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Standard test method for assessing the ignition propensity of cigarettes

Méthode d'essai normalisée pour évaluer le potentiel incendiaire des cigarettes

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12863 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

This International Standard is based, with permission from ASTM International, on ASTM International E2187, S*tandard Test Method for Measuring the Ignition Strength of Cigarettes*, copyright ASTM International.

Introduction

A very common initiating event in a fatal fire is the dropping of a cigarette onto a bed or piece of upholstered furniture. The burning cigarette heats the furnishing materials to the point where smouldering 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.

Standard test method for assessing the ignition propensity of cigarettes

WARNING — This International Standard involves the use of combustible materials that are exposed to ignition sources. The burning materials emit toxic combustion products. The user shall take proper precautions to avoid thermal injury and inhalation of combustion products. The user shall ensure that all burning has ceased before safely discarding test materials.

1 Scope

This International Standard provides a standard assessment of the capability of a cigarette, positioned on one of three standard substrates, to extinguish or to generate sufficient heat to continue burning, and thus potentially cause ignition of bedding or upholstered furniture. This International Standard is applicable to factory-made cigarettes that burn along the length of a tobacco column. This is a performance-based standard; it does not prescribe any design features of the cigarette that might lead to improved or degraded performance in the test method. The output of this method has been correlated with the potential for cigarettes to ignite upholstered furniture.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASTM E2187, *Standard Test Method for Measuring the Ignition Strength of Cigarettes*

ISO 8243, *Cigarettes — Sampling*

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 and the following apply.

3.1
determination
single measurement involving a lit cigarette placed on a selected substrate

3.2
full-length burn
outcome of a determination in which the cigarette continues to burn to or past the front plane of the tipping paper (filter tip cigarettes) or past the tips of the metal pins for non-filter tip cigarettes

3.3
no full-length burn
outcome of a determination in which the cigarette ceases to burn before reaching the front plane of the tipping paper (filter tip cigarettes) or the tips of the metal pins for non-filter tip cigarettes

3.4
substrate (for cigarette testing)
horizontal surface consisting of layers of filter paper on which a test cigarette is placed for testing

3.5
test
set of 40 determinations

4 General principle

This test method measures the probability that a cigarette, placed on a heat absorbing substrate, will generate sufficient heat to maintain burning of the tobacco column and potentially initiate a fire. Each determination consists of placing a lit cigarette on one of three standard substrates (3, 10, or 15 layers of filter paper). Observation is made of whether or not the cigarette continues to burn nominally the length of the tobacco column, as defined in this International Standard. Forty determinations (comprising a test) are performed to obtain the relative probability that the cigarette will continue burning despite heat abstraction by the substrate.

5 Apparatus

5.1 General description

An apparatus consists of a holder for the filter paper substrate, a metal rim to compress the layers of filter paper, a clear enclosure to protect the test specimens from air currents, and associated accessories, as defined in this clause. The materials of construction shall meet occupational health and safety requirements. The apparatus shall be placed under a fume hood to minimize the exposure of personnel to combustion products. Technical drawings of the test chamber are provided in Annex A.

5.2 Test and conditioning environment

5.2.1 General

Cigarettes and filter paper shall be conditioned in one of the two ways described in 5.2.2 and 5.2.3.

5.2.2 Conditioning room

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 ± 5) % and a temperature of (23 ± 3) °C 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.

NOTE These conditioning requirements are consistent with those used for fire safety testing. Other types of testing can require different conditioning requirements.

5.2.3 Conditioning 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 the same temperature and relative humidity conditions as in 5.2.2 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 determination.

5.3 Test chamber

A rectangular test chamber with a chimney that can be placed under an exhaust hood (5.8) shall be constructed of clear, rigid material that allows observation of the entire determination.

NOTE Clear polymethylmethacrylate (PMMA) has been found suitable for this purpose.

The inside dimensions of the test chamber shall be: height (340 ± 25) mm, width (292 ± 6) mm and depth (394 ± 6) mm. 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 (165 ± 13) mm and inside diameter (152 ± 6) mm. The chimney shall be centred on the chamber top and sealed to the chamber top panel. A sheet of rigid material shall be used to cover the chimney when required in the test procedure (Clause 9). The chamber shall be supported on four feet, located near each corner, each approximately 15 mm in height. Technical drawings of the test chamber are provided in Annex A.

5.4 Substrate holder

A cylindrical support for the layers of circular filter paper shall be made of rigid material.

NOTE Clear polymethylmethacrylate (PMMA) has been found suitable for this purpose.

The outer diameter of the substrate holder shall be (165 ± 1) mm, the inner diameter shall be (127 ± 1) mm, and the height shall be (50 ± 1) mm. A recess in the top, (10 ± 2,5) mm deep, shall expand the inner diameter to (152 ± 1) mm. Three or four legs shall raise the bottom of the holder approximately (20 ± 1) mm above the chamber floor. Technical drawings of the holder are provided in Annex A.

5.5 Metal rim

A circular metal rim, made of brass with a density of (8 550 ± 150) $kg \cdot m^{-3}$ or other, equally dense material shall be used to hold the sheets of filter paper flat against each other. The outside diameter of the rim shall be (150 ± 1) mm and shall not exceed the inner diameter of the recess in the substrate holder. The inner diameter shall be (130 ± 2) mm. The thickness shall be (6,4 ± 1) mm. The mass shall be between 235 g and 295 g. The rim surfaces shall be flat and smooth. A pair of parallel metal pins, each approximately 1 mm in diameter and whose inner distance is (8,1 ± 0,5) mm apart, shall be located (3,2 ± 0,05) mm from the bottom of the rim and shall protrude (17 ± 1) mm toward the centre of the rim. The pins shall be spaced to prevent 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. Technical drawings of the rim are provided in Annex A. Information on the placement of additional pins is provided in Annex B.

5.6 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 substrate. The holder shall not clamp the cigarette or stress it in any other manner, nor shall it contact the cigarette within 30 mm of its lit end.

5.7 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 or a hot element igniter shall be used for lighting the cigarette. The air flow and the draw time through the cigarette shall be sufficient to light the cigarette and continue the combustion to within ± 1 mm of the mark 5 mm from the original tip of the cigarette.

5.8 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 6.3.)

6 Verification of test equipment

6.1 Frequency of verification

Verification 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 verifications stated in this method shall be considered to be the minimum.

6.2 Examination for chamber leakage

The test chamber 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.

6.3 Stability of chamber atmosphere

The stability of the air inside the test chamber shall be determined 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 nominally 150 mm above the lit end of the cigarette. This operation shall be conducted prior to use on each day of testing.

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;

c) the air flow of the exhaust system shall be evaluated as the source of the disturbance.

All sources of the turbulence shall be corrected prior to starting testing.

6.4 Humidity and temperature sensors

It shall be assured that the humidity and temperature sensors used to record environmental conditions in the test room, and the conditioning room or conditioning box are operating with the required accuracy. Temperature and humidity shall be validated by using sensors calibrated with a traceable standard. This shall be performed at least weekly unless otherwise prescribed.

NOTE An inaccurate sensor might lead to the rejection of all test data since the last verification of accuracy. One way to lessen this possibility is the use of two independent sensors for temperature and two independent sensors for relative humidity.

6.5 Test performance verification

A laboratory shall verify the performance of the total test system and operator, using a monitor test piece (cigarette) whose ignition propensity has been established using this International Standard or ASTM E2187[1)].

NOTE The frequency of performance verification is determined by the quality control program implemented by the laboratory and also determined by any requirements imposed by e.g. clients and/or regulatory authorities. When the verification is sufficiently frequent and the analytical process is stable, all the test results between two valid verifications are assumed to be valid. By contrast, test results obtained during a period that begins with a valid check result and ends with a non-valid check result are regarded as non-valid, pending the outcome of further investigation. Thus, the frequency of verification is balanced between the magnitude of potentially lost data and the resources expended for verification.

7 Test specimens and standard substrate assemblies

7.1 Handling

Cigarette test specimens and filter paper substrates are sensitive to contamination and shall be handled to avoid any contamination. Test cigarettes shall be handled only by the last nominal 25 mm of the end of the cigarette that is not to be lit. The circular sheets of filter paper shall not be handled in the vicinity where the cigarette will contact the paper during a determination. In all cases, the materials shall be handled with dry hands only.

NOTE The use of clean, dry, non-powdered surgical gloves can mitigate incidental contamination of the test materials while maintaining operator dexterity.

7.2 Cigarettes

7.2.1 Cigarette sampling

For each type of cigarette to be tested, the test specimens shall be representative of a population of cigarettes manufactured for sale. The sampling procedure shall be consistent with one of the methods for sampling, i.e. at the point of sale or at the factory, described in ISO 8243.

7.2.2 Care in handling and storage

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 by the testing laboratory for more than one week, they shall be placed in a freezer at 0 °C to −20 °C reserved for the sole protection of cigarette specimens to minimize the risk of contamination, deformation, or degradation.

7.2.3 Markings

Prior to testing, cigarette test specimens shall be marked, using a soft graphite pencil or other marking device, (5 ± 1) mm and (15 ± 1) mm from the end of the cigarette that will be lit. These marks are used to establish the start (see 9.6) and completion (see 9.11) of a uniform pre-burn period, respectively. Therefore, the marks shall be placed such that they are visible during the test procedure, such as on the cigarette paper seam. Neither the marking of the cigarette nor the mark itself shall distort the cigarette or puncture the cigarette paper.

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1) Standard Reference Material 1082, a standardized cigarette that can be obtained from the (U.S.) National Institute of Standards and Technology, has been widely used for this purpose. Information regarding SRM 1082 can be found at: https://www-s.nist.gov/srmors/view_detail.cfm?srm=1082. This information is provided for the convenience of users of this document and does not constitute an endorsement by ISO.

7.3 Filter paper

7.3.1 General description

The substrates consist of nominal 150 mm diameter circles of Whatman No. 2 cellulosic filter paper[2)]. 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.

7.3.2 Paper mass requirements

For paper from a manufacturer's batch to be used in testing, the mean mass and standard deviation of five sets of 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.

For paper from a manufacturer's batch to be used in testing, the mean mass and standard deviation of five sets 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 ± 2) °C for at least 16 h, placed in a sealed plastic bag upon removal from the oven, cooled to (23 ± 3) °C, and weighed within 3 min of opening the bag. The standard deviation of the five sample weights shall be no more than 0,3 g.

7.3.3 Paper orientation

Determinations shall be conducted with the rough sides of all paper sheets facing up.

8 Conditioning

8.1 Cigarettes

Cigarettes shall be conditioned at the relative humidity and temperature conditions in 5.2.2 for at least 24 h prior to testing. The cigarettes shall be placed in a clean, open 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.

8.2 Filter paper

Boxes of filter paper shall be conditioned at the relative humidity and temperature conditions in 5.2.2 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 ± 5) % and a temperature of (23 ± 3) °C for at least 8 h prior to testing. These filter paper sets shall have been removed from the box and shall be stored with at least 1 mm spacing between the sets to enable free access of air to the specimens.

2) The outcome of a determination is sensitive to the properties of the substrate. Whatman No. 2 is the filter paper with which virtually all prior cigarette ignition propensity data have been developed. This information is provided for the convenience of users of this document and does not constitute an endorsement by ISO. Equivalent products may be used if they can be shown to lead to the same test results. For other types of filter paper, the properties of the paper that need to be controlled can be different from those for the Whatman No. 2 paper, and the mass requirements in 7.3.2 can also be different from those for the Whatman No. 2 paper.

9 Test procedure

9.1 Turn on the exhaust system prior to beginning testing to ensure stable removal of test combustion products.

9.2 Ensure that the substrate holder is in the test chamber at the geometric centre of its bottom. Cover the chimney on the test chamber.

9.3 If the relative humidity and temperature in the test room cannot be maintained within the specified ranges, the filter papers and cigarettes shall be sealed in plastic bags in the conditioning room and transported. Care shall be taken to ensure that test materials are protected from physical damage during transport and prior to use.

9.4 Immediately before testing, place the required number of filter papers in the appropriate orientation on the substrate holder and place the metal rim on top. Discard filter papers that will not lie flat. Ensure that the rough sides of all filter papers are facing up.

If the number of filter papers in the substrate has been pre-determined as one of the three substrates described in Clause 4, testing shall be conducted with the required substrate. If the number of filter papers has not been pre-decided, select the number of filter papers using the procedure in Annex C.

9.5 Place the cigarette holder on the floor of the chamber, just forward of the centre of the substrate holder.

9.6 Without delay, remove a cigarette from the conditioned space. Insert the unmarked end of the cigarette into the cigarette ignition system and hold it in a horizontal position. Turn on the air draw. Hold the ignition flame or hot wire coil just in front of the marked end of the cigarette for as long as is necessary to achieve uniform ignition without passing the 5 mm mark. During the ignition process, the cigarette shall be rotated as needed to obtain an approximately symmetrical burn, avoiding deformation of the cigarette during the process.

If the operator is performing concurrent determinations in multiple test chambers, the operator shall not light a third cigarette until each of the first two cigarettes has been placed on its respective set of filter papers. No more than two cigarettes shall be in the pre-burn stage at any time.

This provision need not be followed by an individual test operator if that operator has demonstrated that lifting the restriction does not introduce error that significantly changes either the measured ignition strength or the uncertainty of that measurement. This determination shall be the responsibility of the testing laboratory.

9.7 Holding the cigarette vertically, lit end up, transport the cigarette to the test chamber.

NOTE It has been found that holding a 600 ml beaker over the lit cigarette is helpful in mitigating the likelihood of a foreign object or room air current impacting the cigarette during transport and thus leading to the need to terminate the determination.

9.8 Place the lit cigarette, in a horizontal position with the cigarette paper seam up, in the cigarette holder.

9.9 Simultaneously close the door and remove the chimney cover.

9.10 If the cigarette self-extinguishes while in the cigarette holder, terminate the determination and record the results as a self-extinguishment, noting that this occurred in the holder. This attempt shall count as a valid determination. The test operator shall be permitted to re-use this set of sheets of filter paper. However, if the room is not at the standard conditioning temperature and humidity (see 5.2.2), the paper shall be reconditioned in a constant humidity box (see 5.2.3).

9.11 When the cigarette has burned to the 15 mm mark, simultaneously cover the chimney and open the chamber door, gently remove the cigarette from the holder, and move the holder to the front corner of the test chamber and ensure that the holder is located where it will not interfere with the remainder of the test operation.

9.12 Gently lay the cigarette with the ash still attached onto the top of the filter papers so that the non-ignited end is placed between the appropriately sized cigarette anti-roll parallel metal pins (5.5 and Annex A). The cigarette paper seam shall be turned up. Do not drop the cigarette onto the filter papers and do not press the lit end into the papers. If the ash falls off during any part of the transport or positioning process, terminate the determination and begin again; do not count the attempt.

9.13 Without delay, simultaneously remove the chimney cover and gently close the door.

9.14 Observe the burning cigarette. The smoke plume near the cigarette shall remain undisturbed. If it does not, the chamber and exhaust system shall be re-checked (see 6.2). If the chamber and exhaust system are in accordance with 6.2, but the particular test cigarette continues to produce a disturbed smoke plume, this observation shall be noted on the test sheet.

NOTE Information on repeatability and reproducibility limits in a similar test method is provided in Annex D.

9.15 Record the following results:

a) full-length burn;

b) no full-length burn;

c) the observations stated in 9.10 and 9.14.

9.16 After the cigarette appears to have ceased burning, open the test chamber door to allow air to circulate throughout its volume.

9.17 Remove the substrate holder from the test chamber and ensure that the cigarette and sheets of filter paper are completely extinguished, for example, by smothering or by application of water. Dispose of the filter paper and cigarette in a safe manner.

9.18 Repeat the determination with a new cigarette, for a total of 40 determinations per test.

9.19 Calculate the fraction of 40 determinations in which the cigarettes burned their full length. This fraction is the test result.

10 Test record

10.1 Results shall be recorded for one test on each of the three substrates, except as described in 9.4 or Annex C.

10.2 Record the following information for each test:

a) laboratory name and address, and identification of the operator performing the determinations;

b) temperature and relative humidity in the laboratory and the conditioning room or (if used) the conditioning box, for each determination;

c) date of sample arrival;

d) identification of the product;

e) description of the sampling procedure, where relevant;

f) date and start time of each determination (if the 40 determinations are run consecutively then the start and end time are sufficient);

g) description of how the test cigarettes where sampled from those supplied;

h) number of layers of filter paper per determination;

i) fraction of 40 determinations in which the cigarettes burned past the front plane of the tipping paper (filter tip cigarettes) or past the tips of the metal pins for non-filter tip cigarettes;

j) observations noted in 9.10 and 9.14.

11 Test report

The test report shall at least include the following information:

a) laboratory name;

b) reference to the test method used, i.e. ISO 12863;

c) date of test;

d) identification of the product;

e) description of the sampling procedure, where relevant;

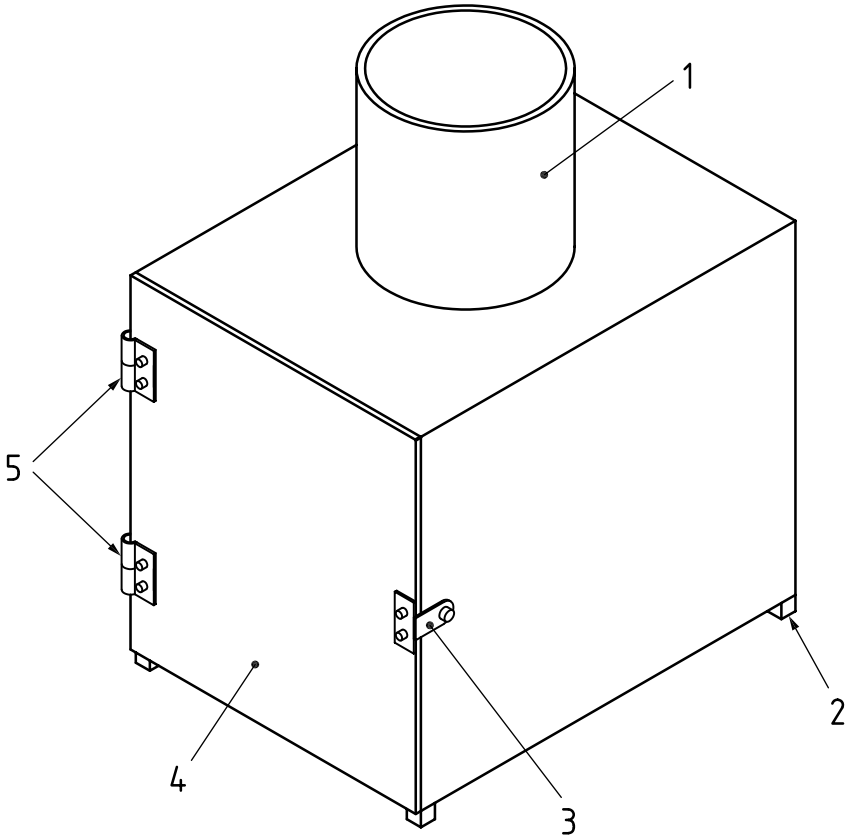
f) number of layers of filter paper per determination;

g) fraction of 40 determinations in which the cigarettes burned past the front plane of the tipping paper (filter tip cigarettes) or past the tips of the metal pins for non-filter tip cigarettes.

Annex A
(normative)

Technical drawings of test apparatus

See Figures A.1 to A.5.

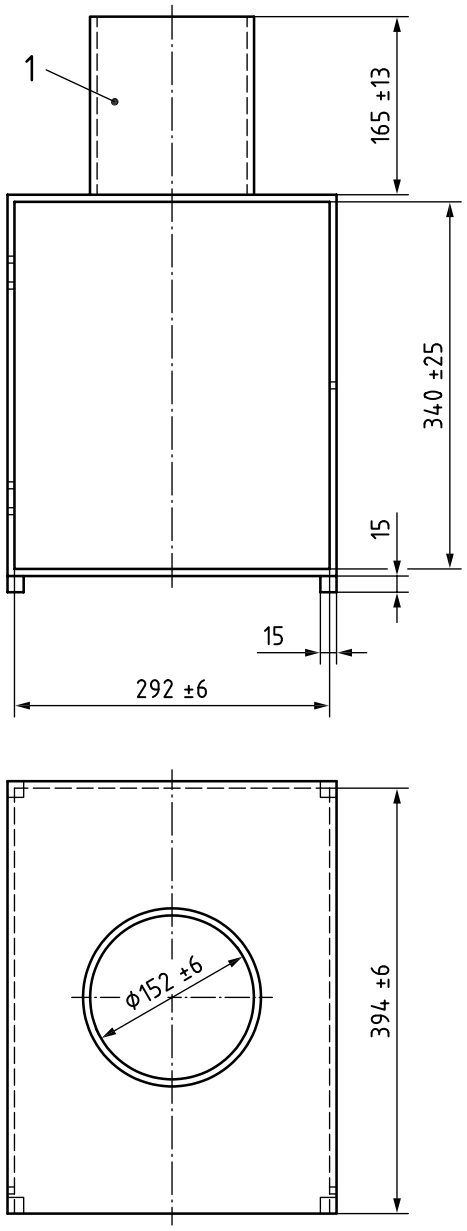


Key

1 chimney
2 feet
3 latch
4 front panel
5 hinges

Figure A.1 — Composite view of test chamber

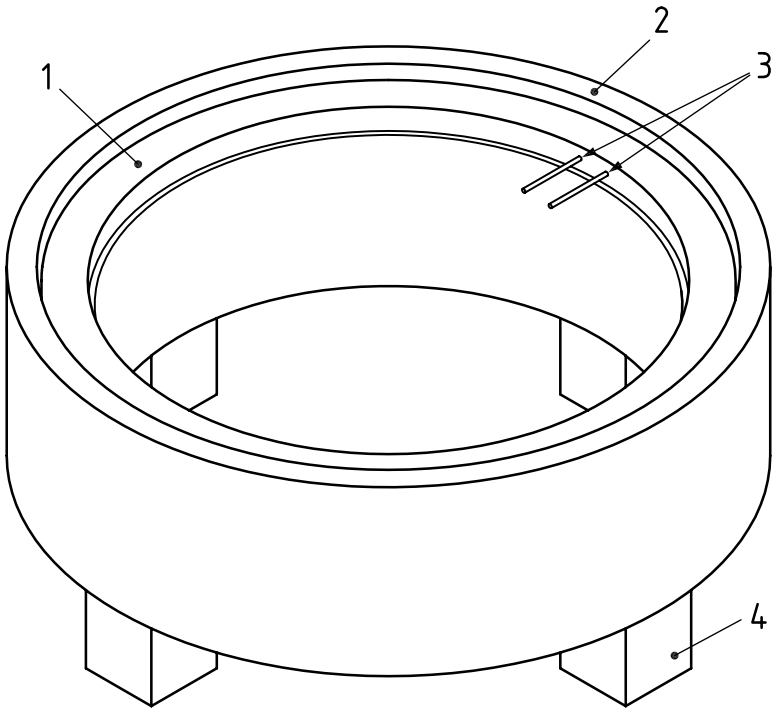
Dimensions in millimetres



Key

1 chimney

Figure A.2 — Dimensions of test chamber components



Key

1 metal rim
2 substrate holder
3 metal pins
4 feet

Figure A.3 — Assembled substrate holder and metal rim assembly

Dimensions in millimetres

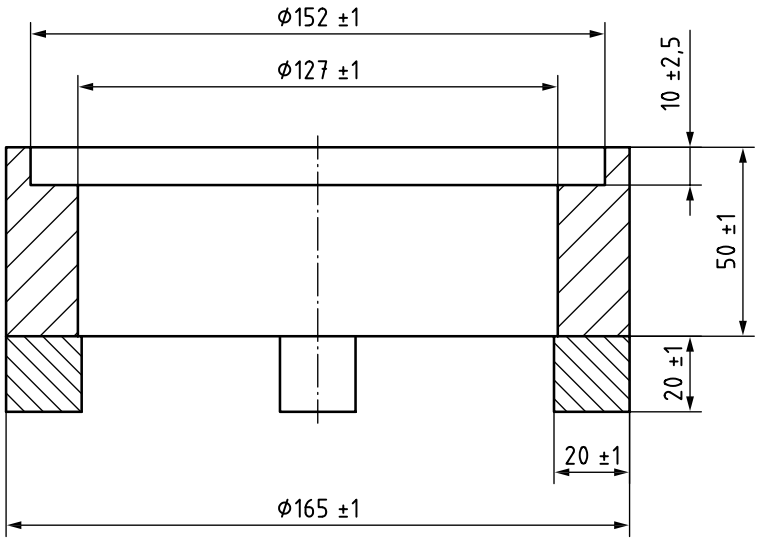


Figure A.4 — View of the substrate holder

Dimensions in millimetres

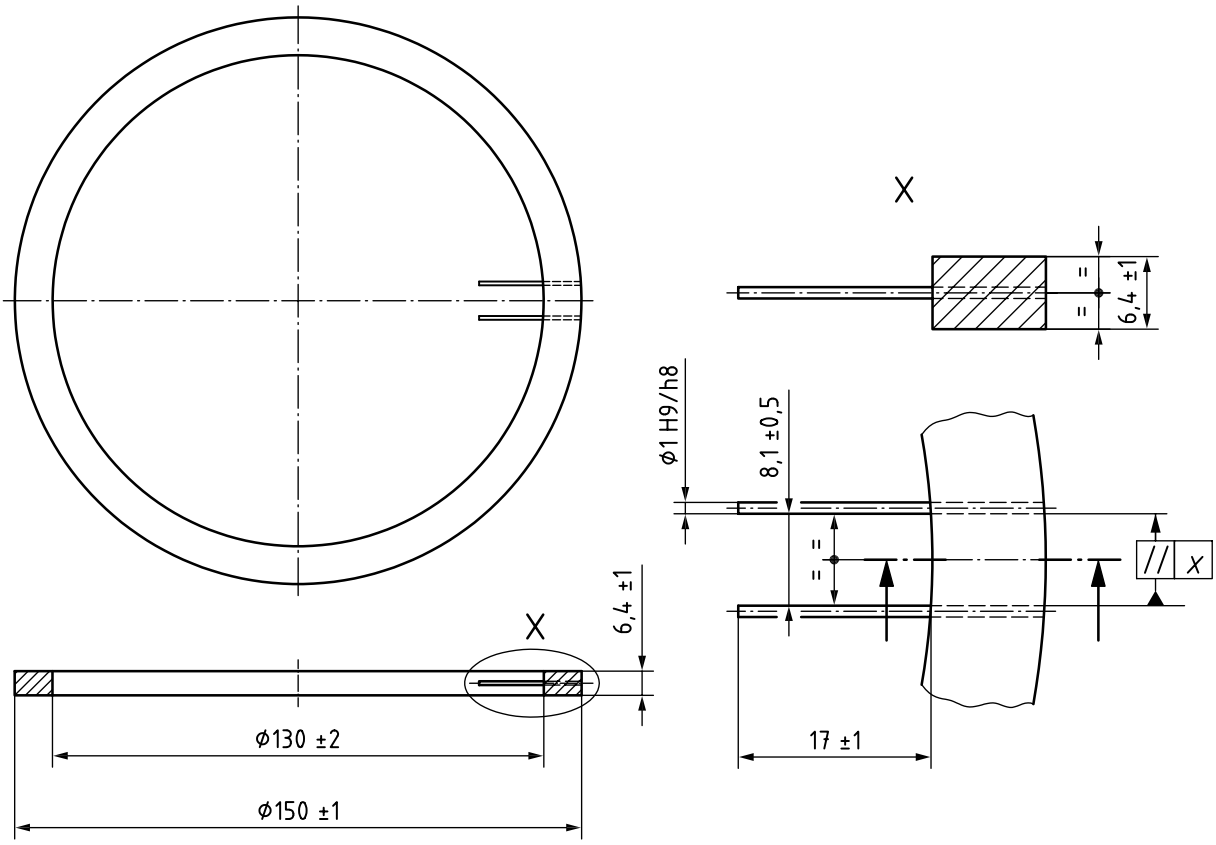


Figure A.5 — Views of the metal rim, with expanded view of pin placement for cigarettes of 8 mm diameter

Annex B
(informative)

Estimation of placement of additional pins

B.1 Proper placement of a pair of pins on the metal rim (5.5) can keep the non-ignited end of a test cigarette from rolling. Depending on the pin separation and the height of the pins from the substrate surface, the behaviours in Table B.1 can result.

Table B.1 — Possible test cigarette behaviour for different combinations of pin separation and pin height

Pin separation relative to cigarette diameter	Pin height from substrate surface relative to cigarette radius		
	Larger	Comparable	Smaller
Larger	Cigarette can roll	Cigarette can roll	Cigarette can roll
Comparable	Cigarette can roll	Appropriate[a]	Cigarette can roll
Smaller	Cigarette will not contact the substrate	Cigarette will not contact the substrate	Either appropriate[b] or cigarette may not contact the substrate[c]
[a,b,c] These superscript letters refer to a), b) and c) in Figure B.1, respectively.			

B.2 When the pins are spaced as described in 5.5, the space between the pins is 8,0 mm. The centerline of the pins is 3,2 mm above the filter paper surface. For a cigarette of 25,0 mm circumference (8,0 mm diameter), the widest part of the cigarette is 4,0 mm above the filter paper surface. The calculated width of the cigarette at 3,2 mm from the filter paper surface is 7,8 mm. Placing such a cigarette between the pins leaves only about 0,1 mm on either side of the cigarette, a reasonable tolerance. This situation reflects the bottom right cell in Table B.1 and drawing b) in Figure B.1. Thus, it is important that the *combination* of pin height and separation be “tuned” to the cigarette being tested. It is not critical that the pins be separated by exactly the cigarette diameter and be at a height equal to the cigarette radius.

B.3 For a given cigarette diameter, one can calculate the width of the cigarette (called the chord) at any height above the surface on which the cigarette is resting. One web site that contains the formula for such a calculation is: www.ajdesigner.com/phpcircle/circle_segment_chord_t.php. For a given pin height, the pin separation needs to be a bit wider than the cigarette chord, so that the test operator can insert the cigarette between the pins without forcing or squeezing the cigarette.

B.4 For the pin placement in 5.5, the metal rim is symmetric, i.e. inserting the rim upside down into the substrate holder makes no difference in the pin height above the filter paper surface. Should the pins not be located on the centerline of the metal rim, it would be helpful to mark the top surface of the rim.

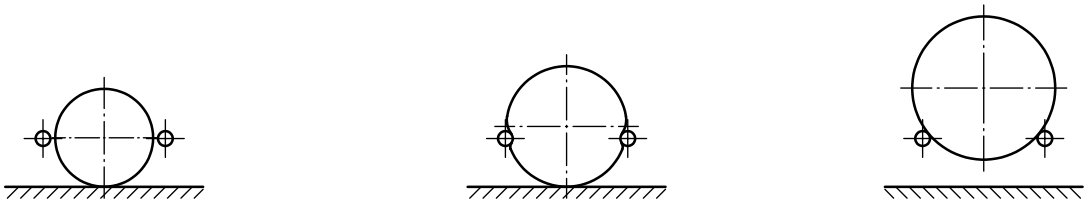
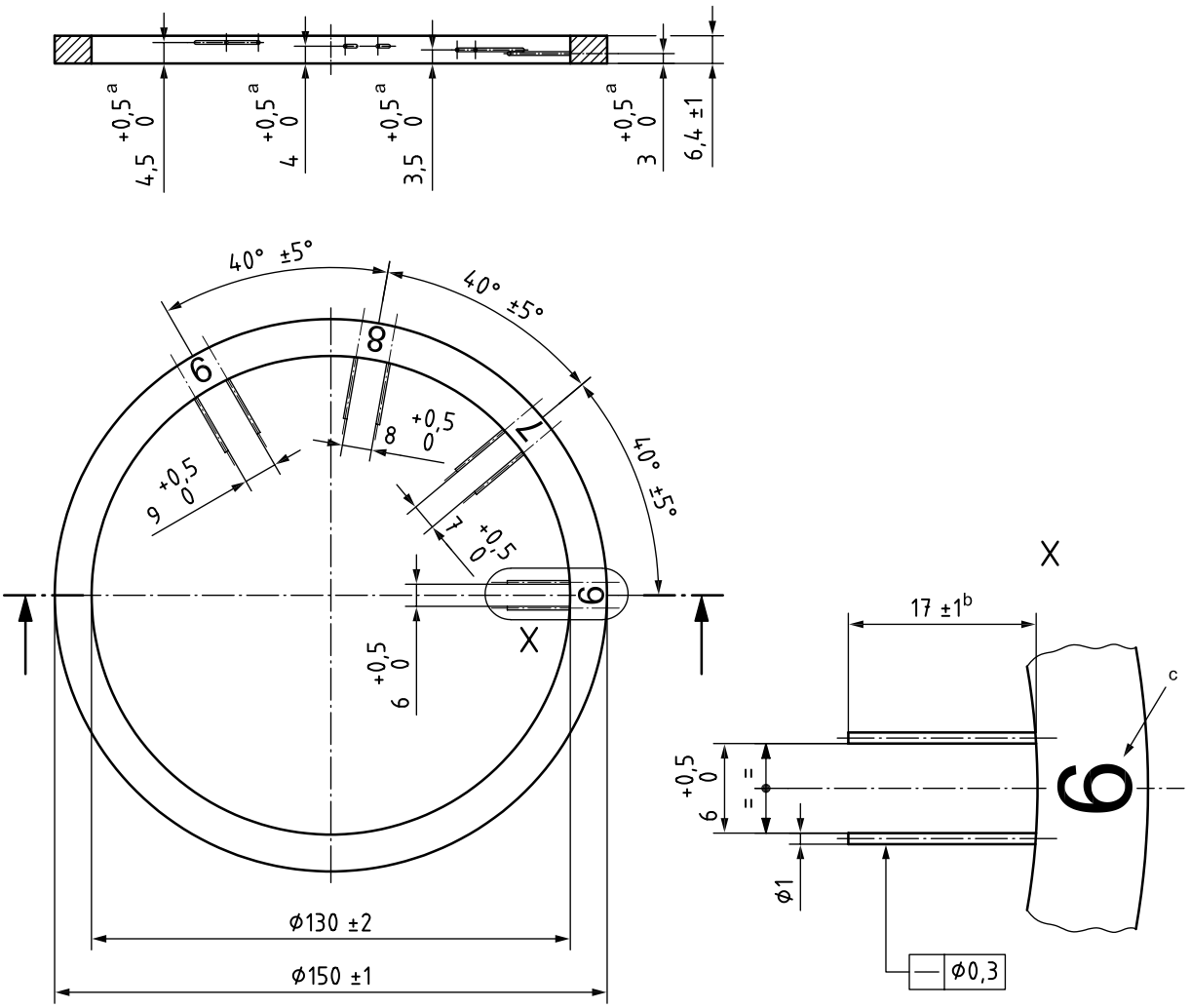


Figure B.1 — Examples of pin separation and height on possible cigarette behaviour

B.5 Figure B.2 shows an example of multiple pin placement.

Dimensions in millimetres



a Pin distance from bottom of rim should be approximately half of distance between pins.

b Pin protrusion.

c Optional number at pin position.

Figure B.2 — Example of multiple pin placement

Annex C
(normative)

Procedure for selection of substrate assemblies for testing

C.1 The performance of a cigarette design on all three substrate assemblies shall be evaluated unless the number of layers of filter paper has been pre-decided.

C.2 In the absence of any information about the likely performance of the cigarette design, testing shall begin with 15 layers of filter paper.

a) If full length burning of the cigarette is observed in over 90 % of the determinations with 15 layers, then it shall be presumed that testing on 3 or 10 layers would also produce virtually all full length burns and no testing on those substrate assemblies shall be performed. See Annex E.

b) If full length burning is observed in under 90 % of the determinations with 15 layers, then testing shall proceed using 10 layers. If full length burning is observed in over 90 % of the determinations with 10 layers, then it shall be presumed that testing on 3 layers would also produce virtually all full length burns and no testing on those shall be performed. If full length burning is observed in under 90 % of the determinations with 10 layers, then testing shall proceed using 3 layers.

C.3 If there is information about the likely performance of a cigarette design that suggests a low tendency to ignite furnishings, the test operator shall have the option to begin testing with 10 or 3 layers of filter paper.

a) Starting with 10 layers. If full length burning is observed in over 10 % of the determinations with 10 layers, testing shall proceed using 15 layers. It shall be presumed that testing on the assemblies using 3 layers would also produce virtually all full length burns and no testing on that substrate assembly shall be performed. If full length burning is observed in under 10 % of the determinations with 10 layers, then testing using 15 layers shall not be performed and testing shall proceed using 3 layers.

b) Starting with 3 layers. If full length burning is observed in under 10 % of the determinations with 3 layers, then testing using 10 and 15 layers shall not be performed. If full length burning is observed in over 10 % of the determinations with 3 layers, testing shall proceed using 10 layers. If full length burning is observed in over 10 % of the determinations with 10 layers, testing shall proceed using 15 layers.

c) The test report shall address the performance of a cigarette on all 3 types of substrate assemblies. For those assemblies on which no testing was performed, as prescribed in C.2 and C.3, the outcome of the trial shall be described as “Substrate not required to be tested”.

Annex D
(informative)

Repeatability and reproducibility

The repeatability and reproducibility of a test method nearly identical to this was established during an inter-laboratory evaluation conducted according to ASTM Practice E691 [1]. The only differences were that the cigarettes were supported in a vertical rather than a horizontal position during the pre-burn period (see 9.14) and that 16 replicates were performed. The evaluation involved 9 laboratories, 5 cigarette types, and 3 substrates, each with a different number of filter papers [2].

The repeatability, r, and reproducibility, R, limits have then been calculated for 40 determinations in a test and the fractions of cigarettes that produced full-length burns (P), assuming a binominal distribution:

Table D.1 — Repeatability and reproducibility limits for a test involving 40 replicate determinations

P	r (n)	R (N)
0,05 or 0,95	0,10 (4)	0,11 (4)
0,10 or 0,90	0,13 (5)	0,16 (6)
0,20 or 0,80	0,18 (7)	0,21 (8)
0,30 or 0,70	0,20 (8)	0,24 (10)
0,40 or 0,60	0,22 (9)	0,26 (10)
0,50	0,22 (9)	0,26 (10)

r Band within which differences among repeat test results (same laboratory) will fall about 95 % of the time.

R Band within which differences among test results from different laboratories will fall about 95 % of the time.

n Number of full-length burns within which differences among repeat test results (same laboratory) will fall about 95 % of the time.

N Number of full-length burns within which differences among test results from different laboratories will fall about 95 % of the time.

Annex E
(informative)

Ignition susceptibility of substrate assemblies

During the development of this test method, it was established[2] that the filter paper substrates showed a systematic progression in measuring ignition strength, i.e. the capability of potentially initiating a fire while heat is being drawn from the cigarette. Additional data were subsequently developed for two commercial cigarettes[3]. In Table E.1, the cigarettes are listed in decreasing order of ignition strength. The cigarettes with high percentages of full-length burns on the filter paper substrates generate enough heat to keep burning and thus are more likely to ignite soft furnishings than the cigarettes with lower such percentages. This means that, relative to a substrate assembly using 3 or 10 layers of filter paper, the 15-layer assembly requires a stronger heat source (cigarette) for full length burning.

Table E.1 — Percent ignitions or full-length burns on test method substrates

Cigarette	Substrate					
	3 layers	Duck No 10	10 layers	Duck No 6	15 layers	Duck No 4
B	100	100	100	92	94	73
503	100	100	100	100	100	53
Conventional[3]	100	100	100	100	100	19
501	100	100	100	100	100	11
D	100	100	94	73	88	46
E	100	100	100	96	94	0
531	99	98	94	95	88	0
A	100	100	94	92	38	4
F	100	100	100	79	19	0
Banded[3]	39	37	8	50	12	3
529	57	30	6	8	2	0
530	6	3	0	0	0	0

Table E.1 also shows that the substrates used in this test method produce results consistent with those from a similar method that measures the propensity of cigarettes to ignite substrates made of standard cotton fabrics and flexible polyurethane foam.

Analysis of the data from the cigarette industry studies of 500 and 300 upholstery fabrics[4][5][6] has shown that most fabrics (80 % and 70 %, respectively) that discriminated among four test cigarettes ranked these cigarettes in the same order as did the cotton duck test fabrics[7][8][9]. In both studies, the remainder of the test fabrics produced some reversal of cigarette rankings.

There is a good correlation between actual pieces of furniture and mock-ups made of the same materials[10].

It is thus expected that significantly improved performance on this test method will lead to reduced ignitions of soft furnishings.

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