



Designation: D1544 – 04 (Reapproved 2023)

# Standard Test Method for Color of Transparent Liquids (Gardner Color Scale)<sup>1</sup>

This standard is issued under the fixed designation D1544; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

## 1. Scope

1.1 This test method covers the measurement of the color of transparent liquids by means of comparison with arbitrarily numbered glass standards.

1.2 Users of this method should have normal color vision.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

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

1.5 *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:*<sup>2</sup>

**D1545** Test Method for Viscosity of Transparent Liquids by Bubble Time Method

**D6166** Test Method for Color of Pine Chemicals and Related Products (Instrumental Determination of Gardner Color)

**E308** Practice for Computing the Colors of Objects by Using the CIE System

<sup>1</sup> This test method is under the jurisdiction of Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.26 on Optical Properties.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

## 3. Significance and Use

3.1 This test method applies to drying oils, varnishes, fatty acids, polymerized fatty acids, and resin solutions. Its application to other materials has not been tested.

## 4. Apparatus

4.1 *Glass Standards*, 18, numbered separately, and having the color characteristics given in **Table 1**. The color shall be produced by the glass components only. Some glass standards in use today do not conform to the values reported in **Table 1**. The calibration of glass standards should be verified prior to use; a suitable procedure for their calibration is contained in **Appendix X1**.

4.2 *Glass Tubes*, clear, 10.65 mm in inside diameter and about 114 mm in outside length. (Viscosity tubes, as described in Test Method **D1545**, are satisfactory.)

4.3 Suitable apparatus for comparing sample and standard. The apparatus may be of any design, but should have the following characteristics:

4.3.1 *Illumination*—CIE Illuminant C.

4.3.2 *Surrounding Field*—The field should be black.

4.3.3 *Field of View*—The specimen and one or more standards should subtend a visual angle of about 2° and be in the field of view simultaneously.

4.3.4 *Separation of Standard and Specimen*—There should be a perceptible separation between specimen and standard, but this should be as small as is mechanically possible.

## 5. Procedure

5.1 Fill a glass tube with the material under test. If the material is perceptibly cloudy, first filter it.

5.2 Compare with glass standards, determining which standard most closely matches the specimen in brightness and saturation. Ignore hue differences.

## 6. Report

6.1 Report the color as the number of the standard most closely matching the specimen. If more precise measurements are needed, report as either matching a standard or lighter or darker. Thus, between colors 5 and 6, the steps will be 5, 5+, 6–, and 6.

**TABLE 1 Color Specifications of Reference Standards**

Gardner Color Standard Number	Chromaticity Coordinates <sup>A</sup>		Luminous Transmittance Y, %	Transmittance Tolerance, ±
	x	y		
1	0.3177	0.3303	80	7
2	0.3233	0.3352	79	7
3	0.3329	0.3452	76	6
4	0.3437	0.3644	75	5
5	0.3558	0.3840	74	4
6	0.3767	0.4061	71	4
7	0.4044	0.4352	67	4
8	0.4207	0.4498	64	4
9	0.4343	0.4640	61	4
10	0.4503	0.4760	57	4
11	0.4842	0.4818	45	4
12	0.5077	0.4638	36	5
13	0.5392	0.4458	30	6
14	0.5646	0.4270	22	6
15	0.5857	0.4089	16	2
16	0.6047	0.3921	11	1
17	0.6290	0.3701	6	1
18	0.6477	0.3521	4	1

<sup>A</sup> A duplicate standard shall have chromaticity coordinates that differ from the reference standard by no more than one third of the difference in x or y between adjacent reference standards. In any one set, no two standards shall be closer together than two thirds of the difference in x or y between corresponding reference standards.

6.2 Report any significant difference in hue between the sample and the nearest-match standard.

**7. Precision and Bias**

7.1 On the basis of a study in which one observer at each of 80 laboratories made duplicate determinations on four samples,

the “between” and “within” standard deviations were found to be 0.5 and 0.1 color number, respectively. Based on these standard deviations, the following criteria should be used for judging the acceptability of results at the 95 % confidence level.

7.2 *Repeatability*—Two results obtained by a single operator should be considered suspect if they differ by more than two thirds of a color number.

7.3 *Reproducibility*—Two results, each of the mean of duplicate measurements, made by operators in different laboratories should be considered suspect if they differ by more than four thirds of a color number.

NOTE 1—If desired, liquid standards matching the colors given in **Table 1**, in glass tubes similar to the sample tubes may be used. These may be filled with potassium chloroplatinate for the light colors and solutions of ferric chloride and cobalt chloride in hydrochloric acid for the darker colors. The specifications and approximate composition of these solutions are given in Test Method D1544 – 58 T.<sup>3</sup> Many Glass Standards in current use do not conform to the values of **Table 1**.

NOTE 2—The precision data were obtained using an instrument in which two standards are viewed simultaneously. There are other instruments available for color matching which would be expected to give similar results, but the statement above applies only to the instrument checked.

**8. Keywords**

8.1 glass filters; other measurements; transparent standards

<sup>3</sup> See 1961 Book of ASTM Standards, Part 8.

**APPENDIX**

(Nonmandatory Information)

**X1. CALIBRATION OF GLASS REFERENCE STANDARDS**

X1.1 Select a dual beam spectrophotometer with a sufficiently small light beam at the sample position so that all rays will pass through the standards to be calibrated. Alternatively equip the spectrophotometer with a condensing lens to accomplish this purpose.

X1.2 Place the standards in turn in the sample position of the spectrophotometer. If the comparator is provided with a separate green filter in front of the light source, place this filter in the reference beam of the dual beam spectrophotometer

during calibration of each standard.

X1.3 Obtain spectral transmittance data for each glass reference standard by following Practice **E308**.

X1.4 From the spectral transmittance data for each reference standard calculate the CIE tristimulus values, X, Y, Z, and the chromaticity coordinates, x, y, for CIE Illuminant C (see Practice **E308**).