxidation are subject to skin formation in a partially filled can or by diffusion of air into a filled can. Since skins are insoluble in the paint they must be removed before use. The referenced test employs a partially filled container to indicate the tendency of a paint to skin. A typical minimum time for skinning is 18 to 24 h.

6.2 Examine the original sample for skins both on the surface and in the mass. Using a well-mixed, skin-free portion of the sample, perform a skinning test in accordance with Guide D154, except use a 0.5-L (1-pt) friction-top can instead of a 0.25-L (8-oz) jar.

7. Coarse Particles

7.1 Paints must be free of oversize particles and foreign matter to avoid clogging application equipment, a typical maximum being 1 % by weight of total paint. The referenced test with a 325-mesh (45-μm) screen gives the percent of this material in the paint.

7.2 Determine coarse particles in accordance with Test Methods D185.

NOTE 1—This test is not used for traffic paint containing pre-mixed retroreflective optics.

8. Fineness of Dispersion

8.1 A key aspect of the pigment dispersion process in paint is fineness of grind, which can be measured by drawing the paint sample down a calibrated, tapered groove in a hardened steel block with the groove varying in depth from 4 to 0 mils (100 to 0 μm). The point at which continuous groupings of particles or agglomerates, or both, protrude through the surface of the liquid is taken as the fineness reading. Lower readings in mils or micrometres or higher reading in Hegman units indicate better fineness of dispersion.

8.2 Fineness of grind is not generally specified for traffic paint but some application equipment may require a limit of 1 to 2 Hegman units (3 to 3.5 mils, 75 to 90 μm). If additional assurance is needed that the paint will not clog application equipment, determine the fineness in accordance with Test Method D1210. When testing solvent based paint it may be necessary to reduce the traffic paint with mineral spirits, or compatible solvent with a similar evaporation rate, to keep the film wet long enough to determine the end point more easily. When a premix traffic paint is being tested, conduct the test on the paint before addition of the beads.

9. Density or Weight per Gallon

9.1 Density as measured by weight per unit volume is not a performance characteristic but is used to check product uniformity from batch to batch. A calibrated weight per gallon cup is used.

9.2 For an unbeaded paint, determine the density in accordance with Test Method D1475.

9.3 For beaded paints, use a special weight-per-gallon cup[3] having a modified cap so that the beads do not interfere with a snug fit of the cap to the cup. Proceed in accordance with Test Method D1475.

9.4 Traffic paints are viscous and known to entrap air giving erroneous low values. Air may be visible as bubbles or too finely dispersed to be seen. The Appendix XI to Test Method D1475 provides a practice of diluting of a material to improve air release. This method is widely used on waterborne paints where equal amounts of water and paint are mixed. The density split mixture is measured and density of the paint calculated using Eq X1.1.

10. Consistency

10.1 Paints of a given type should fall within a stated consistency range as agreed upon between the purchaser and the seller. Consistency is used mainly to ensure product uniformity. Improper consistency, however, can adversely affect application properties, and in turn, paint performance.

10.2 Determine consistency using the Stormer viscometer in accordance with Test Method D562. If the requirement is in Krebs units, Table 1 of Test Method D562 permits changing seconds to KU. Method B (Digital Display Stormer-Type Viscometer) is the preferred method.

11. Package Stability

11.1 Since paints are not normally used immediately after manufacture, they must remain stable in the can for some time, which for traffic paints does not generally exceed 6 months. Although package stability can usually be determined by alternatively heating and cooling a specimen, occasionally the results do not coincide with storage at normal temperature. The referenced methods determine the degree of pigment settling after 2 weeks cycling or after 6 months storage at room temperature. These are usually sufficient as it is difficult to rate numerically the ease of redispersing an aged traffic paint.

11.2 Determine the degree of pigment settling in the accelerated test in accordance with Test Method D1309. Determine the degree of pigment settling and ease of remixing a shelf-aged specimen in accordance with Test Method D869.

APPLICATION AND APPEARANCE PROPERTIES

12. Drying Time

12.1 The drying time of a traffic paint is particularly important because it determines how quickly a lane can be opened to free flow of traffic without the paint being transferred to adjacent pavement.

12.2 No-pick-up time as determined by Test Method D711 is typically used as a quality control test for dry time. While this method does not predict actual drying time during field application, it has been found the Test Method D711 testing accurately predicts trends in most cases. Controlling both humidity and air flow is critical for accurate test results.

13. Bleeding

13.1 Bleeding refers to the passage of colored matter such as bitumen from an asphalt pavement through the traffic paint film. It is a function of the age of the asphalt, its compatibility with the paint, and the speed of drying of the paint. Determine bleeding in accordance with Practice D868.

14. Hiding Power

14.1 Hiding power or opacity is a measure of the ability of a paint to hide the substrate. It varies, naturally, with the thickness of the applied film that may be influenced by the flow and application properties of the paint.

14.2 Determine the dry hiding power of traffic paints in accordance with Test Method D2805.

15. Color and Color Difference

15.1 The color of a paint may be determined precisely by means of a spectrophotometer. However, the exact color is not usually as important as how closely a paint matches a standard. Color difference between a product and a standard can be determined visually or with a suitable instrument. Visual comparison of color is fast and often acceptable although numerical values are not obtained. Spectrophotometers provide numerical values that can be subsequently compared to later measurements.

15.2 If required, determine the color in terms of tristimulus values or chromaticity coordinates in accordance with Practice E308.

15.3 Determine color difference by visual comparison against standard color chips[4] in accordance with Practice D1729. This practice covers the spectral photometric, and geometric characteristics of light source, illuminating and viewing conditions, size of specimens, and general procedures to be used in the visual evaluation of color differences of opaque materials.

15.4 Determine color difference instrumentally in accordance with Practice D2244. The method covers the instrumental measurement of small color differences observable in daylight illumination between nonfluorescent, nonmetameric, opaque surfaces. The instrument used shall conform to all requirements of Guide E179, Practice E1164, Test Method E1347, Test Method E1349, and Practice E308 (bidirectional 45°:0°, capable of reporting data for the CIE D65/2°, D6510°, or C/2° illuminant/observer conditions).

16. Reflectance

16.1 Reflectance is a measure of the light reflected from the surface of a paint. It determines which of two specimens

[3] The sole source of supply of the satisfactory modified cup known to the committee at this time is BYK Additives and Instruments, 9104 Guilford Rd., Columbia, MD 21046. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

[4] The sole source of supply of the standard yellow color chips known to the committee at this time is www.fed-std-595.com/FS-595-Paint-Spec.html. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

appears lighter when viewed in average daylight at an angle that eliminates gloss effects.

16.2 Determine the reflectance in accordance with Test Method E1349.

17. Night Visibility or Retroreflectance of Beaded Paints at Low Angles

17.1 This property is important to traffic paint but visibility at night is not related to daylight reflectance. The retroreflectance evaluation of test panels coated with traffic paint and retroreflective optics applied to the surface of the paint should be in accordance with Test Method E1710.

PROPERTIES OF THE DRIED FILM

18. Resistance to Wear

18.1 Resistance to wear is a measure of the ability of the dried film to withstand wear from traffic and from objects rolled or pulled across the surface.

18.2 Using unbeaded traffic paint, determine the abrasion resistance in accordance with Test Method D4060. The thickness of the paint film being tested, the conditions (time, temperature, etc.) under which the paint film is subjected prior to testing, and the testing conditions (wheel type, weight, and number of test cycles) should be agreed upon between the purchaser and the paint supplier.

19. Flexibility

19.1 Elongation is a measure of the flexibility of a paint film. Traffic paints may have difficulty in meeting the referenced test if they are over-pigmented to obtain high reflectance.

19.2 Using unbeaded traffic paint, determine the flexibility in accordance with Test Methods D522/D522M but using 30-gage (0.32-mm) tin plate in place of the specified steel panel.

19.2.1 As the thickness and curing conditions are not specified in Test Methods D522/D522M, one of the following alternatives should be used for testing solvent borne traffic paint:

19.2.1.1 Apply a 380-µm (15-mil) wet film, allow to air dry 18 h, bake 2 h at 50°C, and let cool before conducting the test with a 12.7-mm (½-in.) mandrel.

19.2.1.2 Apply a 250-µm (10-mil) wet film, allow to air dry 24 h, bake 1 h at 65°C, cool, and use a 6.4-mm (¼-in.) mandrel.

19.2.1.3 Apply a 150-µm (6-mil) wet film, bake 6 h at 100°C, cool, and use a 6.4-mm (¼-in.) mandrel. For waterborne traffic paint apply a 380-µm (15-mil) wet film and allow 48 h to cure at room temperature before conducting the test and use a 12.7-mm (½-in.) mandrel.

20. Water Resistance

20.1 *Water Resistance of Cured Paint Film*—This property is important to traffic paints because they are frequently exposed to rain or condensation on bridges. The immersion test time is quite short in relation to actual exposure so that the test detects only paints with poor water resistance.

20.1.1 Using unbeaded paint, determine water resistance in accordance with Practice D870.

20.1.2 The following should be used for testing traffic paint: apply a 130-µm (5-mil) wet film to a clean glass panel, allow to air dry for 72 h, immerse in reagent water for 24 h, and allow a recovery period of 2 h before examining.

20.2 *Water Resistance of Semi-cured Paint Film*—This property is important to traffic paint because they are frequently exposed to rain or high humidity conditions shortly after application, before the paint film has completely cured.

20.2.1 Using unbeaded paint, determine the water resistance in accordance with either Practice D7377 or D7538.

ANALYSIS OF PAINT

21. Chemical Analysis

21.1 If a specification requires certain raw materials or certain components in a given amount, then chemical analysis is necessary to determine whether the specified materials are present in the required amounts. Analysis does not necessarily establish paint quality that can also be greatly affected by manufacturing techniques. Select test procedures from ASTM methods that are pertinent to the components of traffic paints.

NOTE 2—No single schematic analysis is comprehensive enough to cover the wide variety of traffic paint compositions.

22. Nonvolatile Content (Paint)

22.1 The percent nonvolatile matter indicates the total amount of material remaining after the solvent evaporates and is a measure of the film solids. This includes both the binder and pigment solids portion of the paint sample. Determine the nonvolatile content in accordance with Test Method D2369 using a larger specimen size in the case of beaded paint.

23. Pigment Content

23.1 Pigment gives paint its hiding and color and influences many other properties. Determine the percent pigment in accordance with Test Method D2371, D2698, or D3723.

24. Nonvolatile Vehicle Content (NVV or Vehicle Solids)

24.1 The nonvolatile vehicle is that portion of the film-forming solids in a paint other than the pigment. It is not to be confused with the total nonvolatile portion of the paint as defined in Section 22. The nonvolatile vehicle content is normally referenced as either the percent NVV of the total paint sample or the percent NVV of the vehicle content of the paint sample. The calculation for the determination of NVV varies depending on the referenced value as follows:

NVV as a percentage of the total paint:

$$\%\ NVV = \%\ Nonvolatile\ Content - \%\ Pigment\ Content$$

NVV as percentage of the total vehicle:

$$\%\ NVV = (\%\ Nonvolatile\ Content - \%\ Pigment\ Content)/(100 - \%\ Pigment\ Content)$$

If desired, separate the vehicle for further analysis in accordance with Practice D2372.

FIELD EVALUATIONS

25. Road Service Test

25.1 Whereas numerous laboratory tests in the previous sections indicate general suitability of traffic paint, and also batch-to-batch uniformity, these tests cannot predict performance under all possible end uses. Accordingly, the test paint should be applied in a repeatable manner under carefully stated conditions of end use and then tested, observed, and evaluated at stated times throughout the useful life of the paint.

25.2 It is very important that the markings being evaluated are *clean and dry*. There are many forms of contamination on a roadway that will lower the retroreflectivity readings of a marking, but not all of them can be removed. Asphalt oil and rubber skid marks are examples. Loose dirt can be removed by pressure washing, perhaps using soap, brushing or high-pressure air, however, these techniques are usually insufficient to remove dirt that is packed into the marking surface. Care should be taken to select areas that are *typical* of the marking section, avoiding areas of paint tracking or contamination, for example. It may be useful to take photographs using a digital camera and a good macro lens to be able to see the contamination condition of the markings.

25.3 Proceed in accordance with Practice D713, being careful to record the value of each variable stated.

26. Retroreflectance

26.1 Retroreflectance of the pavement marking relates to the visibility of the markings in night time conditions, which is an important performance characteristic. This property is achieved through the interaction of retroreflective optics that are applied to the surface of the pavement marking paint at the time of application and the composition of the pavement marking paint. The degree of visibility of the markings is a function of how much light from a vehicle's headlight is retroreflected back to the eye of the driver. Quantitative measurements of retroreflectivity can be achieved by use of a hand held retroreflectometer. Readings should be taken after paint has dried and any loose retroreflective optics removed from the surface of the marking. It is important to obtain readings from an adequate sample population in determining if the retroreflectivity of the markings meet the standard requirements.

26.2 Evaluate the retroreflectance of the markings using a 30 meter CEN geometry portable retroreflectometer in accordance with Test Method E1710. The retroreflectometer shall be oriented to face the direction of application when taking the reading. Results shall be reported in millicandelas per square meter per lux.

27. Durability

27.1 The test line rating is based on the paint film remaining at the time of inspection when estimated by close observation with the unaided eye. The rating is on the scale from 0 to 10, the latter representing 100 % remaining, a rating of 9 representing 90 % remaining, etc.

27.2 Determine resistance to wear in accordance with Practice D913.

28. Appearance

28.1 This is the complete impression conveyed when the test stripe is viewed at a distance of at least 3 m (10 ft). Any discoloration of the surface due to bleeding, dirt collection, darkening, fading, mold growth, etc. will affect the rating that is rated as either acceptable or unacceptable.

29. Color

29.1 Daytime Color:

29.1.1 This refers to the color of the installed paint marking, with drop on retroreflective optics applied to the surface, as quantified under standard simulated daytime conditions using a spectrophotometer.

29.1.2 Take readings with a spectrophotometer in accordance with Specification D6628. The readings shall be taken in Y, x, y CIE coordinates with a 2 degree observer using a D65 illuminant.

29.2 Night Time Color:

29.2.1 This refers to the retroreflected color of the installed paint marking, with drop on retroreflective optics applied to the surface, as quantified under simulated night time conditions using a portable reflection colorimeter. The results would relate to the color a person would see as the result of viewing the markings under lighting from a motor vehicle's headlights.

29.2.2 Take readings with a portable reflection colorimeter in accordance with Test Method E2367. The readings shall be taken in x, y CIE coordinates.

FIELD SAMPLING

30. Sampling Precautions

30.1 Like most other types of liquid paints, traffic paints are very uniform when first made in production and also initially in the storage containers when shipped out into the field for striping. The paints can be very stable and homogenous for weeks or months. However, depending on a paint formulation's inherent stability, the paint's viscosity, it's storage environment (internal and external), and time in storage, traffic paint in a container may change composition from top to bottom over time. The change in paint uniformity within a container is often simply due to the effect of gravity resulting in the gradual downward settling or sedimentation of the more dense pigment and/or migration of lower density continuous or disperse phase components upward toward the surface. Pigment settling is minimized in the production of traffic paint with a sufficient grind (reduction of pigment particle size), proper stabilization (with optimized dispersants and surfactants) and also by increasing the viscosity of the paint to within specification with a thickener. An eventual non-homogeneous composition of paint within a container is often a vertical gradient distribution of pigment with a corresponding gradient change in solids content (lower at the top and higher at bottom of the container). Over time, this can produce soft settling at the bottom of the container, or in more extreme cases, hard settling (compaction) may occur. Sometimes the continuous phase components (solvents or water) being of lower density can migrate upward toward the surface of the container eventually resulting in a clear liquid separation at the top (syneresis). Another contributor to non-uniformity of waterborne traffic paint in a container is the common practice of post adding a small "water float" on top of the paint after filling to prevent skinning. Paint in containers exposed to extreme heat, to long periods of elevated temperature, or to one or more freeze-thaw cycles may have accelerated compositional changes.

30.2 It is important that the samples taken are "representative" (have a composition reflecting the overall composition in the container). Thorough mixing of a paint container prior to sampling is a preferred practice, and if complete mixing can be verified, a sample taken by most any type of sampling device after mixing should provide a representative sample. However, mixing may not always be practical or even possible in a field environment. When mixing is not an option, or when thoroughness of mixing is suspect or cannot be verified, an alternative preferred practice is to obtain a sample using a liquid tube sampling device that has the ability to capture a top-to-bottom core of paint from the container.

31. Keywords

31.1 coatings; paints; traffic paint