



Designation: F 2326 – 04

Standard Test Method for Collection and Analysis of Visible Emissions from Candles as They Burn¹

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INTRODUCTION

During the development of this test method with a specially manufactured “standardized” candle, variability of candle burn behavior was observed that introduced a wide statistical variation in the overall test results from a single design. Variability in testing different types of candle products would introduce even greater variability, that is, a pillar candle comprised of 60°C (140°F) melting point wax would not, and would not be expected to, show the same burn behavior as a jar candle comprised of 54.4°C (130°F) melting point wax. It is believed that a significant database of candle burn performance, based on each type of candle and formulation format, would be required before one could determine whether a statistical basis could be developed for pass/fail criteria for visible smoke emissions from candles. This method is intended to provide candle manufacturers a standard procedure to use during the development of candle designs and formulations to compare relative smoking/burn behavior. This method neither implies nor sets a standard level for visible smoke emissions for any candle type or formulation.

1. Scope

1.1 This test method covers the collection and analysis of visible emissions from indoor use candles as they burn.

1.2 The test is to be used to compare relative smoke/burn behavior during development of candle designs and formulations.

1.3 This test method may not be suitable for multiple wick candles; tapers and candles intended to be burned while floating on water commonly known as “floaters.”

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

¹ This test method is under the jurisdiction of ASTM Committee F15 on Consumer Products and is the direct responsibility of Subcommittee F15.45 on Candle Products.

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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.

F 1972 Guide for Terminology Relating to Candles and Associated Accessory Items

PS 59 Provisional Specification for Fire Safety for Candles

3. Terminology

3.1 See Guide F 1972 for definitions of terms not specified in 3.2.

3.2 *Definitions:*

3.2.1 *burn cycle*—length of time the candle is burned during one test day. For this test, a burn cycle is 4 h (see Provisional Specification PS 59).

3.2.2 *burn period*—total time the candle is burned over the duration of the test. For this test, the burn period will be 16 h.

3.2.3 *fuel pool establishment period*—time, 15 min or longer, before each burn cycle that a candle must be burned to establish a normal fuel pool and stable flame.

3.2.4 *molten fuel pool*—portion of the wax or fuel pool of a candle that is in the liquid form when the candle is burning.

3.2.5 *optical densitometer*—instrument used for determining the optical density in the transmittance or reflectance mode.

3.2.6 *top of the candle*—the upper most part of the candle or container.

3.2.7 *visible emissions*—emissions that can be seen once collected on a substrate.

4. Summary of Test Method

4.1 The visible emissions from a candle are collected on a transparent media over the specified burn period. The emissions can then be assigned a relative value as a function of opacity using a densitometer for a given testing sequence.

5. Significance and Use

5.1 The intent of this test method is to aid the candle manufacturer to optimize candle formulations in the reduction of visible smoke emissions.

5.2 This test method is intended to provide candle manufacturers a standard procedure to use during development of candle designs and formulations to compare relative smoke/burn behavior. For the development of this method, a protocol was established for trimming the wick on specially prepared test candles to 6 to 7 mm ($\frac{1}{4}$ in.) prior to each burn cycle. It is recommended that the manufacturer determine a standardized protocol, that is, either not trimming the wick or trimming the wick to an appropriate length in order for direct comparison of results.

5.3 A relative ranking of candle formulations can be established with the use of a histogram of the data and control charts.

5.4 This test method is not intended to set forth pass/fail criteria for visible smoke emissions from candles, as such, this method sets no standard level for visible smoke emissions.

6. Interferences

6.1 The thickness of the collection material, that is, the glass microscope slide, will create a positive interference and should be corrected for in the set up of the densitometer prior to the analysis of test samples.

6.2 Any material that darkens the microscope slide other than the visible emissions of a candle shall create a positive interference.

7. Apparatus and Materials

7.1 *Glass Microscope Slides*, nominally 76 by 25 mm (3 by 1 in.) with a writing surface for sample identification) to be placed above the candle to collect visible emissions.

7.2 *Ring Stands and Clamps*.

7.3 *Black and White Optical Densitometer*.

7.4 *Transparent Step Gray Scales*, for the verification of calibration of the densitometer.

7.5 *Number 1.5 Cover Slips*.

7.6 *Transparent Single-sided Tape*.

7.7 *Lint Free Cloth*, or wipe material.

7.8 *Room or Area*, with minimum drafts for burning candles.

7.9 *Noncombustible Surface*, on which to test candles.

7.10 *Ruler*, or similar measuring device capable of measuring to the nearest millimetre.

7.11 *Thermometers or Temperature Monitoring Device*, accurate to $\pm 1^\circ\text{C}$.

7.12 *Scissors*, or other device suitable for trimming wicks between burn cycles.

8. Preparation of Apparatus

8.1 Prior to sampling, wipe microscope slides with a suitable lint free wipe to remove dust or fingerprints, or both.

8.2 Attach the microscope slide in a flat horizontal position in a ring stand clamp. The microscope slide should be parallel with the ground and as close to level as possible.

8.3 Place the candle(s) to be tested in a chamber or room with minimal drafts on a level-burning surface. The temperature of the room or chamber shall be maintained to $25 \pm 5^\circ\text{C}$ ($77 \pm 9^\circ\text{F}$) throughout the test period.

8.4 Move the microscope slide with ring stand into position such that the center of the microscope slide is above the center of the wick in the candle.

8.5 Position the microscope slide in the ring stand such that it is 102 ± 6 mm (4 ± 0.25 in.) above the solid top surface of the candle wax pool. In the event the flame becomes recessed inside the candle either due to a pillar candle maintaining the side walls as it burns or a containerized candle consuming the fuel as it burns, do not position the slide any closer than 51 ± 6 mm (2 ± 0.25 in.) from the top of the candle as defined in 3.2.6. If the microscope slide is positioned any closer than 51 ± 6 mm (2 ± 0.25 in.) to the top of the candle it may restrict air flow into the candle and effect the performance or behavior of the flame during the test. Once the proper height adjustment has been made prior to the burn cycle, move the slide and holder away from the candle until it is time to collect the sample, that is, after the 15 min or longer required to develop a molten fuel pool and stable flame.

9. Calibration and Standardization

9.1 Place a new, clean microscope slide with a cover slip taped in place in the same manner as the test samples, on the optical portion of the black and white densitometer and zero the instrument. For transparent slides make sure that the densitometer is in the transmittance mode and not the reflectance mode.

9.2 Place another new, clean slide with the cover slip taped in place such that the cover slip is taped only on one side. Place the slide under the optical portion of the black and white densitometer. Slide the step gray scale under the cover slip and into place over the optical portion of the black and white densitometer. Check to verify the instrument is operating properly. The instrument measurement shall be within 5 % of the actual value at a density of 1.0 and within 10 % at a density of 0.40. The instrument is now ready to measure the optical density of actual test samples.

10. Conditioning

10.1 The burn test area shall be controlled to $25 \pm 5^\circ\text{C}$ ($77 \pm 9^\circ\text{F}$) with 20 to 70 % relative humidity and an environment that minimizes the disturbance of the flame of the candles under test.

11. Test Procedure

11.1 Remove all outer wrapping and remove label material (according to manufacturer's instructions) prior to initiating the burn test.