



Designation: F2417 – 23

Standard Specification for Fire Safety for Candles¹

This standard is issued under the fixed designation F2417; 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 is intended to prescribe minimum safety requirements for candles and candle ensembles to provide a reasonable degree of safety for normal use with candles, thereby improving personal safety and reducing fires, deaths, and injuries.

1.2 This specification is not intended to replace other important safety practices that should be in place, such as adult supervision, close monitoring, fire detection, alarm or suppression systems, and use of candles away from combustible materials.

1.3 *This specification is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.*

1.4 *This standard is used to predict or provide a quantitative measure of the fire hazard from a specified set of fire conditions involving specific materials, products, or assemblies. This assessment does not necessarily predict the hazard of actual fires which involve conditions other than those assumed in the analysis.*

1.5 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

1.6 This specification states values in inch-pound units which are to be regarded as the standard. The values given in parenthesis are for information only.

1.7 *This specification 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 requirements prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standard-*

ization 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

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

D93 Test Methods for Flash Point by Pensky-Martens Closed Cup Tester

E136 Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 °C

E176 Terminology of Fire Standards

F1972 Guide for Terminology Relating to Candles and Associated Accessory Items

F2058 Specification for Candle Fire Safety Labeling

2.2 *NFPA Standard:*³

NFPA 909 Code for the Protection of Cultural Resources

3. Terminology

3.1 Certain candle-related terminology is addressed in Guide **F1972**, and the reader is directed to that guide for definitions not found in **3.2**. For definitions of terms associated with fire issues, see Terminology **E176**.

3.2 *Definitions: Candle Classification Terms:*

3.2.1 *candle, n*—one or more combustible wicks supported by a material that constitutes a fuel which is solid, semi-solid, or quasi-rigid at room temperature, 68 °F to 80 °F (20 °C to 27 °C); it can also contain additives that are used for color, scent, stability, or to modify the burning characteristics; the combined function of which is to sustain a light-producing flame.

3.2.2 *candle-making kit, n*—a set of ingredients and materials packaged together that the end consumer uses to make a candle.

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

Current edition approved Aug. 1, 2023. Published August 2023. Originally approved in 2002. Last previous edition approved in 2017 as F2417 – 17. DOI: 10.1520/F2417-23.

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.

³ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

3.2.2.1 *Discussion*—Not all materials necessary to make a candle are needed in a candle-making kit; for instance, fragrance options may be sold separately.

3.2.3 *extended use candle, n*—a candle that is intended for home use to be burned continuously for longer than 4 h, excluding tealight candles.

3.2.3.1 *Discussion*—Examples of extended use candles include religious candles, available to consumers, intended to be burned continuously for 24 h or multiple days.

3.2.4 *filled candle, n*—a candle produced and used within the same container or vessel.

3.2.5 *freestanding candle, n*—a rigid candle that is intended to be burned outside a container and does not require a holder to keep it upright, excluding votive candles.

3.2.5.1 *Discussion*—Examples of freestanding candles include pillar-shaped, column-shaped, and figurine candles.

3.2.6 *gel-containing candle, n*—a candle where the primary fuel is a liquid, such as mineral oil, terpene type chemicals, or modified hydrocarbons that are not mineral oil based, which may or may not contain organic functional groups; it also contains a chemical agent to increase the viscosity (thicken) to a point where the candle has a quasi-rigid property.

3.2.7 *non-freestanding birthday candle, n*—any candle or candle ensemble that does not include pyrotechnics and is designed and marketed for use with birthday cakes and does not comply with the applicable stability requirements.

3.2.7.1 *Discussion*—4.5 contains safety requirements for stability.

3.2.8 *outdoor candle, n*—a candle intended to be burned outdoors.

3.2.9 *religious/ceremonial candle, n*—a candle that is predominantly intended, constructed, packaged, and labeled for use in a public venue during a religious or similar ceremony.

3.2.9.1 *Discussion*—Candles such as an Easter, Paschal, sacramental, or altar (or some combination, for example Easter/Paschal), generally 17 in. (43 cm) or more in length are considered religious/ceremonial candles. These candles are generally displayed and burned in the place of worship as the focal candle during a ceremony, service, or event. These candles may be adorned with symbols and ornamentation as required and deemed appropriate.

3.2.10 *tealight candle, n*—a cylindrical filled candle produced with a diameter and height of approximately 1.5 in. (38 mm) and 0.75 in. (19 mm) respectively.

3.2.11 *votive candle, n*—a candle produced for use fully within a candle accessory, specifically, a votive holder.

3.3 *Definitions: General Terms:*

3.3.1 *barrier technology, n*—a functional design element of a candle accessory that minimizes the risk of the flame spreading to combustible components of the candle accessory as a result of foreseeable misuse or failure of the candle.

3.3.1.1 *Discussion*—Examples include a durable, noncombustible wall, or space absent of combustible objects.

3.3.2 *base material, n*—the intended fuel source for the candle.

3.3.3 *burn cycle, n*—the length of time a candle burns from when it is lit to when it is manually extinguished or from when it is lit until it extinguishes on its own at end of useful life.

3.3.3.1 *Discussion*—Burn cycles for tealight candles are until end of useful life; burn cycles for gel-containing candles are 8 h; burn cycles for extended use candles are as labeled or intended; and burn cycles for all other candles are 4 h.

3.3.4 *burn time, n*—the time a material supports sustained flaming combustion after removal of the ignition source until all flaming ceases.

3.3.5 *candle flashover, n*—the condition where the base material's vapors ignite over the entire fuel pool.

3.3.6 *coating*—any material, other than wax based, which is used to cover at least a portion of the candle.

3.3.6.1 *Discussion*—This material includes, but is not limited to, paint, glue, glitter, wood, plastic, or any other material that is not wax-based (which is generally considered an overdip).

3.3.6.2 *Discussion*—Excludes product labeling on bottom and any packaging meant to be removed prior to use.

3.3.7 *diffusion flame, n*—a type of flame where the fuel is not premixed with air or other oxygen source.

3.3.7.1 *Discussion*—Diffusion flames are typically red, yellow, or orange in color.

3.3.8 *end of useful life, n*—when the candle ceases to support combustion and the candle flame(s) goes(go) out on its own, as designed, and cannot be re-lit.

3.3.9 *ensemble, n*—a candle and items physically packaged together and intended for use with the candle for sale as one unit at the retail level.

3.3.10 *flame height, n*—the length of the candle flame from the base to the tip.

3.3.11 *flame impingement, n*—the situation where the flame makes contact with a surface.

3.3.11.1 *Discussion*—Within this standard, the concern is when a freestanding candle flame impinges on the supporting surface at the end of useful life.

3.3.12 *fuel pool, n*—pool of molten base material.

3.3.13 *noncombustible, adj*—not capable of igniting and burning when subjected to a fire under specified conditions.

3.3.13.1 *Discussion*—Materials that are reported as passing Test Method E136 are considered noncombustible.

3.3.14 *place of worship, n*—any building that functions primarily as a group meeting place for the practice of religion (see NFPA 909).

3.3.14.1 *Discussion*—This includes, but is not limited to, churches, synagogues, cathedrals, temples, mosques, and meeting halls.

3.3.15 *secondary ignition, n*—a self-sustained flame other than that on the intended wick(s) that occurs during candle use, including candle flashover.

3.3.15.1 *Discussion*—If a wick curls over during the burning of the candle such that the wick and the tip are both touching the melt pool but the wick only has one flame it is not to be interpreted as secondary ignition unless two or more separate flames can be distinguished on the same wick.

3.3.16 *self-sustained flame, n*—a flame that continues to burn until the fuel source is removed or depleted or requires manual extinguishing.

3.3.17 *useful life*—total length of time a candle burns.

3.3.18 *wick, n*—an object that delivers fuel to a flame through the process of capillary action.

4. Safety Requirements

4.1 Safety Requirements for Flame Height:

4.1.1 This safety requirement applies to all candles except outdoor candles. See X1.1.

4.1.2 *Performance Requirement*—When tested in accordance with test method in 5.2:

4.1.2.1 Except as listed in 4.1.2.2, candle flame heights shall not exceed 3.0 in. (76 mm).

4.1.2.2 Religious/ceremonial candle flame heights shall not exceed 3¾ in. (95 mm).

4.2 Safety Requirement for Candle Container Integrity:

4.2.1 This safety requirement applies to filled candles, including tealights. See X1.2.

4.2.2 *Performance Requirement*—When tested in accordance with the test method in 5.2:

4.2.2.1 The container shall not crack or break.

4.3 Safety Requirements for Secondary Ignition:

4.3.1 This safety requirement applies to all candles and ensembles except religious/ceremonial candles and non-freestanding birthday candles. See X1.3.

4.3.2 *Performance Requirement*—When tested in accordance with the test method in 5.2:

4.3.2.1 Secondary ignition shall not occur.

4.4 Safety Requirements for Flame Impingement:

4.4.1 This safety requirement applies to freestanding candles. See X1.4.

4.4.2 *Performance Requirement*—When tested in accordance with the test method in 5.2:

4.4.2.1 Candle flames shall not impinge on the supporting surface.

4.5 Safety Requirements for Stability:

4.5.1 This safety requirement applies to freestanding candles and filled candles, including tealight candles and ensembles. See X1.5.

4.5.2 *Performance Requirement Before Burning*—When tested in accordance with the test method in 5.3:

4.5.2.1 Freestanding and filled including tealight candles and ensembles shall not tip over when placed at a 10.0° (–0.0° / +0.5°) incline from horizontal.

4.5.2.2 Asymmetrical candles and ensembles shall not tip over when placed at a 10.0° (–0.0° / +0.5°) incline from horizontal at any position when rotated around the vertical axis.

4.5.3 *Performance Requirement While Burning*—When tested in accordance with the test method in 5.2:

4.5.3.1 Freestanding candles shall not tip over on a level surface.

4.6 Safety Requirements for Plastic Containers:

4.6.1 This requirement applies to all plastic containers used for candles. See X1.6.

4.6.2 *Performance Requirement*—When tested in accordance with the test method in 5.4:

4.6.2.1 The total burn time for the ten plastic containers shall be less than or equal to 300 s.

4.6.2.2 No single burn time of a plastic container shall exceed 30 s.

4.6.2.3 No single plastic container shall be completely consumed during testing.

4.7 Safety Requirements for Coatings on Candles:

4.7.1 This safety requirement applies to all candles which contain a coating (such as a painted surface) except non-freestanding birthday candles, religious/ceremonial candles, and filled candles where there is a noncombustible material, such as glass, between the flame and the coated surface. See X1.7.

4.7.2 *Performance Requirement*—When a minimum of 24 identical candles are tested in accordance with the test method in 5.2:

4.7.2.1 Candle flame heights shall not exceed 3.0 in. (76 mm), 4.1.2.1.

4.7.2.2 Secondary ignition shall not occur, 4.3.

4.7.2.3 Freestanding candle flames shall not impinge on the supporting surface, 4.4.

4.7.2.4 Freestanding candles shall not tip over on a level surface, 4.5.3.

NOTE 1—There is no data to indicate that coatings on the exterior or filled containers are a concern; therefore they are excluded from the coatings on candles requirements.

4.8 Safety Requirements for Wick Migration and Wick Leaning:

4.8.1 This requirement applies to all filled candles.

4.8.2 *Performance Requirement*—When tested in accordance with the test method in 5.2:

4.8.2.1 For all filled candles, the wick(s) of the candle shall not migrate or lean from their original position such that the flame on a wick makes contact with the container for longer than a 5 s duration.

4.8.2.2 For multiple wick candles, the wicks of the candle shall not migrate or lean from their original positions such that 2 or more wicks come close enough to form a single flame for longer than a 5 s duration.

5. Test Methods

5.1 General:

5.1.1 These test methods are intended to monitor candle fire safety issues including flame height, container integrity, secondary ignition, flame impingement, stability, and coating and container flammability.

5.1.2 *Safety Hazards—Warning*—There is an inherent risk of working with and around open flames.

5.1.2.1 Use appropriate personal protective equipment and practices that ensure a safe work environment.

5.1.2.2 Keep fire suppression equipment nearby that is capable of mitigating fires associated with candle fire safety testing.

5.1.3 *Precision and Bias*—No information is presented about the precision or bias for any of the test methods in Section 5.

5.2 *Candle Burning Performance Test:*

5.2.1 *Summary of Test Method*—Trim candle wicks if necessary. Light candles and observe for flame height, container integrity, secondary ignition, flame impingement, and free-standing candle stability at specified periods and record at the end of each burn interval.

5.2.2 *Apparatus:*

5.2.2.1 Noncombustible measuring device graduated in inches (millimeters),

5.2.2.2 Candle holder/glass (if applicable),

5.2.2.3 Lighter, matches, or other source of ignition,

5.2.2.4 Test surface-level, and

5.2.2.5 Wick-trimming device.

5.2.3 *Procedure:*

5.2.3.1 Remove all outer wrapping. Remove label(s) in accordance with label instructions before initiating the burn test.

5.2.3.2 Keep the burn test area environmentally controlled to 68 °F to 86 °F (20 °C to 30 °C) with minimal disturbance of the flames under test. Minimize drafts since they affect flame heights.

5.2.3.3 Place candles at least 7/8 in. (20 cm) apart, measured sidewall to sidewall, on test surface.

5.2.3.4 Test 24 identical candles when the candle has a coating on the exterior that is not separated from the flame of the candle by barrier technology, see 4.7.

5.2.3.5 Place candles with the wicks in a straight/upright position. When appropriate, place candles in a holder and trim wicks in accordance with the label. If no instructions are provided, do not trim the candle wicks.

5.2.3.6 Light candles and avoid contaminating them with carbon or debris from the ignition surface.

5.2.3.7 Burn tealight candles and tealight ensembles to their end of useful life in one continuous burn. Burn gel-containing candles for 8 h. Burn extended use candles for the prescribed length of time. Burn all other candles for 4 h.

5.2.3.8 Make visual observations after initial lighting and at least hourly intervals throughout the entire burn cycle. Measure and record the flame height and the time of occurrence if a flame height appears to approach the maximum allowable flame height.

5.2.3.9 Measure and record flame height a minimum of every 4 h. For candles whose intended product life is less than 8 h, measure and record the flame height a minimum of two times before the end of useful life. Measure flame with a nonflammable measuring device. Carefully place the measuring device as close as possible behind the flame without disturbing the flame. Allow flame to stabilize. Hold the measuring device in place for 5 s and record a maximum value (undisturbed flame). Measure the flame height from bottom of flame arc to the flame tip (see Fig. 1).

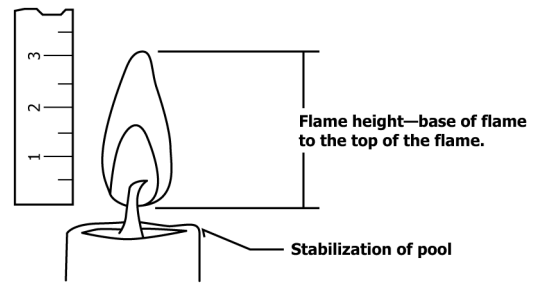


FIG. 1 Flame Measurement Diagram

5.2.3.10 At the end of burn cycle, extinguish the candle and allow to cool.

5.2.3.11 Repeat 5.2.3.5 – 5.2.3.10 until the candle reaches the end of useful life.

5.2.4 *Record and Report Any Failure for:*

5.2.4.1 Maximum flame height, 4.1.

5.2.4.2 Container integrity, 4.2.

5.2.4.3 Secondary ignition, 4.3.

5.2.4.4 Flame impingement on the supporting surface, 4.4.

5.2.4.5 Freestanding candle stability, 4.5.3.

5.3 *Stability Test Method:*

5.3.1 *Summary of Test Method*—Place candles and ensembles on a 10° incline to determine if they remain in a stable, upright position without tipping over.

5.3.2 *Apparatus:*

5.3.2.1 An incline plane, fixed or adjustable, capable of achieving a 10.0° (−0.0° / +0.5°) incline from horizontal. The incline plane may use a stop with a maximum height of 1/4 in. (64 mm) to help prevent the candle accessory from slipping during this test.

5.3.3 *Procedure:*

5.3.3.1 Remove all outer wrapping. Remove label(s) in accordance with label instructions.

5.3.3.2 Place the prepared, unlit candle, or assembled ensemble on an incline apparatus in the orientation most likely to cause tipping at a 10.0° (−0.0° / +0.5°) incline from horizontal.

5.3.3.3 Record whether the tested candle or ensemble remains stable or tips over.

5.3.3.4 Rotate asymmetrical accessories around its vertical axis incrementally to determine the stability of an asymmetrical accessory.

5.3.3.5 Record whether the tested candle or ensemble remains stable or tips over.

5.3.3.6 Repeat 5.3.3.4 and 5.3.3.5 for all rotated positions.

5.3.4 *Record and Report Any Failure for:*

5.3.4.1 Candle or ensemble tip over, 4.5.

5.4 *Plastic Container Flammability Test:*

5.4.1 *Summary of Test Method*—Test ten unused empty plastic containers for flammability with each cup resting on its side. Expose the top lip (12 o'clock position) of the container to an ignition source two times for 10 s each exposure. Record the total length of time the container continues to burn after the ignition source is removed.

5.4.2 *Apparatus:*

5.4.2.1 Ignition source such as a diffusion flame butane stick lighter with the flame adjusted to a length of 1½ in. to 1⅝ in. (29 mm to 41 mm).

5.4.2.2 Stop watch.

5.4.2.3 Level, noncombustible test surface, and

5.4.2.4 Thermometer.

5.4.3 Procedure:

5.4.3.1 Keep the burn test area environmentally controlled between 68 °F to 86 °F (20 °C to 30 °C) with minimal disturbance of the candle flames under test. Minimize drafts since they affect flame heights.

5.4.3.2 Place the test container on its side such that the bottom of the container is perpendicular with the test surface.

5.4.3.3 Hold the ignition source flame so that the metal barrel is parallel with the test surface.

5.4.3.4 Apply the ignition source flame so that the mid-point of the flame maintains contact with the open top edge of the container for 10 s. (See Fig. 2.)

5.4.3.5 Maintain flame contact in a straight line at the 12 o'clock position of the test specimen by moving the ignition source as the wall deforms, shrinks, burns, or melts away.

5.4.3.6 Remove the ignition source from the container after 10 s.

5.4.3.7 Measure and record any burn time after the ignition source is removed.

5.4.3.8 Reapply the ignition source flame as described in 5.4.3.3 – 5.4.3.7 five seconds (5 s) after the flame extinguishes.

5.4.3.9 Remove the ignition source after a second 10 s exposure.

5.4.3.10 Measure and record any burn time after the ignition source is removed this second time.

5.4.3.11 Clean the test surface after testing each specimen to avoid charred material from a previous test interfering with a subsequent test.

5.4.3.12 Repeat this procedure nine more times until a total of ten specimens have been tested.

5.4.3.13 Find the total burn time by adding the burn times after each 10 s exposure for all ten containers tested (20 total burn times).

5.4.4 Record and Report Any Failure for:

5.4.4.1 Containers that exceed the maximum allowable total burn time, 4.6.2.1.

5.4.4.2 Containers that exceed the maximum allowable single burn time, 4.6.2.2.

5.4.4.3 A container that is completely consumed during testing, 4.6.2.3.

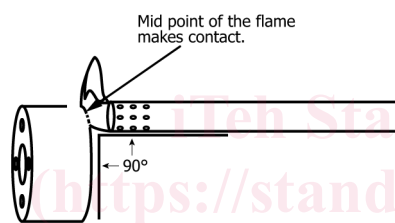


FIG. 2 Plastic Container Flammability Diagram

6. Keywords

6.1 candles; end of useful life; fire safety testing; flame height; gel; secondary ignition; stability; tealight; tealight cup

APPENDICES

(Nonmandatory Information)

X1. RATIONALE FOR CANDLE FIRE SAFETY REQUIREMENTS

X1.1 Safety Requirements for Flame Height, 4.1

X1.1.1 Candle flame heights are critical to the performance and safety of candles. Excessive candle flame heights can increase the risk of fires when using candle products. The 3¾ in. (95 mm) maximum allowable flame height for religious/ceremonial candles is larger than other candles because visibility of the flame during religious services at the place of worship warrants larger flame heights. In addition, candle flame heights are not static. The natural tendency of a candle is for the flame height to vary during the useful life. The maximum allowable flame height takes into account such variation and anticipates that manufacturers will design candles to ensure that they remain below the maximum flame height. Furthermore, the manufacturer should determine the appropriate lower flame height for optimum performance for individual candle types. Following the candle flame height requirement should reduce the potential fire hazard.

X1.2 Safety Requirements for Container Integrity, 4.2

X1.2.1 Container cracks or breaks may lead to laceration injuries and increased potential of fire. A broken glass or ceramic may present sharp edges or points. If a candle container were to crack and break while the candle is lit, molten base material can then spill out, lower the molten pool level, and expose a fuel soaked wick, which suddenly grows a flame larger than expected. In a candle flashover condition, flame may travel with the spread of the molten base material. Following the requirements for container integrity should reduce the potential fire hazard.

X1.3 Safety Requirements for Secondary Ignition, 4.3

X1.3.1 Secondary ignition may result in damaged candles, elevated fuel pool temperatures, excessively rapid base material consumption, and unintended flames. All of these conditions could lead to potential candle flashover or other hazards.