



Standard Test Method for Measuring the Ignition Strength of Cigarettes¹

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INTRODUCTION

The most common initiating event in a fatal fire in the United States is the dropping of a lit cigarette onto a bed or piece of upholstered furniture. The cigarette coal heats the furnishing materials to the point where smoldering combustion begins, perhaps followed by a transition to flaming combustion. Since limiting the frequency of ignitions is a principal approach to reducing fire loss, it is desirable to establish a test method for the propensity of a cigarette to ignite soft furnishings. This test method uses standard substrates to determine the extent to which, as the substrate draws heat from the cigarette, the cigarette combustion remains strong enough to be capable of initiating a fire.

1. Scope

1.1 This fire-test-response standard provides a standard measure of the capability of a cigarette, positioned on one of three standard substrates, to generate sufficient heat to continue burning and thus potentially cause ignition of bedding or upholstered furniture.

1.2 This method has value as a predictor of the relative propensity of a cigarette to ignite upholstered furnishings.

1.3 This method is applicable to cigarettes that burn along the length of a tobacco column.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 This standard measures and describes the response of materials, products, or assemblies to heat 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.

1.6 *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.* For specific hazard statements, see Section 6.

2. Referenced Documents

2.1 ASTM Standards:

E 176 Terminology of Fire Standards²

¹ This test method is under the jurisdiction of ASTM Committee E05 on Fire Standards and is the direct responsibility of Subcommittee E05.15 on Furnishings and Contents.

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² Annual Book of ASTM Standards, Vol 04.07.

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method³

E 1352 Test Method for Cigarette Ignition Resistance of Mock-up Upholstered Furniture Assemblies²

E 1353 Test Method for Cigarette Ignition Resistance of Components of Upholstered Furniture²

2.2 Other Standard:

Standard for the Flammability of Mattresses and Mattress Pads, 16 Code of Federal Regulations, Part 1632

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method refer to Terminology E 176E 176.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *full-length burn, n*—the outcome of a determination in which the cigarette burns to or past the front plane of the tipping paper, which covers the filter and perhaps a short section of the tobacco column in a filter tip cigarette, or past the tips of the metal pins (see 7.5) if the cigarette has no filter.

4. Summary of Test Method

4.1 This test method measures the probability that a cigarette, placed on a substrate, will generate sufficient heat to maintain burning of the tobacco column. Each determination consists of placing a lit cigarette on the horizontal surface consisting of a set number of layers of filter paper. Observation is made of whether or not the cigarette continues to burn to the beginning of the tipping paper. Forty determinations (comprising a test) are performed to obtain the relative probability that the cigarette will continue burning despite heat abstraction by the substrate.

³ Annual Book of ASTM Standards, Vol 14.02.

5. Significance and Use

5.1 The most common initiating event in a fatal fire is the dropping of a cigarette onto a bed or piece of upholstered furniture, causing 20 % of the estimated U.S. fire deaths from 1992–1996 in residential structures, according to statistics provided by the U.S. Consumer Product Safety Commission. Test Methods E 1352E 1352 and E 1353E 1353 have been developed to evaluate the susceptibility of upholstered furniture mock-ups and components to ignition by cigarettes. Federal Standard 16 CFR Part 1632, Standard for the Flammability of Mattresses and Mattress Pads, was promulgated to reduce the likelihood that mattresses and mattress pads would ignite from a lighted cigarette.

5.2 This test method enables comparison of the relative ignition strength of different cigarette designs.

5.3 In this procedure, the specimens are subjected to a set of laboratory conditions. If different conditions are substituted or the end use conditions are changed, it may not be possible, using this test, to predict quantitative changes in the fire test response characteristics measured. Therefore, the quantitative results are valid only for the fire test exposure conditions described in this procedure.

6. Hazards

6.1 This test method involves the use of combustible materials that are exposed to ignition sources. Consequently, the user shall take proper precautions to avoid thermal injuries.

6.1.1 Personnel shall be instructed on general procedures to handle an unwanted fire. Appropriate fire extinguishing equipment shall be provided to suppress any fires that exceed normal controlled limits.

6.2 Personnel shall take proper precautions to avoid inhaling combustion products.

6.2.1 Exhaust systems shall be checked regularly to ensure that they are removing all products of combustion from the workspace.

6.2.2 Respiratory equipment shall be made available for personnel.

6.3 The user shall ensure that all burning has ceased before discarding used test materials. An appropriate closed metal waste container shall be used in each fire test laboratory for safe disposal of specimens and test assemblies after being exposed to heat and fire.

7. Apparatus and Equipment

7.1 *Test and Conditioning Environment*—An environmental conditioning room shall be maintained which provides an area adequate for conditioning both cigarettes and filter paper specimens. This room shall be capable of maintaining a relative humidity of $55 \pm 5\%$ and a temperature of $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$) and shall be continuously monitored. The room in which the tests are conducted, which may also be the conditioning room, shall be maintained within the same temperature and relative humidity ranges.

7.2 *Constant Humidity Box*—Alternatively, cigarettes and filter paper shall be stored in a box of sufficient size to hold the needed quantities of filter paper and cigarettes. The interior of the box shall be maintained at a relative humidity of $55 \pm 5\%$

and a temperature of $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$) and shall be continuously monitored. A tray containing a saturated solution of sodium bromide (NaBr) in water will provide the appropriate relative humidity when the box temperature is as prescribed. The box shall be located convenient to the test chamber such that test materials shall not be exposed to a non-conditioned environment for more than 5 min between their removal from the box and the beginning of a test.

7.3 *Test Chamber*—A test chamber of the design photographed in Fig. 1 shall be constructed of clear plastic such as PMMA, nominally 6 mm (0.25 in.) in thickness. The inside dimensions shall be: height: 340 ± 2 mm (15.5 ± 0.1 in.), width: 292 ± 2 mm (11.5 ± 0.1 in.), depth: 395 ± 2 mm (15.5 ± 0.1 in.). The full front panel of the chamber shall be hinged, with a latch to effect positive closure. The top of the chamber shall have a flattop cylindrical chimney of height 178 ± 2 mm (6.00 ± 0.1 in.) and inside diameter 150 ± 2 mm (6.00 ± 0.1 in.). The chimney shall be centered on the chamber top and sealed to the chamber top panel.

7.4 *Filter Paper Holder*—A cylindrical support for the layers of filter paper, shown in Fig. 2, shall be made of PMMA or similarly rigid material, dimensioned as follows. The outer diameter shall be 165 ± 1 mm (6.50 ± 0.04 in.), the inner diameter shall be 127 ± 1 mm (5.00 ± 0.04 in.), and the height shall be 50 ± 1 mm (1.97 ± 0.04 in.). A recess in the top, 8 ± 1 mm (0.31 ± 0.04 in.) deep, shall expand the inner diameter to 152 ± 1 mm (6.00 ± 0.04 in.). Three or four legs shall raise the bottom of the holder approximately 20 mm (0.8 in.) above the chamber floor.

7.5 *Metal Rim*—A circular brass or other dense metal rim, shown in Fig. 2, shall be used to hold the sheets of filter paper flat against each other. The outside diameter of the rim shall be 150 ± 2 mm (5.90 ± 0.08 in.). The inner diameter shall be 130 ± 2 mm (5.1 ± 0.08 in.). The thickness shall be 6.4 ± 1 mm (0.25 ± 0.04 in.). The rim surface shall be flat and smooth. A pair of parallel metal pins, each approximately 1 mm in diameter and 8.1 ± 0.05 mm (0.32 ± 0.02 in.) apart, shall protrude 20 ± 2 mm (0.8 ± 0.1 in.) toward the center of the rim. The pins are to be spaced to keep the non-ignited end of a conventional 25 mm circumference cigarette from rolling, but without pressuring the cigarette. If cigarettes of significantly different diameter are to be tested, other pairs of pins, appropriately spaced, shall be inserted into the rim.

7.6 *Cigarette Holder*—A holder shall be used to support the lit cigarette in a horizontal position in the test chamber prior to placement of the cigarette onto the filter paper substrate. The holder shall not clamp the cigarette nor stress it in any other manner, nor shall it contact the cigarette within 30 mm of its lit end.

7.7 *Cigarette Ignition System*—A system consisting of an air draw component and an ignition source shall be used to ignite the test cigarettes. The cigarette shall be supported in a horizontal position. A butane gas lighter capable of producing a stable luminous flame for 15 ± 3 mm (0.6 ± 0.1 in.) in length or a hot coil igniter shall be used for lighting the cigarette. The airflow and the draw time through the lit cigarette shall be sufficient to establish a coal to within ± 1 mm of the pencil mark 5 mm (0.2 in.) from the tip of the cigarette. Appropriate



FIG. 1 Photograph of Test Chamber and Filter Paper Holder

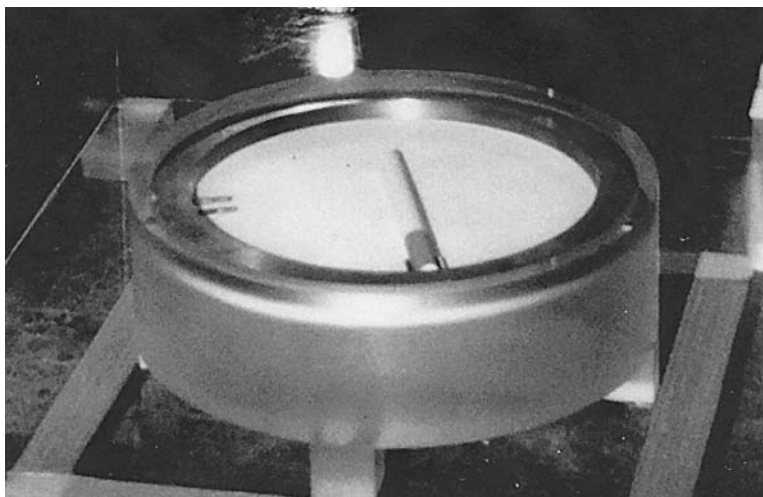


FIG. 2 Close-up of Test Cigarette, Filter Paper Holder, Metal Pins and Metal Rim

filtering media shall be used downstream of the cigarette to remove smoke and condensable combustion gases in order to prevent contamination of the downstream components.

7.8 *Exhaust Hood*—A chemical or canopy hood shall be used for removing combustion products from the test room. Air flow through the hood shall be sufficient to remove cigarette and substrate combustion products while not being high enough to influence the combustion processes in the test chamber(s). (See 8.1.2.)

7.9 *Extinguishment*—Following a determination, the cigarette and sheets of filter paper shall be completely extinguished, for example, by smothering or by application of water.

8. Calibration and Standardization

8.1 Calibrations of equipment shall be carried out as noted below and at any time when equipment or test conditions indicate that evaluation and re-calibration are necessary. The time intervals for calibrations stated in this method shall be considered to be the minimum.

8.1.1 The test chambers shall be checked before use to minimize air leakage so that the smoke plume from a cigarette rises undisturbed during testing. Door seals shall be checked visually to ensure that they are closed flush against the chamber's side wall and the latching device secures the door tightly. All construction seams shall be inspected to ensure they are airtight and no cracks shall be visible on any surface of the test chamber. If leaks are detected, measures shall be taken to ensure that these areas are again made sufficiently air tight.

8.1.2 Stability of air inside the test chamber shall be determined daily by placing a lit cigarette in the test position on three or more layers of filter paper, then closing the chamber door. Air movement in the chamber shall be observed to ensure that smoke being emitted by the cigarette is rising vertically and is not showing turbulence within 150 mm (6 in.) above the lit end of the cigarette. If turbulence is noted, then (a) the test chamber shall be checked for leaks, (b) the test chamber locations shall be evaluated for excess air flow in the laboratory, and (c) the air flow of the exhaust system shall be evaluated as the source of the disturbance.

8.1.3 The humidity and temperature sensors used to record environmental conditions in the conditioning room or the chamber and test room shall be checked for accuracy each week.

8.1.4 The air draw apparatus used for igniting cigarettes shall be calibrated at least each week using a rotameter, wet test meter or equivalent device.

9. Test Specimens and Standard Substrate Assemblies

9.1 Cigarette test specimens and filter paper substrates are sensitive to contamination. Clean plastic or rubber gloves shall be worn at all times when these materials are handled.

9.2 Cigarettes:

9.2.1 Cigarette test specimens shall be protected from physical or environmental damage while in handling and storage. It is important that the specimens not be crushed or deformed in any manner. Measures shall be taken to ensure that the specimens are not contaminated while in storage and they shall be protected from degradation by insects. If the specimens are to be stored for more than one week, they shall be

placed in a freezer at approximately 0°C (32°F) reserved for the sole protection of cigarette specimens to minimize the risk of contamination.

9.2.2 Prior to testing, cigarette test specimens shall be marked, using a #2 or softer graphite pencil, on their paper seam 5 ± 1 mm and 15 ± 1 mm (0.2 and 0.6 in., each ± 0.04 in.) from the end of the cigarette that will be lit. These marks are used to establish the start (11.4) and completion (11.5.4) of a uniform pre-burn period, respectively.

9.3 *Filter Paper*—The substrates consist of 150 mm (6 in.) diameter circles of Whatman #2 ash-free cellulosic filter paper. Substrates are formed by placing multiple layers of filter paper into the holder assembly, then placing the metal rim on top to ensure good contact between the layers.

9.3.1 For paper from a manufacturer's batch to be used in testing, the median mass of the 15 sheets of the conditioned filter paper shall be 26.1 ± 0.5 g. This shall be determined by weighing five samples of 15 sheets, each sample being from a different box from the manufacturer's batch. The standard deviation of the five samples shall be no more than 0.3 g.

9.3.2 For paper from a manufacturer's batch to be used in testing, the median mass of 15 sheets of the dried filter paper shall be 24.7 ± 0.5 g. This shall be determined by weighing five samples of 15 sheets, each sample being from a different box from the manufacturer's batch. Each set of 15 sheets shall have been stored at $60 \pm 2^\circ\text{C}$ for at least 16 h, placed in a sealed plastic bag upon removal from the oven, cooled to $23 \pm 3^\circ\text{C}$, and weighed within 3 min of opening the bag. The standard deviation of the five samples shall be no more than 0.3 g.

10. Conditioning

10.1 Cigarettes shall be conditioned at a relative humidity of $55 \pm 5\%$ and a temperature of $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$) for at least 24 h prior to testing. The cigarettes shall be oriented vertically in a small clean container, with the number of cigarettes being sufficiently small as to enable free air access to the specimens, for example, a maximum of 20 cigarettes in a 250 mL polyethylene or glass beaker.

10.1.1 Boxes of filter paper shall be conditioned at a relative humidity of $55 \pm 5\%$ and a temperature of $23 \pm 3^\circ\text{C}$ ($73 \pm 5^\circ\text{F}$) for at least one week prior to testing. The top of each 100 sheet box of filter paper shall be removed prior to being placed in the conditioning room or box. The top opening of the box shall not be obstructed. The paper sheets need not be removed from the box. Alternatively, sets of no more than 15 sheets of filter paper shall be conditioned at a relative humidity of $55 \pm 5\%$ and a temperature of $23 \pm 3^\circ\text{C}$ for at least 8 h prior to testing. These filter paper sets shall have been removed from the box and shall be stored upright with at least 1 mm spacing between the sets to enable free access of air to the specimens.

11. Procedure

11.1 Turn on the exhaust system designated for removal of test combustion products 30 min prior to beginning testing.

11.2 Ensure that the filter paper holder is in the test chamber at the geometric center of its bottom. Cover the chimney on the test chamber.