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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Specification for Artists' Oil, Resin-Oil, and Alkyd Paints[1]

This standard is issued under the fixed designation D 4302; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification establishes requirements for composition, physical properties, performance, and labeling of artists' oil, resin-oil, and alkyd paints.

1.2 This specification covers pigments, vehicles, and additives. Requirements are included for pigment identification, lightfastness, consistency, and drying time.

1.3 Table 1 lists some pigments meeting the lightfastness requirements in this specification. In order to identify other pigments that meet these requirements, instructions are given for test specimen preparation. Test methods for determining relative lightfastness are referenced.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 This pertains only to the test method found in Section 8. *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:*

D 79 Specification for Zinc Oxide Pigments[2]
D 185 Test Methods for Coarse Particles in Pigments, Pastes, and Paints[2]
D 387 Test Method for Color and Strength of Color Pigments with a Mechanical Muller[3]
D 476 Specification for Titanium Dioxide Pigments[2]
D 602 Specification for Barium Sulfate Pigments[2]
D 1133 Test Method for Kauri-Butanol Value of Hydrocarbon Solvents[4]
D 1210 Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman–Type Gage[3]
D 1640 Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature[3]
D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials[3]
D 2244 Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates[3]
D 2245 Test Method for Identification of Oils and Oil Acids in Solvent-Reducible Paints[3]
D 2369 Test Method for Volatile Content of Coatings[3]
D 2689 Practices for Testing Alkyd Resins[2]
D 4236 Practice for Labeling Art Materials for Chronic Health Hazards[5]
D 4303 Test Methods for Lightfastness of Pigments Used in Artists' Paints[5]
D 4838 Test Method for Determining the Relative Tinting Strength of Chromatic Paints[5]
D 4941 Practice for Preparing Drawdowns of Artists' Paste Paints[5]
E 284 Terminology of Appearance[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *Colour Index Name*—consists of the category (type of dye or pigment), general hue, and an assigned number given to a colorant in the Colour Index[6] as an international identification system.

3.1.1.1 *Discussion*—For example, the Colour Index Name of one phthalocyanine blue pigment is Pigment Blue 15 (PB 15).

3.1.2 *Colour Index Number*—a five-digit number given in the Colour Index that describes the chemical constitution of a colorant.

3.1.2.1 *Discussion*—For example, the Colour Index Number of one phthalocyanine blue pigment is 74160.

3.1.3 Refer to Terminology E 284 for appearance terms used in this specification.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *alkali refined oil*—triglyceride oil of vegetable origin that has been treated with alkali to reduce the free acidity by formation of water-soluble salts, subsequently removed by washing.

3.2.1.1 *Discussion*—An appreciable degree of free acidity may cause a greater development of yellowing in a dried film

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[1] This specification is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.57 on Artist Paints and Related Materials.

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[2] *Annual Book of ASTM Standards*, Vol 06.03.

[3] *Annual Book of ASTM Standards*, Vol 06.01.

[4] *Annual Book of ASTM Standards*, Vol 06.04.

[5] *Annual Book of ASTM Standards*, Vol 06.02.

[6] *Colour Index*, 3rd ed., 5 Vols and Revisions, The Society of Dyers and Colourists, London, 1971–75. Available from the American Association of Textile Chemists and Colorists, P. O. Box 12215, Research Triangle Park, NC 27709.

of oil. Most artists' oil paints are ground in alkali refined oil.

3.2.2 *alkyd paint*—paint containing a resin produced by combining a polybasic acid, a polyhydric alcohol, and the fatty acid of a drying vegetable oil. For this specification, the resin produced must be soluble in mineral spirits or turpentine.

3.2.3 *drier (siccative)*—a substance, usually an organometallic compound, that accelerates the rate of drying of an oil paint or oil medium.

3.2.4 *oil paint*—paint containing an alkali refined triglyceride drying oil of vegetable origin.

3.2.5 *resin-oil paint*—paint containing 90 weight % minimum of vehicle solids, vegetable drying oil, and 10 weight % maximum of vehicle solids replaced by gum or resin.

4. Significance and Use

4.1 This specification establishes quality requirements and provides a basis for common understanding among producers, distributors, and users.

4.2 It is not intended that all paints meeting the requirements be identical nor of uniform excellence in all respects. Variations in manufacture, not covered by this specification, may cause some artists to prefer one brand over another, either of which may be acceptable under this specification.

5. Labeling Requirements

5.1 *Pigment(s) Identification*:

5.1.1 Every label shall include for each pigment contained in the paint (*1*) the information underlined in Table 1 (which includes the Common Name, Colour Index Name, and any additional terms necessary to identify the form of the pigment) and (*2*) the appropriate Lightfastness Category.

5.1.2 The complete pigment identification given in Table 1, which also includes the Colour Index Number and a simple chemical description, shall be given in an appropriate producer publication. Manufacturers are encouraged to put this complete identification on the container label when label size permits.

5.1.3 The Common Name shall be placed on the front of the label and shall be the name of the paint except as described in 5.1.5 and 5.1.6. Other identification may be placed elsewhere on the container.

5.1.4 The Colour Index name may be spelled out in full or abbreviated depending on the size of the label. Example: Pigment Blue 15, or Pig. Blue 15 or PB 15.

5.1.5 *Substituted Pigment*—In the case of substituted pigments, the word "Hue" in equal size letters shall follow in the title, on the front of the tube, immediately after the name of the pigment that has been simulated. Directly below the title, the Common Name from Table 1 of the pigment(s) used shall be given in letters no less than the next type size smaller than the title; or if more that one pigment is used, then 5.1.7 covering mixed pigments, can be followed. For example:

CADMIUM RED MEDIUM HUE (Naphthol Red AS-OL)	COBALT BLUE HUE (Mixture)

5.1.6 Proprietary names or optional names may be used provided the Common Name(s) given in Table 1 appears on the front of the label directly under the proprietary or optional name in letters no less than the next type size smaller than the proprietary or optional name; or if more than one pigment is used, then 5.1.7 covering mixed pigments, can be followed.

5.1.7 *Mixed Pigments*—Artists' paints containing more than one pigment comply with this specification if all colored pigments included in the mixture are on the suitable pigment list (Table 1) and provided the mixture itself has passed all other test requirements in this specification. The Common Names for the pigments in the mixture, or the word "Mixture," must appear under the title in letters no less than the next type size smaller than the title. For example:

PERMANENT GREEN LIGHT (Cadmium Yellow Light, Phthalocyanine Blue)	PERMANENT GREEN LIGHT (Mixture)

If the word "Mixture" is used under the title, the Common Names of the pigments in the mixture, as given in Table 1, must be listed along with their Colour Index Names and the Lightfastness Category of the mixture somewhere on the label. The lightfastness category shall be that of the least lightfast pigment. This lightfastness category may be changed if the mixture is tested for lightfastness in accordance with Test Methods D 4303 and results indicating a different category are submitted to ASTM Subcommittee D01.57 for evaluation.

5.2 Provide on the label:

5.2.1 *Artists' Oil Paints*—Vegetable origin of the oil and method of refinement.

NOTE 1—The type of oil can be identified in accordance with Test Method D 2245.

5.2.2 *Artists' Alkyd Paints*—Type of fatty acid used. If free vegetable oil is used in combination with an alkyd resin, declare this also on the label. State if compatible with artists' oil paints.

NOTE 2—The type of alkyd can be identified in accordance with Practices D 2689.

5.2.3 *Artists' Resin-Oil Paints*—Vegetable origin and method of refinement of the oil and type of resin or gum. If the colors in a resin-oil paint line contain more than one, or different, gums or resins, the identification on the individual labels may uniformly include all of the gums or resins used in the paint line. Example: "Damar or Mastic Gum." State if compatible with artists' oil paints.

NOTE 3—The type of oil can be identified in accordance with Test Method D 2245.

5.3 *Lightfastness*—The label shall contain the word "Lightfastness" followed by the appropriate rating, I or II, as given for each pigment in Table 1.

5.3.1 Lightfastness I pigments, when made into paint specimens as described in Section 8 and exposed, tested, and rated in accordance with Test Methods D 4303, shall have a color difference (ΔE^*_{ab}) of 4 or less CIELAB units between the specimens measured before and after exposure.

5.3.2 Lightfastness II pigments, when made into paint specimens as described in Section 8 and exposed, tested, and rated in accordance with Test Methods D 4303, shall have a color difference (ΔE^*_{ab}) of more than 4.0 but not more than 8.0 CIELAB units between the specimens measured before and after exposure.

5.3.3 Pigments were placed in a lightfastness category on the basis of either known historical performance in art works or the ratings from four lightfastness tests conducted as described

in Test Methods D 4303. Results from further tests on these, or other pigments, are solicited by Subcommittee D01.57.

5.3.3.1 The lightfastness category of a pigment shall be changed if results from several further tests conducted in accordance with Test Methods D 4303 and approved by ASTM Subcommittee D01.57, establish a different lightfastness category than the one given in Table 1.

5.3.3.2 Additional pigments shall be placed in Table 1 after they have been tested for lightfastness in accordance with Test Methods D 4303 and the test results submitted to ASTM Subcommittee D01.57 for evaluation, provided the results demonstrate that the pigments have the lightfastness ratings required for Lightfastness I or Lightfastness II, as described above.

5.3.4 For information and to establish nomenclature, pigments in Lightfastness III, IV, and V categories are given in Table X1.1 in Appendix X1. However, such pigments are not to be used in paint conforming to this specification.

5.4 *Contents*—To be expressed in volumetric measure as required by law.

5.5 *Toxicity*—All products and labeling must conform to the Federal Hazardous Substances Act and to Practice D 4236.

5.6 *Statement of Conformance*—"Conforms to ASTM Specification D 4302," or "Conforms to ASTM D4302," or "Conforms to the quality requirements of ASTM D4302." This statement may be combined with other conformance statements, such as, "Conforms to the quality and health requirements of ASTM Specification D 4302 and Practice D 4236."

5.7 *Address*—Include on the label (*1*) the name and address of the manufacturer or importer and (*2*) the country of manufacture.

6. Quality Assurance for Artists' Oil Paints and Artists' Resin-Oil Paints

6.1 *Conditions Not Covered in This Specification that Affect Artists' Oil and Resin-Oil Paints*:

6.1.1 *Substrate*—Factors such as the texture, gloss, effective pH, porosity, chemical composition, and condition of the substrate will affect gloss, gloss uniformity, drying time, adhesion, and the flexibility of the dried film.

6.1.2 *Environmental Conditions*—Factors such as temperature, humidity, air flow, and light conditions affect application properties, film formation, drying time, and adhesion.

6.1.3 *Storage*—With aging and elevated temperatures, there may be a change in consistency and a separation of oil from the paste paint.

6.2 *Vehicles*—Only vegetable drying oils shall be used in artists' oil paints. Resin-oil paints shall contain 90 weight % minimum of vehicle solids, vegetable drying oil (see Note 1), and 10 weight % maximum of vehicle solids replaced by gum or resin.

6.3 *Pigments*—Pigments to be used in oil paints shall be limited to those listed in the column labeled "Oil" and pigments to be used in resin-oil paints shall be limited to those listed in the column labeled "Resin-Oil" in Table 1. Their lightfastness rating shall be the numeral given in the same row. Those pigments listed as "not tested" shall not be used.

6.4 *Driers*—Driers may be used in minimal amounts in paints that contain a pigment which has a retarding effect on the drying of oil. This is allowed so these paints can conform to the drying requirements of this specification.

6.5 *Inerts*—Minimal amounts of inert pigments may be used to produce desirable working qualities and consistency, to prevent separation, to develop chromatic properties, or to ensure the durability of the paint film.

6.6 *Preparation of Sample*—Empty the contents of a previously unopened container onto a glass slab and mix thoroughly with a spatula to a homogeneous sample.

6.7 *Nonvolatile*—The nonvolatile content shall not be less than 97 weight % for the oil paints and 90 weight % for the resin-oil paints, as determined by Test Method D 2369.

6.8 *Coarse Particles*—Paints shall be free of oversize particles and shall form a uniform film. The maximum content of coarse particles shall be 1 weight % as determined by Test Methods D 185.

6.9 *Fineness of Dispersion*—On a glass plate, using a spatula, mix the paint with an equal volume of linseed oil until homogeneous. If the paint is very thick, it may be necessary to add a minimum amount of mineral spirits or turpentine to make the paint sufficiently fluid to read the gage accurately. Determine the fineness of dispersion by Test Method D 1210. The maximum allowable grind reading is 1.5 mils (40 µm).

6.10 *Consistency*—The paste type of paint shall not flow or level when applied with a palette knife.

6.11 *Drying*—Using a film applicator with a 3-mil (75-µm) clearance, make a uniform drawdown on a lacquer-sealed panel. At a relative humidity of 50 to 75 % and a temperature of 65 to 80°F (18 to 27°C), the dustfree drying time, as determined by Test Methods D 1640, shall not be more than ten days.

6.12 Tinting strength requirements will be included in this specification as appropriate tinting strength standards for individual pigments are established. Test Method D 387 may be used to determine the tinting strength of pigments or paints when all ingredients are known. Test Method D 4838 can be used to determine the relative tinting strength of chromatic paints containing a single pigment and the same vehicle but where other ingredients are unknown.

7. Quality Assurance for Artists' Alkyd Paints

7.1 *Conditions Not Covered in This Specification that Affect Artists' Alkyd Paints*:

7.1.1 *Substrate*—See 6.1.1.

7.1.2 *Environmental Conditions*—See 6.1.2.

7.1.3 *Storage*—With aging and elevated temperatures, there may be a change in consistency and possible solvent loss. Some separation of the medium is also possible.

7.2 *Vehicles*—Only alkyds that are soluble in mineral spirits or turpentine may be used in artists' alkyd paints. Free vegetable drying oils may be included in artists' alkyd paints up to 25 weight % of the vehicle solids.

7.2.1 The amount of yellowing in a vehicle should not exceed the yellowing of a linseed oil paint. To assess excessive yellowing of the alkyd vehicle or alkyd vehicle/drying vegetable oil blend used in alkyd artists' paints, put the vehicle including its usual drier and all additives in the following formula:

	Weight %
Alkyd vehicle under test including driers	22
Mineral spirits	11
Rutile titanium white[7](conforming to Type II of Specification D 476)	30
China clay	14
Blanc fixe (conforming to Specification D 602)	22
Anti-skinning agent	1

NOTE 4—More or less mineral spirits may be used for ease of brushing.

7.2.2 Prepare a white oil paint using the same titanium white dispersed in alkali refined linseed oil. Make specimens from the alkyd and oil paints as directed in Test Methods D 4303, and expose them to light filtered through glass using Test Method 1 and either Test Method 2 or Test Method 3 as described in the Procedure section of Test Methods D 4303.

7.2.3 Following exposure check that the alkyd specimens are the same or less yellow than the oil specimens exposed by the same test method. (Use Practice D 1729 or Test Method D 2244 to determine amount of yellowing.)

7.3 *Pigments*—Pigments shall be limited to those recommended for use in alkyd paints in the column labeled "Alkyd" in Table 1. Their lightfastness rating shall be the numeral given in the same row. Those pigments listed as "not tested" shall not be used.

7.4 *Driers*—Minimal amounts of driers may be used to allow paints to conform to the drying requirements of this specification.

7.5 *Inerts*—See 6.5.

7.6 *Sampling*—See 6.6.

7.7 *Coarse Particles or Foreign Matter*— See 6.8.

7.8 *Fineness of Dispersion*—On a glass plate, using a spatula, mix the paint with linseed oil in a one-to-one volumetric ratio until homogeneous. If the paint is very thick, it may be necessary to add a minimum amount of turpentine or mineral spirits to make the paint sufficiently fluid to read the gage accurately. Determine the fineness of dispersion in accordance with Test Method D 1210. The maximum allowable grind reading is 1.5 mils (40 µm).

7.9 *Drying*—Using a film applicator with a 3-mil (75-µm) clearance, make a uniform drawdown on a lacquer-sealed panel. At a relative humidity from 50 to 75 % and a temperature from 65 to 80°F (18 to 27°C), the dust-free drying time shall be not more than 2 days or less than 30 min.

8. Lightfastness Determination

8.1 If a pigment is not listed in Table 1, test specimens of a paint containing the pigment shall be prepared. These test specimens shall be tested in accordance with the requirements for exposure and evaluation given in Test Methods D 4303.

NOTE 5—A report of the results of these tests may be submitted to Subcommittee D01.57 for inclusion of the pigments in Table 1. The report shall include information on test conditions and instruments used and shall be accompanied by test specimens, which will be returned. [7]

8.2 *Materials*:

8.2.1 *Aluminum Exposure Panels*[8] 3 by 6 in. (75 by 150 mm).

8.2.2 *Posterboard*— Heavy paper stock with one sealed surface, which is specifically designed for and used in the industry to accept paint for drawdown or brushout.

8.2.3 *White Soya Alkyd Enamels* used to prepare white ground coats.

8.2.4 *White Artists' Paints*—Depending on the vehicle in which the pigments are to be tested:

8.2.4.1 Titanium dioxide yellowing-resistant oil paint,

8.2.4.2 Titanium dioxide yellowing-resistant alkyd paint, or

8.2.4.3 Titanium dioxide yellowing-resistant resin-oil paint.

8.2.5 *Spray Apparatus*, for applying ground coats.

8.2.6 *Soft Hair Paint Brush*, for applying ground coats if spray apparatus is not available.

8.3 *Summary of Method*:

8.3.1 Pigments to be tested are dispersed in the appropriate vehicle and diluted with a standard mixing white of the same type of vehicle until the spectrophotometric measurement of the dried film reads from 35 to 45 % reflectance at the wavelength of maximum absorption for that pigment. Prepared artists' paints of known composition may be tested.

8.4 *Specimen Preparation*:

8.4.1 *Ground Coats*:

8.4.1.1 For two ground coats to be used under oil, alkyd, and resin-oil paints, prepare the following enamel:

	Weight %
Medium oil length soya alkyd, 50 % nonvolatile	20
Rutile titanium chloride[8] (conforming to Type II of Specification D 476)	40
Blanc fixe (conforming to Specification D 602)	40
Driers 0.15 % zinc and 0.15 % zirconium as metal on the alkyd nonvolatile	
Sufficient mineral spirits for milling	

8.4.1.2 Mill to a Hegman fineness of 7 as measured by Test Method D 1210. Thin with mineral spirits to appropriate viscosity for spraying or for flow coating by brush.

NOTE 6—These soya alkyd enamels are used for the ground coats because of their color stability, nonabsorbency, adhesion of the specimen coats under humid conditions, and freedom from blistering that can occur with an acrylic ground coat under high humidity.

8.4.2 *Application of Ground Coats*:

8.4.2.1 Degrease aluminum substrates before applying the ground coat.

8.4.2.2 Apply two coats of the enamel described in 8.4.1.1 to the aluminum or posterboard supports, either by spraying or by flow coating with a soft hair brush. Spray application will result in a more uniform surface for subsequent drawdown application of the paints to be tested. Coat the posterboard to be used for laboratory exposure on the less absorbent, glossy side.

NOTE 7—Coating the posterboard is most conveniently done on the whole sheet before cutting to size.

[7] The sole source of supply of the material, DuPont R900 known to the committee at this time is E. I. du Pont de Nemours & Co., 1007 Market St., Wilmington, DE 19898. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, [1] which you may attend.

[8] The sole source of supply of the aluminum panel, No. A-36 known to the committee at this time is The Q-Panel Co., 26200 First St., Cleveland, OH 44145. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

8.4.2.3 Allow a minimum of five days drying time following the first coat and two weeks or more before applying the specimen to be tested.

8.4.3 *Mixing Whites for Dilution of Colors*:

8.4.3.1 For oil paints use the following white:

	Weight %
Alkali refined safflower oil	22.5
Aluminum distearate	2.0
Rutile titanium dioxide[7] (conforming to Type II of Specification D 476)	30.0
Blanc fixe (conforming to Specification D 602)	39.5
Zinc oxide (conforming to Specification D 79)	6.0

8.4.3.2 Mill to a Hegman fineness of 7 as measured by Test Method D 1210.

8.4.3.3 Keep the viscosity of the mixing white to 250 P or slightly lower.

8.4.3.4 For diluting alkyd paints use the following white containing two alkyd resins:

	Weight %
Medium oil length soya alkyd,[9] 62 % oil length, 70 % nonvolatile, white spirit as volatile	10
Medium oil length soya alkyd, 62 % oil length, 51 % nonvolatile, mineral spirits as volatile	12
Mineral spirits	11
Rutile titanium dioxide[7] (conforming to Type II of Specification D 476)	30
Blanc fixe (conforming to Specification D 602)	16
China clay	14
Anti-skinning agent	1
Zinc oxide (conforming to Specification D 79)	6

8.4.3.5 Mill to a Hegman fineness of 7 as measured by Test Method D 1210.

8.4.3.6 For diluting resin-oil paints, use the following white:

	Weight %
Alkali refined safflower oil	20.7
Aluminum distearate	2
Damar resin dissolved in 3 % mineral spirits (Note 8)	1.8
Rutile titanium dioxide[7] (conforming to Type II of Specification D 476)	30
Blanc fixe (conforming to Specification D 602)	39.5
Zinc oxide (conforming to Specification D 79)	6

NOTE 8—The kauri-butanol value of the mineral spirits shall be ≥40 as determined by Test Method D 1133.

8.4.3.7 Mill to a Hegman fineness of 7 as measured by Test Method D 1210.

8.4.4 *Preparation of Test Paints*:

8.4.4.1 The pigment to be tested may be milled in a concentrated paste in a resin-oil vehicle. If a prepared resin-oil artists' paint of known composition is available, it may be used for this test.

8.4.4.2 Dilute the pigment paste or paint with the white given in 8.4.3.6 until the spectrophotometric measurement of the dried film shows 35 to 45 % relative reflectance at the wavelength of maximum absorption for that pigment. The wavelength of maximum absorption is located at the point of lowest reflectance on the spectral curve between 420 and 620 nm.

8.4.4.3 To obtain this reflectance, use the Kubelka-Munk Single Constant Method described in Appendix X2 or use a trial and error method.

8.4.4.4 Make instrumental readings with the specular reflectance excluded.

8.4.4.5 Use an applicator with a 6-mils (150-µm) aperture to make a minimum size drawdown, 1½by 1½ in. (40 by 40 mm), or other minimum size appropriate for the viewing area of the instrument used. Return all recoverable paint to the batch to allow for repeat mixes and measurements.

8.4.4.6 For oil, alkyd, or resin-oil paint, an initial amount of 40 g of white paint is sufficient if specimens are read wet and recoverable paint is returned to the batch. If the instrument provides a way to read wet paint behind glass, and specimens measured this way fall within the accepted range when dry, this method can be used.

NOTE 9—Another suggested method for reading oil paints while wet is to cut from 0.013-mm thick kitchen plastic wrap (such as saran wrap) the minimum size piece that will protect the instrument and then die-cut a hole in the proper location ⅛ in. (3.2 mm) smaller than the instrument aperture. Rubbing the plastic several times with a paper towel or tissue imparts sufficient static charge that the protective plastic adheres to the instrument enabling the operator to center the hole on the aperture. The wet oil paint drawdown can then be placed in position, taking care not to disturb the plastic shield.

8.4.4.7 For the initial weights of white stated in 8.4.3.1, 8.4.3.4 and 8.4.3.6 the weighing must be accurate to 0.05 g.

8.4.5 *Application of Paints to Panels*:

8.4.5.1 Prepare four specimen panels on appropriate substrates for each pigment under test. Aluminum panels are required for outdoor exposure. Posterboard may be used for the remaining panels. Two of the prepared panels are used in the first lightfastness tests and two are retained in subdued light, one for visual comparisons with the exposed panels and one in case a third test is needed to supplement results from the first two tests, as described in Test Methods D 4303.

8.4.5.2 Apply the test paints by drawdown, as described in Practice D 4941, to the exposure panels.

8.4.5.3 After coating, allow specimens to dry hard, as described in the Procedure section (Dry-Hard Time) of Test Methods D 1640, before measuring them prior to exposure. General guidelines for drying times are one to two months to dry hard for oil and resin-oil paints, and five days for alkyd paints.

8.4.5.4 When testing alkyd paints, prepare and expose a specimen of the mixing white along with the colored specimens diluted with this white. Since the purpose of these lightfastness tests is to evaluate any color change in the pigments, if the white yellows appreciably during exposure, adjust any color change between unexposed and exposed colored specimens to eliminate the effect of this yellowing.

9. Exposure

9.1 Conduct exposure tests in conformance with Test Methods D 4303. Assign lightfastness categories as described in Section 8 of Test Methods D 4303.

10. Keywords

10.1 artists' alkyd paints; artists' oil paints; artists' resin-oil paints; lightfastness; quality requirements; test specimens

TABLE 1 Suitable Pigments List

NOTE 1—Underlined information and the lightfastness rating in the table shall be included on every label.

NOTE 2—The chemical classes in Table 1 have been revised to more closely conform to recommended terminology. When relabeling or publishing literature, the chemical classes given in Table 1 should be used; however, product labels or literature using the chemical descriptions given in Table 1 of D 4302–96a are still in conformance with this specification.

Key:
Lightfastness Category:
Lightfastness I Excellent Lightfastness
Lightfastness II Very Good Lightfastness
Abbreviations Used in Colour Index Names:
NR Natural Red
PB Pigment Blue
PBk Pigment Black
PBr Pigment Brown
PG Pigment Green
PO Pigment Orange
PR Pigment Red
PV Pigment Violet
PW Pigment White
PY Pigment Yellow
Pigment Notations:
(BS) Blue shade
(CC) Concentrated cadmium pigments may contain up to 15 % barium sulfate for color control. Cadmium-barium pigments contain a much higher amount of barium sulfate.
(DL) May darken in strong light
(LF) Lightfast type
(NA) Colour index name or number not assigned
... Not tested
(RS) Red shade
(SM) Sensitive to moisture in direct sunlight
(SS) Sensitive to hydrogen sulfide

Colour Index Name	Lightfastness Category		Common Name and Chemical Class	Colour Index Number
	Oil and Resin-Oil	Alkyd		
			YELLOWS	
PY 3	II	II	Arylide Yellow 10G, with option of adding the name Hansa Yellow Light, Organic: monoazo, acetoacetyl, 10G	11710
PY 35	I	...	Cadmium (hue designation), Inorganic: cadmium zinc sulfide (CC) (SM)	77205
PY 35:1	I	...	Cadmium-Barium (hue designation), Inorganic: cadmium zinc sulfide coprecipitated with barium sulfate (SM)	77205:1
PY 37	I	I	Cadmium (hue designation), Inorganic: cadmium sulfide (CC) (SM)	77199
PY 37:1	I	...	Cadmium-Barium (hue designation) Inorganic: cadmium sulfide coprecipitated with barium sulfate (SM)	77199:1
PY 40	II	...	Aureolin, or Cobalt Yellow, Inorganic: potassium cobaltinitrite	77357
PY 41	I	...	Naples Yellow, Inorganic: lead antimoniate (SS)	77589
PY 42	I	...	Mars Yellow or Iron Oxide Yellow, Inorganic: synthetic hydrated iron oxide	77492
PY 42	I	...	Mars Orange or Iron Oxide Orange, Inorganic: synthetic hydrated iron oxide	77492
PY 43	I	I	Yellow Ochre, Inorganic: natural hydrated iron oxide	77492
PY 53	I	...	Nickel Titanate Yellow, Inorganic: oxides of nickel, antimony and titanium	77788
PY 65	I	...	Arylide Yellow RN, with option of adding Hansa Yellow RN, Organic: monoazo, acetoacetyl RN	11740
PY 73	I	...	Arylide Yellow GX, with option of adding the name Hansa Yellow GX, Organic: monoazo, acetoacetyl, GX	11738
PY74(LF)	I	...	Arylide Yellow 5GX, with option of adding Hansa Yellow 5GX, Organic: monoazo: acetoacetyl 5GX	11741
PY 83 HR 70	I	...	Diarylide Yellow HR70, Organic: disazo, HR 70	21108
PY 97	I	...	Arylide Yellow FGL, Organic: monoazo, acetoacetyl FGL	11767
PY 98	II	...	Arylide Yellow 10GX, with the option of adding the name Hansa Yellow 10GX, Organic: monoazo, acetoacetyl, 10GX	11727
PY 108	I	...	Anthrapyrimidine Yellow, Organic: anthraguinone	68420
PY 109	I	...	Isoindolinone Yellow G, Organic: aminoketone, G tetrachloroisoindolinone	56284
PY 110	I	...	Isoindolinone Yellow R, Organic: aminoketone, R tetrachloroisoindolinone	56280
PY 112	I	...	Flavanthrone Yellow, Organic: anthraquinone	70600
PY 129	I	...	Azomethine Yellow 56, Organic: methine, 5G copper complex of azomethine	48042
PY 138	I	...	Quinophthalone Yellow, Organic: aminoketone, quinophthalone	56300
PY 139	I	...	Isoindoline Yellow, Organic: aminoketone, isoindoline	56298
PY 150	I	...	Nickel Azo Yellow, Organic: monoazo, heterocyclic hydroxy, nickel complex	12764
PY 151	I	...	Benzimidazolone (hue designation) H4G, Organic: monoazo, acetoacetyl, H4G	13980
PY 153	I	...	Nickel Dioxine Yellow, Organic: methine, dioximer, nickel complex	48545
PY 154	I	...	Benzimidazolone (hue designation) H3G, Organic: monoazo, acetoacetyl, H3G	11781
PY 175	I	...	Benzimidazolone (hue designation) H6G, Organic: monoazo, acetoacetyl, H6G	11784
			ORANGES	
PO 5	II	...	Dinitraniline Orange, Organic: monoazo, acetoacetyl (SM)	12075
PO 20	I	I	Cadmium (hue designation), Inorganic: cadmium sulfo-selenide (CC)	77202
PO 20:1	I	...	Cadmium-Barium (hue designation), Inorganic: cadmium sulfoselenide coprecipitated with barium sulfate	77202:1

TABLE 1 *Continued*

Colour Index Name	Lightfastness Category		Common Name and Chemical Class	Colour Index Number
	Oil and Resin-Oil	Alkyd		
PO 23	I	...	Cadmium Vermilion Orange, Inorganic: cadmium mercury sulfide (CC)	77201
PO 23:1	I	...	Cadmium-Barium Vermilion Orange, Inorganic: cadmium mercury sulfide coprecipitated with barium sulfate	77201:1
PO 36	I	...	Benzimidazolone (hue designation) HL, Organic: monoazo, acetoacetyl, HL	11780
PO 43(DL)	I	...	Perinone Orange, Organic: anthraquinone	71105
PO 48	I	...	Quinacridone (hue designation), Organic: quinacridone	73900 and 73920
PO 49	I	...	Quinacridone (hue designation), Organic: quinacridone	NA
PO 60	I	...	Benzimidazolone (hue designation) HGL, Organic: monoazo, acetoacetyl, HGL	11782
PO 62	I	...	Benzimidazolone (hue designation) H5G, Organic: monoazo, acetoacetyl, H5G	11775
			REDS	
PR 5	II	...	Naphthol ITR, Organic: monoazo, 3-hydroxy-2-naphthanilide, ITR	12490
PR 7	I	...	Naphthol AS-TR, Organic: monoazo, 3-hydroxy-2-naphthanilide, AS-TR	12420
NR 9	II	...	Natural Rose Madder or Genuine Rose Madder , Organic: natural madder lake	75330
PR 9	II	I	Naphthol AS-OL, Organic: monoazo, 3-hydroxy-2-naphthanilide, AS-OL	12460
PR 14	II	...	Naphthol AS-D, Organic: monoazo, 3-hydroxy-2-naphthanilide, AS-D	12380
PR 88 MRS[A]	I	...	Thioindigoid Violet, Organic: indigoid	73312
PR 101	I	I	Indian Red, Inorganic: synthetic red iron oxide (bluish hue)	77491
PR 101	I	...	Light or English Red Oxide, Inorganic: synthetic red iron oxide (yellowish hue)	77491
PR 101	I	...	Mars Red or Iron Oxide Red, Inorganic: synthetic red iron oxide	77491
PR 101	I	...	Mars Violet or Iron Oxide Violet, Inorganic: synthetic iron oxide (violet hue)	77015
PR 101	I	...	Venetian Red, Inorganic: synthetic iron oxide (yellowish hue)	77491
PR 102	I	...	Light Red, Inorganic: calcined yellow ochre	77492
PR 106	I	...	Vermilion, Inorganic: mercuric sulfide (DL)	77766
PR 108	I	I	Cadmium (hue designation) , Inorganic: cadmium-seleno sulfide (CC)	77202 and 77196
PR 108:1	I	...	Cadmium-Barium (hue designation), Inorganic: cadmium seleno-sulfide coprecipitated with barium sulfate	77202:1
PR 112	II	...	Naphthol AS-D, Organic: monoazo, 3-hydroxy-2-naphthanilide, naphthol AS-D	12370
PR 113	I	...	Cadmium Vermilion (hue designation), Inorganic: cadmium mercury sulfide (CC)	77201
PR 113:1	I	...	Cadmium-BariumVermillion (hue designation), Inorganic: cadmium mercury sulfide coprecipitated with barium sulfate	77201:1
PR 119	I	...	Naphthol Red, Organic: monoazo, 3-hydroxy-2-naphthanilide	NA
PR 122	I	I	Quinacridone (hue designation), γ quinacridone	73915
PR 123	I	...	Perylene (hue designation), Organic: anthraquione, perylene	71145
PR 149	I	...	Perylene (hue designation), Organic: anthraquione, perylene	71137
PR 168	II	...	Brominated Anthanthrone, Organic: anthraquione, brominated	59300
PR 170 F3RK-70	II	...	Naphthol Red, Organic: monoazo, 3-hydroxy-2-naphthanilide F3RK–10	12475
PR 170 F5RK	II	...	Naphthol Crimson, Organic: monoazo, 3-hydroxy-2-naphthanilide, F5RK	12475
PR 175	I	...	Benzimidazolone (hue designation), Organic: monoazo, 3-hydroxy-naphthanilide	12513
PR 177	I	...	Anthraquinone Red, Organic: anthraquinone	65300
PR 178	I	...	Perylene (hue designation), Organic: anthraquinone perylene	71155
PR 179	I	...	Perylene (hue designation), Organic: anthraquinone perylene	71130
PR 188	I	...	Naphthol AS, Organic: monoazo, 3-hydroxy-2-naphthanilide, AS	12467
PR 190	I	...	Perylene (hue designation), Organic: anthraquinone, perylene	71140
PR 192	I	...	Quinacridone (hue designation), Organic: γ quinacridone red	NA
PR 194	I	...	Perinone Red Deep, Organic: anthraquinone, perinone	71100
PR 207	I	...	Quinacridone (hue designation), Organic: quinacridone	73906 and 73900
PR 242	I	...	(hue designation), Organic: Disazo condensation	20067
PV 19	I	...	Quinacridone (hue designation), Organic: γ quinacridone	73900
			PURPLES	
PV 14	I	...	Cobalt Violet, Inorganic: cobalt phosphate, cobalt ammonium phosphate	77360
PV 15	I	...	Ultramarine Red or Ultramarine Violet, Inorganic: complex silicate of sodium and aluminum with sulfur, or sodium alumino-sulphosilate	77007
PV 16	I	...	Manganese Violet, Inorganic: manganese ammonium pyrophosphate	77742
PV 19(DL)	I	I	Quinacridone Violet, Organic: quinacridone	73900
PV 23BS	II	...	Dioxazine Purple, Organic: otazine, carbazole dioxazine BS	51319
PV 23RS	I	I	Dioxazine Purple, Organic: otazine, carbazole dioxazine RS	51319
PV 31	I	...	Isoviolanthrone Violet, Organic: anthraquinone, isoviolanthrone	60010
			BLUES	
PB 15	I	I	Phthalocyanine Blue or Phthalo Blue, Organic: phthalocyanine, copper	74160
PB 16	I	...	Phthalocyanine Blue, Organic: phthalocyanine, metal free	74100
PB 22	I	...	Indanthrone Blue, Organic: indanthrone	69810
PB 27	I	I	Prussian Blue, with the option of adding the name Milori Blue, Inorganic: ferriammonium ferrocyanide	77510
PB 28	I	I	Cobalt Blue, Inorganic: oxides of cobalt and aluminum, or cobalt aluminate	77346
PB 29	I	I	Ultramarine Blue, Inorganic: complex silicate of sodium and aluminum with sulfur or sodium alumino-sulphosilate	77007
PB 33[B]	I	...	Manganese Blue, Inorganic: barium manganate with barium sulfate	77112
PB 35	I	...	Cerulean Blue, Inorganic: oxides of cobalt and tin, or cobalt stannate	77368

TABLE 1 *Continued*

Colour Index Name	Lightfastness Category		Common Name and Chemical Class	Colour Index Number
	Oil and Resin-Oil	Alkyd		
PB 36	I	...	Cerulean Blue, Chromium or Cobalt Chromite Blue, Inorganic: oxides of cobalt and chromium or cobalt chromite	77343
PB 60	I	...	Indanthrone Blue, Organic: anthraquinone, indanthrone	69800
			GREENS	
PG 7	I	I	Phthalocyanine Green, Organic: phthalocyanine, chlorinated copper	74260
PG 10	I	...	Green Gold or Nickel Azo Yellow, Organic: monoazo, hetrocytlic hydroxy	12775
PG 17	I	...	Chromium Oxide Green, Inorganic: anhydrous chromium sesquioxide	77288
PG 18	I	I	Viridian, Inorganic: hydrous chromium sesquioxide	77289
PG 19	I	...	Cobalt Green, Inorganic: oxides of cobalt and zinc, or cobalt zincate	77335
PG 23	I	I	Green Earth or Terra Verte, Inorganic: natural ferrous silicate containing magnesium and aluminum potassium silicates	77009
PG 36	I	...	Phthalocyanine Green, Organic: phthalocyanine, chlorinated and brominated	74265
PB 36	I	...	Cobalt Chromite Green or Cobalt Turquoise, Inorganic: oxides of colbalt and chromium, or cobalt chromite	77343
PG 50	I	...	Light Green Oxide, Inorganic: oxides of nickel, cobalt and titanium	77377
			BROWNS	
PBr 6	I	...	Mars Brown, or Brown Iron Oxide, Inorganic: oxide or oxides	77491 + 77492 + 77499
PBr 7	I	I	Burnt Sienna, Inorganic: calcined natural iron oxide	77491 or 77492
PBr 7	I	I	Burnt Umber, Inorganic: calcined natural iron oxide containing manganese	77491 or 77492
PBr 7	I	I	Raw Sienna, Inorganic: natural iron oxide	77491 or 77492
PBr 7	I	I	Raw Umber, Inorganic: natural iron oxide containing manganese	77491 or 77492
			BLACKS	
PBk 6	I	I	Lamp Black, Inorganic: nearly pure amorphous carbon	77266
PBk 7	I	...	Carbon Black, Inorganic: nearly pure amorphous carbon	77266
PBk 8	I	...	Charcoal Black or Vine Black, Inorganic: impure amorphous carbon of vegetable origin	77268
PBk 9	I	I	Ivory Black or Bone Black, Inorganic: amorphous carbon produced by charring animal bones	77267
PBk 11	I	...	Mars Black or Black Iron Oxide, Inorganic: synthetic black iron oxide	77499
			WHITES	
PW 1	I	I	Flake White, Inorganic: basic lead carbonate (SS)	77597
PW 4	I	...	Zinc White, Inorganic: zinc oxide	77947
PW 6	I	I	Titanium White, Inorganic: titanium dioxide (rutile or anatase) with option of including some barium sulfate or zinc oxide	77891[A]

[A] Applies only to Permanent Red Violet MRS, product of Clariant Corp., Coventry, RI 02816. Pigments described as thioindigoids have varying degrees of lightfastness.
[B] Not commercially available.

APPENDIXES

(Nonmandatory Information)

X1. LIGHTFASTNESS III, IV, V

X1.1 The pigments in Table X1.1 are not sufficiently lightfast to be used in paints that conform to this specification.

TABLE X1.1 Lightfastness III, IV, V

Colour Index Name	Lightfastness Category		Common Name and Chemical Class	Colour Index Number
	Oil	Alkyd		
PY 1	III	V	Arylide Yellow G, Monoazo: acetocetyl	11680
PY 6	III		Arylide Yellow 3G, Monoazo: acetocetyl	11670
PO 1	III		Arylide Anisidine, Monoazo: acetocetyl	11725
PR 3	IV		Toluidine Red, Monoazo: 2-naphthol	12120
PR4	V		Chlorinated Para Red, Monoazo: 2-naphthol	12085
PR 17	III		Naphthol AS-D, Monoazo: 3-hydroxy-2-naphthanilide	12390
PR 48:2	IV		Calcium BON Red, Monoazo: salt of 2-naphthol acid	15865:2
PR 52:1	IV		Calcium Red Lake C, Monoazo: salt of 2-naphthol acid	15860:1
PR 53:1	V		Barium Red Lake C, Nonoazo: salt of 2-naphthol acid	15585:1
PR 83	III		Alizarin Crimson, Anthraquinone: 1,2-dihydroxy anthraquinone lake	58000
PR 83	III		Rose Madder, Anthraquinone: 1,2-dihydroxy anthraquinone lake	58000
PR 146	III		Naphthol Carmine FBB, Monoazo: 3-hydroxy-2-naphthanilide	12495
PR 181	III		Thioindigoid Magenta, Indigoid	73360

These pigments are listed here solely to establish common terminology. It is recommended that the Lightfastness Category and the underlined information in Table X1.1 be given on product labels. Pigments in Lightfastness Category III may be satisfactory when used full strength (without dilution with white) or with extra protection from exposure to light.
Lightfastness III, ($\Delta E^* > 8, < 16$); fair lightfastness
Lightfastness IV, ($\Delta E^* > 16, < 24$) poor lightfastness
Lightfastness V, ($\Delta E^* > 24$) very poor lightfastness

X2. KUBELKA-MUNK SINGLE CONSTANT METHOD FOR PREPARING PAINT FILMS 40 ± 5 % REFLECTANCE

X2.1 Prepare a 6–mil (150 µm) drawdown of a mixture of white and colorant in proportions estimated to give a paint having a reflectance of 35–45 % at the wavelength of maximum absorption. Calculate C_c, the concentration of colorant in this mix, as follows:

$$C_c = W_c/W_w + W_c \quad \text{(X2.1)}$$

where:
W_w and W_c = weight of white and colorant, respectively, with weights accurate to 10^{-1} grams.

X2.1.1 After drying, measure the film's reflectance at the wavelength of maximum absorption with a spectrophotometer, specular component excluded. Calculate $(K/S)_m$, the Kubelka–Munk Single Constant Value of this reflectance as follows:

$$(K/S)_m = (1-R_m)^2/2R_m \quad \text{(X2.2)}$$

where:
R_m = reflectance measurement of the mixture, expressed as a decimal value.

X2.1.2 Calculate K_c, the Kubelka–Munk absorption coefficient for unit concentration, as follows:

$$K_c = (K/S)_m/C_c \quad \text{(X2.3)}$$

X2.2 Calculate C_d, the concentration of colorant in white required to give the desired 35 to 45 % reflectance at the wavelength of maximum absorption, as follows:

$$C_d = 0.45/K_c \quad \text{(X2.4)}$$

X2.3 Calculate W_c, weight of colorant in batch of paint to be used for coating test panels, as follows:

$$W_c = C_d(W_w + W_c) \quad \text{(X2.5)}$$

where:
W_w = Weight of white the user determines will provide the approximate batch size desired.

X2.4 Prepare an initial drawdown of the resulting batch, let dry and measure reflectance at the wavelength of maximum absorption to ensure it falls within the desired 35–45 % range.