



Designation: F3214 – 23

Standard Practice for Characterization of Fire Properties of Seating, Upholstery, and Padding Materials for Vehicles Associated with Amusement Rides and Devices¹

This standard is issued under the fixed designation F3214; 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 practice describes the required smoldering ignition fire properties for seating, upholstery, and padding materials used for vehicles associated with amusement rides and devices.

1.2 This practice includes an annex with an example of an optional open flame test method for padding materials.

1.3 This practice also contains a non-mandatory appendix with optional guidance for the procedure to follow in the event that an optional fire hazard analysis is to be conducted for vehicles used on amusement rides and devices.

1.3.1 In the event that such a fire hazard analysis is to be conducted, it needs to include considerations related to heat release, smoldering, and flaming ignition, flame spread and smoke release.

1.3.2 The appendix contains specific recommendations of standardized fire test methods that are suitable (but not required) for determining material properties related to heat release rates, smoldering, and flaming ignition, flammability, and smoke release for materials.

1.4 This practice is not a fire test method.

1.5 This practice does not require the conduction of a fire hazard analysis.

1.6 This practice does not address the use of active fire protection measures, such as fire sprinklers, or smoke, fire, or heat detectors.

1.7 This practice does not address the probability of any fire scenario associated with amusement rides or devices resulting in a hazardous event. Thus, this practice does not address the potential risk associated with any fire scenario. Practice F2291-21 includes general requirement to assess and mitigate hazards for all rides and devices.

1.8 This practice shall not apply to:

1.8.1 Materials specified for amusement rides or devices other than those associated specifically with the ride vehicle assembly.

1.8.2 Materials used for the construction of facilities.

1.8.3 Fluids and lubricants.

1.8.4 Vehicles used on water slides or other aquatic devices.

1.9 The values stated in SI units, see [IEEE/ASTM SI-10-16](#), are to be regarded as standard. The values given in parentheses, if any, after SI units are provided for information only and are not considered standard.

1.10 *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.*

1.11 *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:*²

[D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position](#)

[D1929 Test Method for Determining Ignition Temperature of Plastics](#)

[D2843 Test Method for Density of Smoke from the Burning or Decomposition of Plastics](#)

[D2859 Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials](#)

[D6413/D6413M Test Method for Flame Resistance of Textiles \(Vertical Test\)](#)

[E84 Test Method for Surface Burning Characteristics of Building Materials](#)

¹ This practice is under the jurisdiction of ASTM Committee F24 on Amusement Rides and Devices and is the direct responsibility of Subcommittee F24.10 on Test Methods and Component Parts.

Current edition approved March 1, 2023. Published April 2023. Originally approved in 2018. Last previous edition approved in 2018 as F3214 – 18. DOI: 10.1520/F3214-23.

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.

- E136** Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 °C
- E162** Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
- E176** Terminology of Fire Standards
- E648** Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
- E662** Test Method for Specific Optical Density of Smoke Generated by Solid Materials
- E1354** Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter
- E2067** Practice for Full-Scale Oxygen Consumption Calorimetry Fire Tests
- F747** Terminology Relating to Amusement Rides and Devices
- F2291** Practice for Design of Amusement Rides and Devices
- IEEE/ASTM SI-10-16** American National Standard for Metric Practice
- 2.2 *BSI Standards:*³
- BS 5852** Methods of test for assessment of the ignitability of upholstered seating by smouldering and flaming ignition sources (2006)
- 2.3 *CPSC Standards:*⁴
- 16 CFR 1615** Standard for the Flammability of Children's Sleepwear Sizes 0 through 6X (FF-3-71) (2017)
- 16 CFR 1640** Standard for the Flammability of Upholstered Furniture (2021)
- 2.4 *DIN Standard:*⁵
- DIN 4102** Fire behavior of building materials and building components
- 2.5 *EN Standards:*⁶
- EN-1021-1** Furniture – Assessment of the ignitability of upholstered furniture – Part 1: Ignition source smouldering cigarette (2014)
- 2.6 *ISO Standards:*⁷
- ISO 5659-2** Plastics — Smoke generation — Part 2: Determination of optical density by a single chamber test (2017)
- ISO 5660-1** Fire tests – Reaction to fire – Part 1: Rate of heat release from building products – (Cone calorimeter method)
- ISO 5660-2** Reaction-to-fire tests – Heat release, smoke production and mass loss rate, Part 2: Smoke production rate (dynamic measurement)
- 2.7 *NFPA Standards:*⁸
- NFPA 130** Standard for Fixed Guideway Transit and Passenger Rail Systems

- NFPA 260** Standard Methods of Tests and Classification System for Cigarette Ignition, Resistance of Components of Upholstered Furniture
- NFPA 275** Standard Method of Fire Tests for the Evaluation of Thermal Barriers (2017)
- NFPA 286** Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth (2019)
- NFPA 289** Standard Method of Fire Test for Individual Fuel Packages (2019)
- NFPA 701** Standard Methods of Fire Tests for Flame Propagation of Textiles and Films (2019)

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology **F747-21**.

3.2 For definitions of terms used in this practice and associated with fire issues, refer to Terminology **E176-21a**^{e1}.

4. Significance and Use

4.1 This practice requires that seating, upholstery, and padding materials used for vehicles associated with amusement rides and devices exhibit adequate smoldering ignition properties.

4.1.1 Noncombustible materials are permitted to be used as seating, upholstery, and padding materials, and do not require testing for smoldering ignition.

4.2 The structural components or framing associated with a vehicle or ride are not considered seating, upholstery, or padding materials.

4.3 **Annex A1** provides an optional open flame test suitable for seat padding materials.

4.4 **Appendix X1** provides non-mandatory guidance for conducting an analysis of fire scenarios associated with the operation of vehicles associated with amusement rides and devices. The conduction of a fire hazard analysis is not a requirement of this practice. The purpose of **Appendix X1** is to provide manufacturers, owners, and operators with criteria and references for fire properties of materials used in vehicles either following construction or major modifications of an amusement ride or device.

4.5 This practice does not address the probability of occurrence of a hazardous event in any fire scenario associated with amusement rides or devices. Thus, this practice does not address the potential risk associated with any fire scenario. Practice **F2291-21** includes general requirement to assess and mitigate hazards for all rides and devices.

4.6 The requirements in this practice are not intended to supersede any additional or alternate requirements provided by the authority having jurisdiction.

5. Fire Properties of Seating, Upholstery, and Padding Materials

5.1 Seating, upholstery, and padding materials used in vehicles associated with amusement rides or devices shall be resistant to smoldering ignition by complying with any one of the following:

³ Available from British Standards Institution (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., <http://www.bsigroup.com>.

⁴ Available from U.S. Consumer Product Safety Commission (CPSC), 4330 East West Hwy., Bethesda, MD 20814, <http://www.cpsc.gov>.

⁵ Available from Deutsches Institut für Normung e.V.(DIN), Am DIN-Platz, Burggrafenstrasse 6, 10787 Berlin, Germany, <http://www.din.de>.

⁶ Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

⁷ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

⁸ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

5.1.1 Exhibiting a Class I classification when tested in accordance with NFPA 260 (2019).

5.1.2 Passing the requirements of EN 1021 Part 1 (2006).

5.1.3 Passing the requirements of 16 CFR 1640 (2021).

5.1.4 Being noncombustible materials.

NOTE 1—Combustible materials used for the production of upholstered furniture sold in the United States are required to comply with 16 CFR 1640. The 16 CFR 1640 smoldering ignition test is similar to the tests in NFPA 260 (2019) and in EN 1021 Part 1 (2006). Therefore, materials complying with any of those tests are commercially available and would not need to be retested to a similar standard.

5.2 For the purposes of this practice, noncombustible materials are those that pass Test Method E136-22.

5.2.1 Noncombustible materials are not required to be tested for smoldering ignition.

5.2.2 Materials that are inherently noncombustible, such as most metals, are not required to be tested in accordance with Test Method E136-22.

6. Report

6.1 Report the following information for each material assessed for response to smoldering ignition:

6.1.1 Description of the material being tested, including its composition or generic identification, thickness, and any relevant additional details.

6.1.2 The smoldering ignition test used.

6.1.3 If the material was tested to NFPA 260 (2019), whether the material achieved a Class I classification.

6.1.4 If the material was tested to EN 1021 Part 1 (2006) or to 16 CFR 1640 (2021), whether the material complied with the test requirements.

6.1.5 Any relevant test observations.

7. Keywords

7.1 amusement ride; device; fire; fire hazard analysis; heat release; ignition; smoke release; smoldering

ANNEX

(Mandatory Information)

A1. OPEN FLAME TEST FOR PADDING MATERIALS

A1.1 Fire policy caveats, associated with this annex:

A1.1.1 This standard 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.

A1.1.2 Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.

A1.2 *Summary of Test Method*—The vertical flame test of padding materials is used to determine the flame propagation of paddings in the vertical orientation. The small open flame ignition source represents a match, candle, or cigarette lighter or similar size ignition source.

NOTE A1.1—This test method is based on the open flame test in the 2000 edition of the CA Technical Bulletin 117, “Requirements, Test Procedures, and Apparatus for Testing the Flame Retardance of Resilient Filling Materials Used in Upholstery Furniture.”

A1.3 A small open flame is applied to the lower edge of the test specimen. The burning of the test specimen is observed, and the char length and after-flame times are recorded and averaged, along with any flaming melts or drips.

A1.4 *Conditioning*—Condition test specimens prior to the test for a minimum of 24 ± 1 h at 70 ± 5 °F and less than 55 % relative humidity. If conditions in the test area are not the same as in the conditioning area, tests shall begin within 10 \pm 1 min of removal from conditioning area.

A1.5 *Test Apparatus*:

A1.5.1 *Gas Flame Ignition Source*—The burner shall have a tube of 11 ± 0.5 mm (0.43 ± 0.02 in.) inside diameter. The input line to the burner shall be equipped with a needle valve. It shall have a variable orifice to adjust the height of the flame. The burner shall be equipped with an adjustable stop collar, to allow it to be positioned quickly under the test specimen. The burner shall be connected to the gas source by rubber or other flexible tubing. The gas used shall be methane, of at least 97 % purity. The flow rate of methane shall be 45 ± 2 mL/min ($1.6 \pm 0.1 \times 10^{-3}$ ft³/min) at 23 ± 2 °C (73 ± 4 °F), which produces a flame height of approximately 38 mm (1 ½ in.) (measured from the center end of the burner tube when held horizontally and the flame allowed to burn freely in air).

A1.5.2 *Test Chamber*—The test chamber shall be a steel cabinet with inside dimensions of approximately 32.9 cm (12 15/16 in.) wide, 32.9 cm (12 15/16 in.) deep, and 76.2 cm. (30 in.) high. It shall have a frame which permits the suspension of the specimen holder over the center of the base of the cabinet at such a height that the bottom of the specimen holder is 1.7 cm (3/4 in.) above the highest point of the barrel of the gas burner and perpendicular to the front of the cabinet. The front of the cabinet shall be a close-fitting door with a glass insert to permit observation of the entire test. The cabinet floor shall be permitted to be covered with a removable noncombustible surface, whose length and width are approximately 2.5 cm (1 in.) less than the cabinet floor dimensions. The test chamber to be used in this test method is illustrated in Fig. A1.1.

NOTE A1.2—This test chamber is the one described in 16 CFR 1615, Standard for the Flammability of Children’s Sleepwear Sizes 0 through 6X (FF-3-71) (2017).

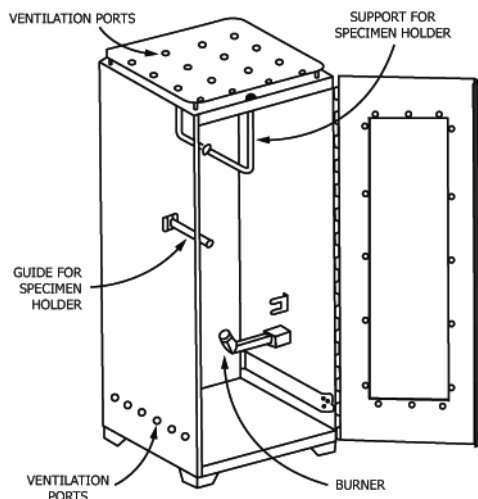


FIG. A1.1 Test Cabinet

A1.5.3 *Specimen Holder*—A stainless-steel specimen holder fabricated in accordance with Fig. A1.2 shall be used. This holder is designed for testing padding specimens 12 mm (0.5 in.) thick.

A1.5.4 Additional items to be provided:

A1.5.4.1 A stopwatch, accurate to 0.01 s and capable of measuring for at least 1 h.

A1.5.4.2 A steel measure (ruler or tape), graduated to 1 mm (0.04 in.) intervals and at least 300 mm (12 in.) in length.

A1.6 *Test Specimens*—Cut each test specimen to size: 305 ± 5 mm by 75 ± 5 mm by 12 ± 2 mm (12 ± 0.2 in. by 3 ± 0.2 in. by ½ ± 0.08 in.). Specimens less than 12 mm (½ in.) in thickness shall be permitted to be used if the full 12 mm thickness is not available.

A1.7 *Test Procedure:*

A1.7.1 Age each test specimen in a forced air circulating oven for 24 ± 1 h at 104 ± 2 °C (220 ± 5 °F), suspending specimens so that they do not contact each other. Then remove all samples from the oven and suspend on a conditioning rack for 24 ± 1 additional hours, before testing.

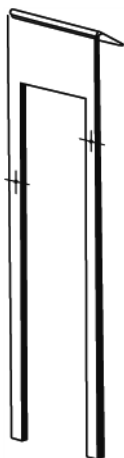


FIG. A1.2 Specimen Holder

A1.7.2 Suspend each test specimen vertically in the test cabinet in such a manner that the lower end of the specimen is approximately 19 mm (0.75 in.) above the top of the burner.

A1.7.3 Adjust the burner flame with the needle valve in the base of the burner to a flame height of approximately 38 mm (1 ½ in.). Obtain the flame height by adjusting the valve so that the uppermost portion (tip) of the flame is at the correct level.

A1.7.4 After inserting the test specimen, apply burner flame vertically at the middle of the lower edge of the specimen for 12 ± 1 s, and then remove burner. Keep cabinet door closed during testing.

A1.7.5 Record the char length of each test specimen to the nearest 2 mm (0.1 in.) and calculate and record an average char length.

A1.7.6 Record the after-flame time of each test specimen to the nearest 0.1 s and calculate and record an average after-flame time.

A1.7.7 Determine the maximum and average char length and after-flame time for each test specimen tested.

A1.7.8 Test a minimum of 5 padding specimens of each material.

A1.7.9 *Test Criteria:*

A1.7.9.1 *Char Length*—The char length shall be the distance from the end of the specimen, which was exposed to the flame, to the upper edge of the void area. In the measurement of char length all readily removable portions of carbonaceous char shall be removed prior to measurement.

A1.7.9.2 *After-Flame Time*—The after-flame time shall be the time the specimen continues to flame after the burner flame is extinguished. It shall include after-flame of molten drops of material.

A1.7.9.3 *Afterglow*—The afterglow time shall be the time the specimen continues to glow after it has ceased to flame. It shall include afterglow of molten drops of material.

A1.7.10 *Test Requirements:*

A1.7.10.1 The average char length of all specimens shall not exceed 150 mm (6 in.).

A1.7.10.2 The maximum char length of any individual specimen shall not exceed 200 mm (8 in.).

A1.7.10.3 The average after-flame, including after-flame of molten material or other fragments dropping from specimens, shall not exceed 5 s.

A1.7.10.4 The maximum after-flame of any individual specimen, including after-flame of molten material or other fragments dropping from the specimen, shall not exceed 10 s.

A1.7.10.5 The average afterglow, including afterglow of molten material or other fragments dropping from the specimen, shall not exceed 15 s.

A1.8 *Test Report*—The test report shall contain, at a minimum, the following information:

A1.8.1 Name and address of the test laboratory.

A1.8.2 Date of the test(s).

A1.8.3 Complete description of the test materials.

A1.8.4 Char length (in inches), after-flame time (in seconds), and afterglow time (in seconds) for each individual test specimen.

A1.8.5 Average char length (in inches) and the average after-flame time (in seconds) of all test specimens.

A1.8.6 Whether the material has passed the requirements in A1.7.10.

APPENDIX

(Nonmandatory Information)

X1. OPTIONAL GUIDANCE FOR CONDUCTING A FIRE HAZARD ANALYSIS FOR MATERIALS USED IN VEHICLES ASSOCIATED WITH AMUSEMENT RIDES OR DEVICES

X1.1 Analysis Based on Selection of Materials in Accordance with their Fire Properties

X1.1.1 If an optional fire hazard analysis is to be performed, select materials selected using the following criteria. This practice does not specify which fire tests are to be conducted for a fire hazard analysis, because that will depend on the fire scenario, but provides recommendations for the process to be followed.

NOTE X1.1—There are many fire tests that can be used for assessing fire properties of materials. Some of such fire tests may not be applicable to the materials and applications relevant to this practice. However, if a material has already been assessed by a fire test and is deemed by this section to be appropriate for use in vehicles associated with amusement rides and devices, the use of such a material should be permitted without requiring additional testing.

X1.1.1.1 This appendix deals only with an analysis of fire properties of materials and does not address the use of active fire protection measures, such as fire sprinklers, or smoke, fire, or heat detectors.

X1.1.2 Noncombustible materials, complying with Test Method E136-22 (5.2), are permitted for use in any application.

NOTE X1.2—Noncombustible materials can contain adhesives, binders, or resins, which may result in the final product no longer being noncombustible. In such cases, the product should be further evaluated to determine if it is noncombustible by testing it in accordance with Test Method E136-22, if necessary.

X1.1.3 All seating, upholstery, and padding materials need to be resistant to smoldering ignition in accordance with 5.1.

NOTE X1.3—It is possible that a specific fire hazard analysis may find that seating, upholstery, and padding materials will need to comply also with a flaming ignition requirement.

X1.1.4 Select combustible materials based on how they would potentially contribute to a fire. The manner in which materials contribute to a fire will depend on the fire scenario (distribution of the materials and of potential ignition sources within the environment to be assessed) and on the fire properties of the materials. The main material fire properties to be considered are ignitability, tendency to release heat, and tendency to spread flame. Heat release is particularly relevant because flame spread increases as heat release (or heat release rate) increases.

NOTE X1.4—Heat release rate is considered the most important fire property because the maximum heat release rate is a representation of the

intensity of a fire, as demonstrated by fire research (for example, Babrauskas and Peacock, “Heat Release Rate: The Single Most Important Variable in Fire Hazard”, Fire Safety Journal, 18, 255-272, 1992). The research has demonstrated that an increase in heat release rate has a much more negative effect on decreasing available time to escape than an increase in smoke toxicity or a decrease in time to ignition.

X1.1.5 If no ignition takes place, there will be no fire. However, all combustible materials have the potential to be ignited. Therefore, the ignitability of the materials to be used needs to be the first item to be considered.

X1.1.5.1 If ignition does occur, it is the potential of the resulting fire to release heat and to spread flame that will determine the contribution of the material. While most fire tests used to assess flame spread depend on the fire scenario, heat release tests are of more general applicability. Thus, while it is possible that the assessment of flame spread will provide sufficient information to determine material suitability, the assessment of heat release rate is more likely to do so successfully.

X1.1.5.2 Assessment of material flame spread is to be done using a fire test suitable for the fire scenario.

X1.1.6 Materials with low heat release rate and low smoke release rate, assessed in accordance with X1.1.6.1, are the preferred materials when combustible materials are used.

X1.1.6.1 Test the materials in accordance with Test Method E1354-22a or ISO 5660-1 (2015). Fabricate test specimens in the sample size required (100 by 100 mm) and conduct testing using a retainer frame, at a thickness of 6 mm, in the horizontal orientation, at an incident heat flux of 50 kW/m². The materials need to comply with the criteria in X1.1.6.1(1) through X1.1.6.1(3).

NOTE X1.5—The test equipment used for Test Method E1354-22a or for ISO 5660-1 (2015) is commonly known as the cone calorimeter.

(1) *Peak Heat Release Rate*—The acceptable peak heat release rate needs to be based on an analysis of the fire scenario, such as a fire hazard analysis, and needs to be such that the heat release rate is not high enough to cause ignition of adjacent materials and flame spread beyond the initial burning product.

NOTE X1.6—It has been shown that heat release rates that do not exceed 300 kW/m² are often considered acceptable, and such a threshold is often found in codes.

(2) *Smoke Release*—Assess smoke release based on an analysis of the fire scenario, such as a fire hazard analysis, and ensure that the loss of visibility is not high enough to endanger