Designation: F2417 – 16

Standard Specification for Fire Safety for Candles[1]

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 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 Flame-producing devices, such as candles, present a potential hazard to the user. This specification cannot eliminate all hazards, but will minimize the potential hazards of candles to the user.

1.4 *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.*

1.5 *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.*

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

1.7 This specification states values in SI units which are to be regarded as the standard. The values given in parenthesis are for information only.

1.8 *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 and health practices and determine the applicability of regulatory requirements prior to use.*

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 Behavior of Materials in a Vertical Tube Furnace at 750°C

E176 Terminology of Fire Standards

F400 Consumer Safety Specification for Lighters

F1972 Guide for Terminology Relating to Candles and Associated Accessory Items

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:*

3.2.1 *altar candle, n*—candle that is constructed, packaged, and labeled as an altar candle.

3.2.1.1 *Discussion*—The candle is used in a place of worship in close proximity to the altar during the religious service or ceremony.

3.2.2 *base material, n*—intended fuel source for candle flame.

3.2.3 *birthday candle, n*—candle or candle ensemble whose sole purpose is to be used on a birthday cake.

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

[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.

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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.

[3] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269-9101.

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

3.2.5.1 *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).

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

3.2.6 *Easter, Paschal, sacramental candle, n*—candle that is constructed, packaged, and labeled as an Easter, Paschal, or sacramental candle (or some combination of these names, for example, Easter/Paschal), generally 43.2 cm (17.0 in.) or more in length.

3.2.6.1 *Discussion*—The candle shall be displayed and burned in the place of worship as the focal candle during Easter or with the celebration of various sacraments. The candle is adorned with symbols and ornamentation as required and deemed appropriate.

3.2.7 *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.

3.2.8 *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.

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

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

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

3.2.11 *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.

3.2.11.1 *Discussion*—Section 4.4 of Specification F2417 contains safety requirements for stability.

3.2.12 *paint, n*—a pigmented material which is generally applied to the outside surface of the candle, primarily used to decorate the candle.

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

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

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

3.2.14.1 *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.

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

4. Safety Requirements

4.1 *Safety Requirements for Flame Height*—This safety requirement applies to all candles except candles intended to be burned outdoors.

4.1.1 *Rationale:*

4.1.1.1 Candle flame heights are burn characteristics that shall be monitored closely by manufacturers, consumers, retailers, and anyone associated with the distribution and use of candles.

4.1.1.2 Excessive candle flame heights can increase the risk of fires when using candle products.

4.1.1.3 The 76.2-mm (3.0-in.) maximum allowable flame height requirement for all candles excluding Easter, Paschal, sacramental, altar, and outdoor candles is, in part, based on the established requirement for nonadjustable, non-windproof lighters contained in Consumer Safety Specification F400, taking into account certain differences in measurement methods and other candle performance considerations not relevant to fire safety. In addition, candle flame heights are not static. The natural tendency of a candle is for the flame height to vary during the burn life. The maximum allowable flame height requirement in this specification takes into account such variation and anticipates that manufacturers will design candles to ensure that they remain below the maximum flame height requirement throughout the burning period. Furthermore, the manufacturer shall determine the appropriate lower flame height for optimum performance for individual candle types.

4.1.1.4 The 95.3-mm (3.75-in.) maximum allowable flame height requirement for Easter, Paschal, sacramental, and altar candles is larger than other candles because visibility of the flame during services at the place of worship warrants slightly larger flame heights.

4.1.2 *Performance Requirement:*

4.1.2.1 Candle flame heights (other than those of Easter, Paschal, sacramental, altar, and outdoor candles), when tested in accordance with the test method in 5.2, shall not exceed 76.2 mm (3.0 in.). If at any time during the testing period the flame height exceeds 76.2 mm (3.0 in.), extinguish that candle and record it as a failure.

4.1.2.2 Easter, Paschal, sacramental, and altar candle flame heights, when tested in accordance with the test method in 5.2, shall not exceed 95.3 mm (3.75 in.). If at any time during the testing period the flame height exceeds 95.3 mm (3.75 in.), extinguish that candle and record it as a failure.

4.1.2.3 For filled candles, if at any time during the testing period, regardless of flame height, the container cracks or breaks, it shall be recorded as a failure.

4.2 *Safety Requirements for Secondary Ignition*—This safety requirement applies to all candles and ensembles with the exception of all Easter, Paschal, and sacramental candles predominantly intended to be used at the place of worship during the service (for less than 60 min). Non-freestanding birthday candles are also exempt.

4.2.1 *Rationale:*

4.2.1.1 Potential hazards associated with secondary ignition sources in and on candles exist, especially if the candle is not designed properly. The ignition of material other than the intended wick(s) 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 fire hazards.

4.2.1.2 This requirement describes the method to determine the tendency of candles to support ignition at points other than the intended wick(s) that are integrated into the candles to enable them to burn.

4.2.2 *Performance Requirement:*

4.2.2.1 When the candle is tested in accordance with 5.2 of this specification, no secondary ignition shall occur.

4.2.2.2 Record the candle as passing the secondary ignition specification if no secondary ignition is observed during the testing.

4.3 *Safety Requirements for End of Useful Life*—This safety requirement applies to all votive, freestanding, and filled (including tealights) candles and to all ensembles containing tealights. This safety requirement does not apply to candles requiring a holder to keep them upright, birthday candles, and candles intended to float on water.

4.3.1 *Rationale*—When the candle meets the safety requirements for the end of useful life, this will reduce the risk of fires.

4.3.2 *Performance Requirement:*

4.3.2.1 Record votive and filled (including tealights) candle or tealight ensembles as passing the end of useful life requirement when tested in accordance with the test method in 5.2 if the candle or tealight ensemble meets the definition in 3.2.7 and does not break or crack the container, does not exhibit excessive flame height, and does not exhibit secondary ignition as detailed in this specification.

4.3.2.2 Record the freestanding candle as passing the end of useful life requirement when tested in accordance with the test method in 5.2 if the candle meets the definition in 3.2.7 and the flame does not impinge on the supporting surface, does not exhibit excessive flame height, does not exhibit secondary ignition as detailed in this specification, and does not tip over on its own accord when tested on a level surface in accordance with 5.2.

NOTE 1—The use of current processes or devices that limit the candle's ability to consume all of the available fuel is offered as a way to reduce candle fires that occur at the end of the candle's life. This does not preclude the development of other suitable means to meet the requirements set forth in 4.3 – 4.3.2.2. This reduces heat buildup at the end of life and the possibility of secondary ignition, candle flashover, and container failure. While it is understood that current processes and devices will not guarantee that all fuel will not be consumed, the anticipated benefit in reducing candle fires warrants their consideration for use.

4.4 *Safety Requirements for Stability*—This safety requirement is intended to cover freestanding candles that are normally used without the aid of a holding device to keep them upright, filled candles (including tealights), and ensembles. Candles requiring a holder to keep them upright and votive candles are excluded unless they are incorporated in an ensemble. Easter, Paschal, sacramental, and altar candles specifically designed for use during the service at the place of worship are also excluded from the requirements of this section.

4.4.1 *Rationale*—This requirement is intended to minimize the hazards of candle tip over.

4.4.2 *Performance Requirement:*

4.4.2.1 Candles specified in 4.4 must not tip over when placed on a minimum 10.0° incline when tested in accordance with 5.3 in this specification.

4.4.2.2 Asymmetrical candles must pass this requirement if they do not tip over when rotated around the candle's vertical axis and tested on the incline apparatus in all orientations in accordance with 5.3.

4.4.2.3 Candles must remain stable when tested on a level surface in accordance with 5.2 and not tip over at any time during the candle burning performance test.

4.5 *Safety Requirements for Plastic Containers (Including Tea Light Cups)*—This requirement applies to all plastic containers used for candles. Containers constructed of non-combustible materials are exempt from this test.

4.5.1 *Rationale*—Plastic containers used for candle applications are intended to be used in close proximity to an open flame. A wide variety of materials are used to manufacture plastic containers, some of which are inappropriate and can catch fire resulting in a potential candle fire hazard. When plastic containers meet this requirement for flammability the risk will be reduced of the container igniting while in use and contributing to a candle fire.

4.5.2 The plastic containers specified in 4.5 must have a total burn time less than or equal to 300 s with no single burn time event exceeding 30 s when the containers are tested in accordance with the method in 5.4 of this standard.

4.6 *Safety Requirements for Paints/Coatings on Candles*—This safety requirement is intended to cover all candles which contain a coating or a painted surface. This requirement excludes filled containers where there is a noncombustible material, such as glass, between the flame and the painted/coated surface.

4.6.1 *Rationale*—Candles with coating or paint applied to the outside of the product are susceptible to the secondary ignition of this coating or paint, thereby leading to the possibility of candle fires if this occurs. This requirement will reduce the possibility of this happening. There is no data to indicate that coatings on the exterior of filled containers are a concern, therefore they are excluded from the requirement.

4.6.2 *Performance Requirement:*

4.6.2.1 When the candle is tested in accordance with 5.2 of the specification, no secondary ignition shall occur. A minimum of 24 identical candles shall be tested.

4.6.2.2 Record the candle as passing the secondary ignition specification if no secondary ignition is observed during the testing in 4.3.2.

5. Test Methods

5.1 Candle fire safety issues intended to be monitored by these test methods include flame height, secondary ignition, end of useful life, and stability.

5.2 *Candle Burning Performance Test:*

5.2.1 *Summary of Test Method*—Candle wicks are trimmed in accordance with the label's instructions. If no information is provided on the label, the wicks are not trimmed for this test. All candles except tealights, tealight ensembles, and gel-containing candles are lit and allowed to burn for 4 h with

periodic observation. Gel candles and candles containing any gel materials shall be lit and allowed to burn for 8 h with periodic observation. This procedure is repeated until the end of the candle's useful life. Flame heights are observed at specified intervals and recorded at the end of each burn cycle. Flame heights shall be measured and recorded in millimetres (inches).

5.2.2 *Apparatus:*

5.2.2.1 Nonflammable measuring device graduated in millimetres (inches),

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, noncombustible, and

5.2.2.5 Wick-trimming device.

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

5.2.3.1 Appropriate personal protective equipment must be used and safe work practices must be followed.

5.2.3.2 Fire suppression equipment capable of mitigating fires associated with candle fire safety testing must be readily available during testing.

5.2.4 *Procedure:*

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

5.2.4.2 The burn test area will be environmentally controlled to 20 to 30°C (68 to 86°F) with minimal disturbance of the flames of the candles under test. Drafts affect flame heights and shall be minimized.

5.2.4.3 Place candles with the wicks in a straight/upright position. When appropriate, place candles in a holder and trim wicks in accordance with the manufacturer's instructions.

5.2.4.4 Place candles at least 20 cm (7.87 in.) apart, measured sidewall to sidewall, on test surface.

5.2.4.5 Light candles and avoid contaminating them with carbon or debris from the ignition surface. Burn tealight candles and tealight ensembles to their end of useful life. Burn gel candles and any candles containing gel materials for 8 h. Burn all other candles for 4 h.

5.2.4.6 Make visual observations after initial lighting and at least hourly intervals throughout the entire burn duration. If a flame height appears to approach the maximum allowable flame height, measure and record the flame height and the time of occurrence.

5.2.4.7 Measure and record flame height at the end of the specified burn cycle. 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).

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

5.2.4.9 Repeat 5.2.4.2 – 5.2.4.8 until the end of candle life.

5.2.5 *Calculation of Results:*

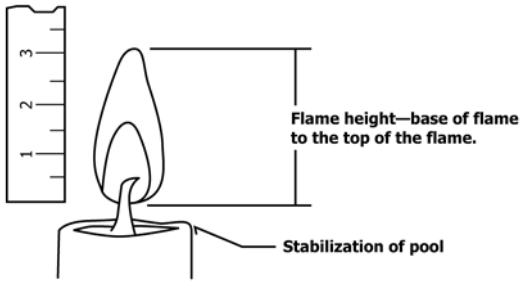

FIG. 1 Flame Measurement Diagram

5.2.5.1 Record any failure for maximum flame height.

5.2.5.2 Record any occurrence of secondary ignition.

5.2.5.3 Record any candle that does not pass the requirements at end of useful life in accordance with 4.3 – 4.3.2.2 of this specification.

5.2.5.4 Record any occurrence of container breakage or cracking.

5.2.6 *Precision and Bias*—No information is presented about either the precision or bias for flame height, secondary ignition, or end of useful life since these test results are nonquantitative.

5.3 *Stability Test Method:*

5.3.1 *Summary of Test Method*—Candles shall be placed on a minimum 10.0° incline to determine if they remain in a stable, upright position without tipping over.

5.3.2 *Apparatus*—An incline plane, either fixed or adjustable, capable of achieving a minimum of 10.0° from level. The plane may need a stop to help prevent the candle from slipping during this test. When a stop is used, its maximum height shall not exceed 6.4 mm (0.25 in.) so as not to affect the test results.

5.3.3 *Procedure:*

5.3.3.1 *Preparation of Samples*—Remove all wrapping. Remove label material when instructed by the manufacturer and prepare the candle or ensemble, or both, for use.

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 minimum of 10.0° from level. The tested candle or assembled ensemble, or both, shall remain stable and not fall over. Rotation around the candle's vertical axis will be necessary to determine the stability of an asymmetrical candle.

5.3.4 *Calculation of Results*—Record any stability failures.

5.3.5 *Precision and Bias*—No information is presented about either the precision or bias of the measurement of stability since the test results are nonquantitative.

5.4 *Plastic Container Flammability Test:*

5.4.1 *Summary of Test Method*—Ten unused empty plastic container specimens are tested for flammability with each cup resting on its side. The top lip (12 o'clock position) of the plastic container is exposed to an ignition source two times for 10 s each exposure. The total length of time the container continues to burn after the ignition source is removed is recorded. If the total burn time exceeds 300 s or if any single test burn time exceeds 30 s the sample of test specimens fails.

5.4.2 *Apparatus:*

5.4.2.1 *Ignition Source*—A post mix butane stick lighter with the flame adjusted to a length of 35 ± 5 mm.

5.4.2.2 *Stop Watch*.

5.4.2.3 *Test Surface,* level, noncombustible.

5.4.2.4 *Thermometer*.

5.4.2.5 *Safety Hazards* (**Warning—**There is an inherent risk of working with and around open flames. Appropriate personal protective equipment shall be used and safe work practices shall be followed. Fire suppression equipment capable of mitigating fires associated with fire safety testing must be readily available during testing.)

5.4.3 *Procedure:*

5.4.3.1 The burn test area shall be environmentally controlled to 20 to 30°C (68 to 86°F) and drafts shall be minimized.

5.4.3.2 Place the container to be tested on its side such that the bottom of the container is perpendicular with the test surface. While holding the ignition source such that the length of the metal barrel is parallel with the test surface, apply the flame ignition source described in 5.4.2.1 such that the mid point of the flame maintains contact with the open top edge of the container for 10 s. (See Fig. 2.) 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. At the end of the first 10-s exposure remove the ignition source from the test specimen, measure any burn time and record it. Five seconds (5 s) after the flame extinguishes re-apply the ignition source for ten more seconds, again such that the mid point of the ignition source is contacting the previously heated edge of the container. Remove the ignition source after the second 10-s exposure and measure and record the burn time.

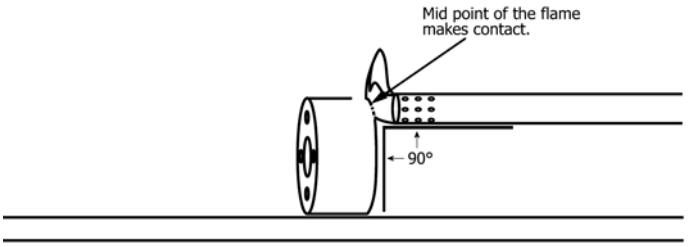

FIG. 2 Plastic Container Flammability Diagram

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

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

5.4.4 *Calculation of Test Results:*

5.4.4.1 Record the material as passing this specification when the total burn time from the first 10-s exposure and the second 10-s exposure for all ten specimens added together is less than or equal to 300 s and no one single burn time exceeds 30 s.

5.4.4.2 If any specimen is completely consumed during testing, the sample of test specimens fails.

6. Keywords

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

APPENDIX

(Nonmandatory Information)

X1. GEL-CONTAINING CANDLES

X1.1 *Introduction*—Over the course of several years, the Candle Fire Safety Task Group (Task Group) under ASTM F15.45 has been evaluating the effectiveness of this standard as it relates to detecting potential failures of gel and gel-containing candles in the laboratory. Of specific concern is the unpredictable nature of flashover events in these types of candles. The task group has commissioned several testing rounds involving multiple laboratories to assess the potential of gel and gel-containing candles to flashover. During this testing, various parameters were evaluated including the effects of storage, fragrance loadings, wick size, and the use of low flash point mineral oil base gels versus high flash point mineral oil gels. The testing conducted was limited to mineral oil products with block copolymer gelling agents. While the prescribed testing method outlined for gel and gel-containing candles included in this standard provides a framework for testing these candles and sets performance requirements, it is possible that a sample population may pass this test in the laboratory yet fail in the field. Based on the testing conducted to date and information provided by the U.S. Consumer Product Safety Commission (CPSC), the recommendations listed below should be followed in the development of gel and gel-containing candles that contain mineral oil and block copolymer gelling agent, to reduce the risk of flashovers. No specific research or technical information is currently available for other types of gelled materials, including but not limited to polyamide type gels.

X1.2 In an attempt to identify specific characteristics associated with gel and gel-containing candle failures, the burn interval for gel and gel-containing candles in the candle burning performance test has been increased to 8 h from the requisite 4 h in the specification.

X1.3 Additional gel-containing candle(s) safety recommendations for raw materials and finished products:

X1.3.1 The mineral oil used in the raw gel material shall have a Cleveland Open Cup flash point (Test Method D92) of no less than 202°C (395°F).

X1.3.2 The flash point of the fragrance oil used in the product shall have a Pensky-Martens Closed Cup flash point (Test Methods D93) of no less than 82°C (180°F).

X1.3.3 The flash point of the finished candle shall have a Cleveland Open Cup flash point (Test Method D92) of no less than 191°C (375°F).

X1.4 It is the manufacturers responsibility to design, test, and produce gel and gel-containing candles that perform to a reasonable degree of safety within normal use. It is highly recommended that candle manufacturers consult and work closely with the gel material suppliers as they develop these products regardless of the type of gel. It has been brought to the attention of the task group that higher concentrations of either the gelling agent or fragrance oil, or both, in these types of candles may present unexpected problems including but not limited to flashover. Furthermore, it is incumbent upon the candle manufacturer to demonstrate that the fragrance oil used in the formulation of gel and gel-containing candles is soluble in the system. It is recommended that the manufacturers retain samples of each batch produced.

X1.5 It should be understood that the task group was not able to develop a test method that will reasonably assure that statistical sampling will provide repeatable performance for an entire lot. Finally, it is highly recommended that gel candles, regardless of their formulation, for example, block copolymer, polyamide, or other, be extensively tested to try to prevent potential problems with this type of product.