INTERNATIONAL STANDARD

ISO 16840-10

Second edition
2021-06

Wheelchair seating —

Part 10: Resistance to ignition of postural support devices — Requirements and test method

Sièges de fauteuils roulants —

Partie 10: Résistance à l'inflammation des dispositifs de soutien postural — Exigences et méthode d'essai

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 173, *Assistive products*, Subcommittee SC 1, *Wheelchairs*.

This second edition of ISO 16840-10 cancels and replaces ISO 16840-10:2014 and ISO 7176-16:2012, which have been technically revised.

The main changes compared to the previous edition are as follows:

— inclusion of the other postural support devices originally covered by ISO 7176-16:2012 rather than just seat and back support cushions;

— inclusion of integrated as well as non-integrated postural support devices;

— provision for postural support devices that are smaller than the specified test sample size;

A list of all parts in the ISO 16840 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ignition and subsequent burning of wheelchairs is very rare, but this can occur as a result of

— being close to a burning object such as a fire beside the wheelchair,

— overheating of any electrical or electronic device on the wheelchair, and

— contact from sparks or flames (such as welding sparks, cigarettes, or matches).

Wheelchair occupants are at particular risk of injury or death from these fires and resulting fumes because it is very possible that they do not have the ability to move away from the wheelchair.

NOTE In the United States, data collected in the 1990s showed that only a small number of individuals per million wheelchair users had died due to fire.[7] Public FDA records indicate that most 21st century flammability incidents involving wheelchairs are from electrical faults.[8]

Wheelchairs can be considered to comprise the following components:

a) structural components such as the frame, wheels, etc., that are essential to the mechanical integrity of the wheelchair;

b) power-related components, such as motors, energy sources, controllers, etc., that are required for the functioning of powered devices on wheelchairs.

c) integrated or non-integrated devices to manage tissue integrity, such as seat and back support cushions, that are intended to have primarily a clinical function to minimize the risks of skin damage (these can also be intended to control or accommodate posture);

d) postural support devices, including, but not limited to, sling seats, sling back supports, arm supports, foot supports, pelvic positioning supports (hip belts), anterior trunk supports (harnesses and chest belts), lateral pelvic/trunk supports (lateral pads), etc., that are attached to the wheelchair and are primarily intended to give positioning and postural support to the wheelchair occupant (these can also be intended to aid in pressure redistribution).

Each of the above components has a different severity of risk associated with its likelihood of igniting and its resulting harm to the wheelchair occupant. This document specifies requirements and test methods to help manufacturers and purchasers of wheelchairs to design and procure wheelchairs and their components that are appropriate for the risk of ignition balanced against the functional needs of the wheelchair occupant. The aim of this document is to provide appropriate alternatives to using furniture-based flammability standards, to reflect the uses and purposes of wheelchairs and their accessories.

At the time of publication of this document, there is yet no International Standard on the resistance to ignition of structural components [see list item a) above].

The power related components [see list item b) above] are the subject of ISO 7176–14, which specifies requirements to prevent overheating in electrical components that could lead to a fire.

The tissue integrity devices [see list item c) above] and postural support devices [see list item d) above] are the subject of this document. For this purpose, using a smouldering cigarette as a standardized heat source is not necessarily a reproducible heat source, since the heat output between cigarettes from within one pack is variable, and between different packs even more so. Since the early furnishing flammability standards were introduced, filter tipped and fire safe cigarettes have evolved, and thus today, testing is not being carried out with the equivalent heat source as when the furnishing flammability standards were first drafted. The aim of this document is to describe a reproducible standardized heat source output comparable with that employed in the original flammability standards, and that can be scaled to equate with other heat sources.

The pass criteria within this document have been set at a basic minimum level and are less severe than current requirements in some countries. However, given the minimal risks of flammability as a

hazard in wheelchair seating and the significant potentially adverse health effects of flame retardants, strong consideration should be given to utilizing this document as the ignition resistance standard for all wheelchair seating textiles/soft components that interface with the human body. Eliminating the more severe flame resistance required by furniture standards and in ISO 7176-16:2012 allows the use of more clinically appropriate textiles for the health and comfort of the wheelchair user.

Good practice is also to use materials that minimize the risk of release of toxic substances as a result of ignition and that do not pose a biocompatibility risk to the wheelchair user. The change of emphasis around the materials to use minimizes the use of toxic and hazardous flame-retardant chemicals, which is preferable due to the minimal contribution of seating system materials to fire severity. Materials chosen are required to conform to biocompatibility requirements and risk management guidance of ISO 10993–1, which includes consideration of cytotoxicity, sensitization, and irritation evaluation for surface devices in contact with the skin as covered by ISO 10993-5 and ISO 10993-10.

The day to day usage of a wheelchair can affect its materials' resistance to ignition through cyclic loading, movement of materials, washing, cleaning, etc. Manufacturers will often take this effect into account as part of their risk assessment when selecting materials for their products to minimize the effects of this normal use. However, although this document can be used on parts that have been used, etc., the test samples specify new or unused parts.

Different environments commonly encountered by some wheelchair occupants can also affect the flammability of materials. For example, home oxygen systems, delivery systems for drugs carried in an inflammable medium, etc., can turn a non-combustible material into a flammable one. Dust and other materials accumulated within the chair have also been found to be a source of readily ignitable material. Wheelchair manufacturers and occupants should be aware of these risks and should design and use wheelchairs accordingly, as covered by ISO 14971.

Wheelchair seating —

Part 10: Resistance to ignition of postural support devices — Requirements and test method

1 Scope

This document specifies requirements and test methods to assess the resistance to ignition by smouldering cigarette equivalent of integrated or non-integrated components of a wheelchair intended to protect tissue integrity and/or provide postural support. The electronic ignition source is also a simulation of other potential sources of environmental ignition hazards.

The tests measure only the resistance to ignition of the items tested, and not the ignitability of the complete wheelchair. It gives an indication, but cannot guarantee, the ignition behaviour of the assembled devices of a complete wheelchair.

This document does not apply to resistance to ignition of structural parts of a wheelchair. This document does not cover changes in resistance to ignition as a result of regular washing or use of the postural support devices.

This document does not apply to the control of risks created by electrical and electronic components.

This document allows for the separate testing of components of a wheelchair that are normally used in the horizontal plane (e.g. a seat cushion) from those normally used in the vertical plane (e.g. a back support).

This document describes testing an assembly of the composite of materials as used in the component. The results of the tests in this document do not give any indication of the resistance to ignition of any of the separate individual materials of the test sample.

NOTE The intent of this document is primarily to address components that interface with the human body, such as cushions for positioning, or whose described purpose is that of protecting skin tissue against pressure, shear, and maceration related damage, as well as textile, foam, and plastic-based postural support devices.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 7176-15, *Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling*

ISO 7176-26:2007, *Wheelchairs — Part 26: Vocabulary*

ISO 8191-1:1987, *Furniture — Assessment of the ignitability of upholstered furniture — Part 1: Ignition source: smouldering cigarette*

ISO 14971, *Medical devices — Application of risk management to medical devices*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7176–26 and ISO 8191–1:1987 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
flaming
undergoing combustion in the gaseous phase with the emission of light

[SOURCE: ISO 8191–1:1987, 3.2]

3.2
non-integrated
detachable without the use of tools

Note 1 to entry: Seat or back support cushions held in place by hook and loop fastenings are also considered non-integrated.

3.3
postural support device
PSD
structure, attached to a wheelchair, that has a surface that contacts the occupant's body and is used either to modify or to accommodate the occupant's sitting posture

EXAMPLE seat, back support, lateral support, head support, pelvic positioning belt, anterior trunk support

[SOURCE: ISO 7176-26:2007, 4.7.3]

3.4
progressive smouldering
exothermic oxidation, not accompanied by *flaming* (3.1), that is self-propagating, i.e. independent of the ignition source

Note 1 to entry: It might or might not be accompanied by incandescence.

[SOURCE: ISO 8191–1:1987, 3.1]

4 Principle

Test materials used in integrated and non-integrated seat and back support, and other postural support devices as used in wheelchairs are assembled in either horizontal or vertical samples and subjected to a heat source that is equivalent to a smouldering cigarette. The resulting effects on the test materials are observed and measured.

NOTE The tests are repeated one time to ensure that they are repeatable, but without incurring the costs of more tests than needed as a minimum

The pass criteria within this document have been set at a basic minimal level and are less severe than current requirements in some countries. Where practical, manufacturers shall use materials with superior resistance to ignition, when the overall risk analysis indicates the benefits outweigh any unintended harm, in accordance with ISO 14971.

5 Health and safety of test personnel

5.1 General

WARNING — The following test requirements call for the use of procedures that can be hazardous to health if adequate precautions are not taken.

The precautions listed in 5.2 and 5.3 are drawn from ISO 8191–1:1987, Clause 6.

Ensure that there is no hidden smouldering of the sample before disposal.

5.2 Enclosure

For safety, the tests should be conducted in a non-combustible fume cupboard. If such a cupboard is not available, a test enclosure shall be constructed (see 6.2) so that the operator is protected from the fumes.

5.3 Extinguishers

Adequate means of extinguishing the assembly shall be provided, bearing in mind that some product combinations can produce severe flaming during the test.

NOTE A hand and/or a fixed water spray that can be directed over the burning area is useful. Other means such as fire extinguishers (water and halogenated hydrocarbons), fire blankets, and a bucket of water will assist in extinguishing. In some cases, smouldering can be difficult to extinguish completely and complete immersion in water can be necessary.

6 Apparatus

6.1 Test rig

An example of a suitable test rig is found in ISO 8191–1:1987.

NOTE The frame of the test rig described as the back frame with a width of 450 mm ± 2 mm, but with a height of 450 mm ± 2 mm can be used for both the horizontal and vertical tests.

6.2 Test enclosure

The test enclosure shall consist of either a room with a volume greater than 20 m^3 (that contains adequate oxygen for testing) or a smaller enclosure with a through flow of air. Inlet and extraction systems providing air flows of 0,02 m/s to 0,2 m/s in the locality of the rig provide adequate oxygen without disturbing the burning behaviour.

NOTE This enclosure is the equivalent to that specified in ISO 8191–1:1987, 7.2.

6.3 Timer

A means of measuring time for a period of 5 s to 1 000 s with an accuracy of ±0,1 s.

6.4 Heat source

A temperature-controlled heat source consisting of two separate parts.

a) A heat source conforming to the following:

   — 8 mm ± 0,5 mm diameter;

   — 75 mm ± 5 mm heated length;

— 200 W ± 20 W heat output;

— K-type thermocouple integrated in the centre of the heat source;

— minimum wire length of 3 m;

— heat resistant wire insulation;

— a fixture to hold the heat source in place throughout the test, designed to avoid burns while handling the heat source.

b) A temperature controller conforming to the following:

— temperature controller with automatic identification of the control area or model based tuning of the controller parameters;

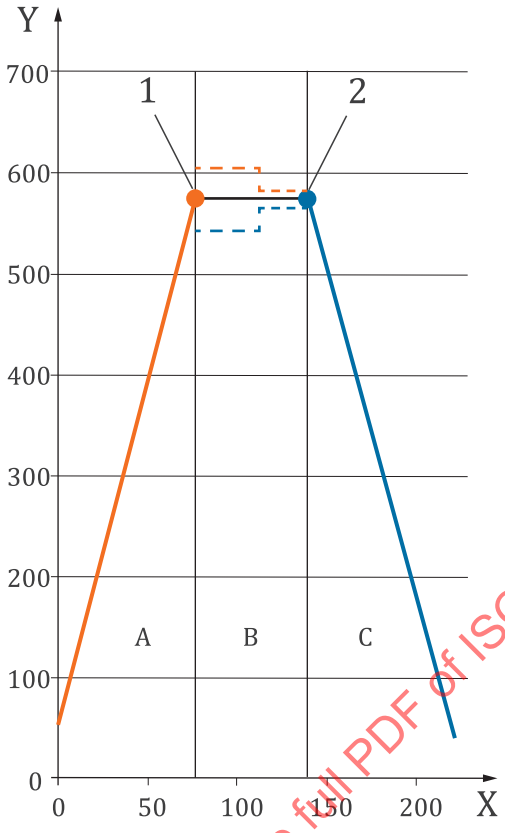
— the temperature values follow the temperature heating curve in Figure 1 and Table 1 automatically during the test cycle.

NOTE 1 Annex A provides details of an apparatus that meets these specifications.

NOTE 2 This source has been designed to give a calorific output approximating to that of a stabilized smouldering cigarette (ISO 8191–1:1987).

NOTE 3 By adjusting the parameters of the set point curve, this apparatus can be utilised to simulate a 'match' or other heat source.

NOTE 4 Other means, such as a NiCr coil, that achieve the same heat transfer to the test sample, can be used as an alternative heat source.



Key

X	time (s)
Y	°C
A	warming heat source phase
B	test cycle phase (step-down tolerances allows time for devices to adjust to setpoint)
C	cooling heat source phase
1	application of heat source and beginning of test cycle
2	end of test cycle and removal of heat source
———	ramp down (cooling)
———	ramp up (heating)
———	plateau (set point)
- - - -	minimum value (+ tolerance)
- - - -	maximum value (- tolerance)

Figure 1 — Temperature-time-diagram of the test cycle with set point curve and allowed tolerances

Table 1 — Set point table for the test

	Duration	Initial set point	Final set point
Ramp	Variable	<150 °C	575 ± 30 °C
Plateau	30 s ± 1 s	575 °C ± 30 °C	575 °C ± 10 °C
Plateau	30 s ± 1 s	575 °C ± 10 °C	575 °C ± 10 °C

6.5 Conditioning environment

Prior to conditioning described below, all removable covering materials shall be subjected to the washing and drying procedures described in Annex B.

An environment with an atmosphere that can be maintained for up to 20 h at a temperature of 23 °C ± 2 °C and relative humidity of 50 % ± 5 % as specified in ISO 554 shall be employed.

6.6 Test environment

An environment in which the test procedure in Clause 7 can be conducted and that has an atmosphere with a temperature between 10 °C and 30 °C and a relative humidity between 15 % and 80 %.

In the area of the test rig within 100 mm ± 5 mm of the heat source, the airflow shall be less than 0,2 m/s.

6.7 Test sample

6.7.1 General

6.7.1.1 Test samples shall be in new or unused condition. A test sample shall consist of the materials as assembled in the final product, and include: cover, filling, and any other components (such as an interliner) that can possibly be used.

Spray-on flame retardant substances shall not be relied on unless the durability of their effectiveness for the life of the manufactured part is confirmed.

6.7.1.2 If the postural support device is designed to be used only with its cover, then the test sample shall include that cover.

6.7.1.3 If the postural support device is designed to be used only with its cover from a choice of covers, each cover option shall be tested separately in combination with that device.

6.7.1.4 If the postural support device is designed to be used either with or without its cover, then the device shall be tested with and without its cover.

6.7.2 Seat and back support cushions

The sample shall have dimensions of a minimum width of 300 mm and a maximum width of 450 mm, and a depth or length of a minimum of 300 mm and a maximum of 450 mm.

NOTE A manufactured, non-integrated seat or back support cushion, provided that it is no smaller than the minimum dimensions or no larger than the maximum dimensions specified above, can be used.

6.7.3 Other postural support devices

Use a sample consisting of materials assembled as used in the relevant postural support device, and with dimensions comprising a minimum width of 30 mm in one dimension and a length of a minimum of 150 mm in the second dimension, and flat over at least 95 % of the surface projection.

A manufactured part may be used, provided that it is no smaller than the minimum dimensions.

7 Test procedure

7.1 Preparation

a) Identify the PSD.

b) Select the surface(s) that the manufacturer assesses to be at risk from a fire source (see Annex C).

c) If testing items that are intended to be used only in the range of the horizontal plane ±30°, use the horizontal test, and for all other supports, use the vertical test. If the part is intended for use in either plane, then only the vertical test is necessary.

d) Attach the test sample(s) to the test rig(s).

e) Place the test rig and sample in the conditioning environment for a minimum of 16 h.

f) Ensure the heat source is below 50 °C.

7.2 Horizontal test

a) Set up the test sample mounted in the test rig or on the wheelchair in a horizontal orientation ±3° in the test environment;

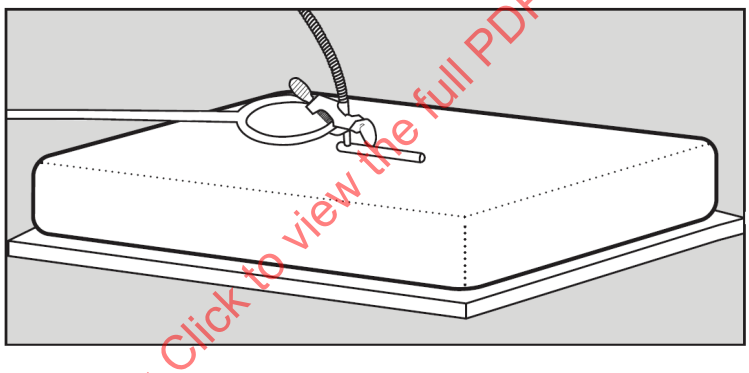


Figure 2 — Placement position of heat source cartridge on a horizontal surface

b) When using the heat source specified in 6.4, apply within 50 mm ± 5 mm of the centre of the top surface and parallel to the top surface of the test sample with a force to within a range of 0,1 N to 0,5 N, and without a gap, as far as is practically possible, during the test (see Figure 2);

Ensure that the heat source is in constant contact with the sample throughout the test.

NOTE This can be achievable by means of a pendulum device.

c) Switch on the heat source. When the initial plateau temperature of 575 °C ± 30 °C has been reached, the test phase of the cycle begins. Observe the subsequent progress of combustion, and record any evidence of progressive smouldering, or flaming in the interior and/or surface. Remove the heat source at the end of the 60 s plateau phase. Disregard any afterglow, smoking, or smouldering that ceases within 20 s of the end of the plateau of the heat temperature curve;

d) Repeat a) to c) once on a new or the same test sample in an unaffected area.

Ensure that there is no carbon build up on the heat source between tests.

7.3 Vertical test

Perform the test specified in 7.2, but with the following adjustments:

a) The test rig supported in a vertical configuration (of the contact surface);

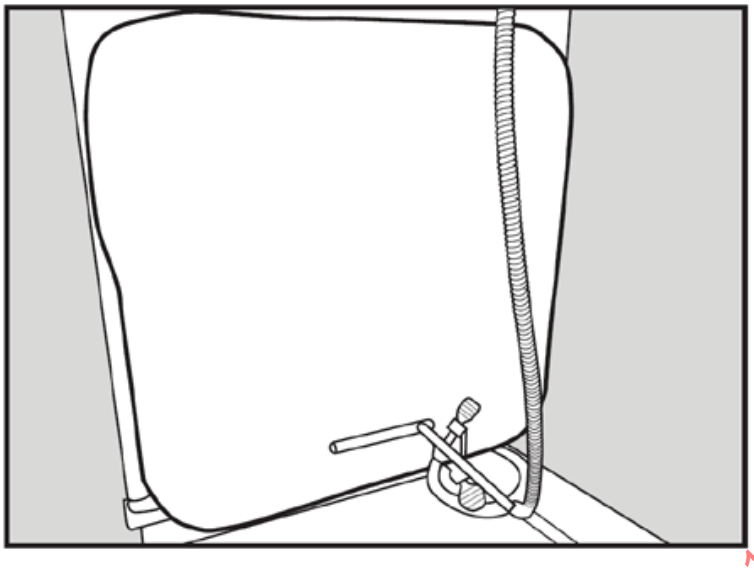


Figure 3 — Placement position of heat source cartridge on a vertical surface

b) When using the heat source specified in 6.4, apply half way ±5 mm across the test sample in the width dimension and at a distance of (0,1 h + 20) mm ± 5 mm above the lowest side of the test sample where *h* = total length of the test sample in mm in the length dimension (see Figure 3);

c) Align the heat source in the horizontal plane and parallel ±3° to the contact surface of the test sample with a force of 0,5N ± 0,1 N from the heat source, nor a gap between the heat source and the sample (see Figure 3);

Ensure that the heat source is in constant contact with the sample throughout the test;

NOTE This can be achievable by means of a pendulum device.

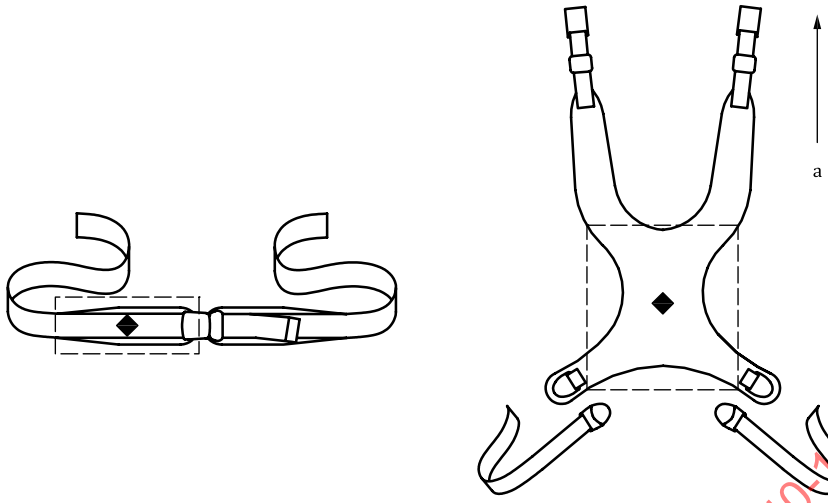
d) Switch on the heat source. When the initial plateau temperature of 575 °C ± 30 °C has been reached, the test phase of the cycle begins. Observe the subsequent progress of combustion, and record any evidence of progressive smouldering, or flaming in the interior and/or surface. Remove the heat source at the end of the 60 s plateau phase. Disregard any afterglow, smoking, or smouldering that ceases within 20 s of the end of the plateau of the heat temperature curve;

e) Repeat a) to d) once on a new or the same test sample in an unaffected area.

Ensure that there is no carbon build up on the heat source between tests.

7.4 Smaller PSDs

For PSDs that are smaller than the sample sizes specified in 6.7, apply the heat source to the centre of the largest area that could be exposed to an external ignition source when the device is in use. See Figure 4 for examples. In these examples, the red box defines the largest surface region that could be exposed to a falling heat source, and the diamond indicates the centre of this region. The PSD shall be positioned according to the typical orientation for its intended use.



a Vertical.

Figure 4 — Examples of heat source application positions for small PSDs

8 Requirements

In horizontal and vertical orientations, when subjected to the heat source specified in 6.4, PSDs used in a wheelchair shall

a) show no evidence of flaming in the interior and/or surface during or after the test, and

b) show no evidence of progressive smouldering 20 s ± 1 s after the end of the maximum temperature plateau of the temperature heating curve.

9 Test report

The test report shall include the following:

a) date of the test report;

b) name and address, and accreditation status, if any, of the test institution;

c) a statement confirming that prior to testing, equipment was calibrated or verified against measurement standards traceable to international or national measurement standards. When no such standards exist, the basis used for calibration or verification shall be recorded;

d) a statement that "The following test results relate only to the ignitability of the combination of materials under the particular conditions of the test. They are not intended as a means of assessing the full potential hazard of a complete wheelchair";

e) identification and construction of the test samples;

f) name and address of the manufacturer(s) of the test sample tested;

g) materials references, a brief description, and any batch or serial numbers;

h) photographs of the end result of the test;

i) results of the tests carried out, and a statement as to whether the materials met the requirements of this document, with the exception of Clause 10;

j) a unique test report reference.

10 Disclosure of results

Manufacturers shall disclose in their specification sheet(s), in the manner and sequence specified in ISO 7176–15:

a) if the PSD met the requirements of this document;

b) that resistance to ignition can change with use, ageing, and/or cleaning;

c) that precautions should be taken to avoid sources of ignition, including flames, cigarettes, etc.;

d) that the environment (such as oxygen, alcohol, etc.) of the user can increase the risk of ignition;

e) whether the component is designed to be used either with or without a non-integrated cover, or only with a specified cover, and has been tested as such.

NOTE The results of this test do not give any indication of the resistance to ignition of any of the separate individual components of the test sample, unless stated otherwise.

Annex A
(informative)

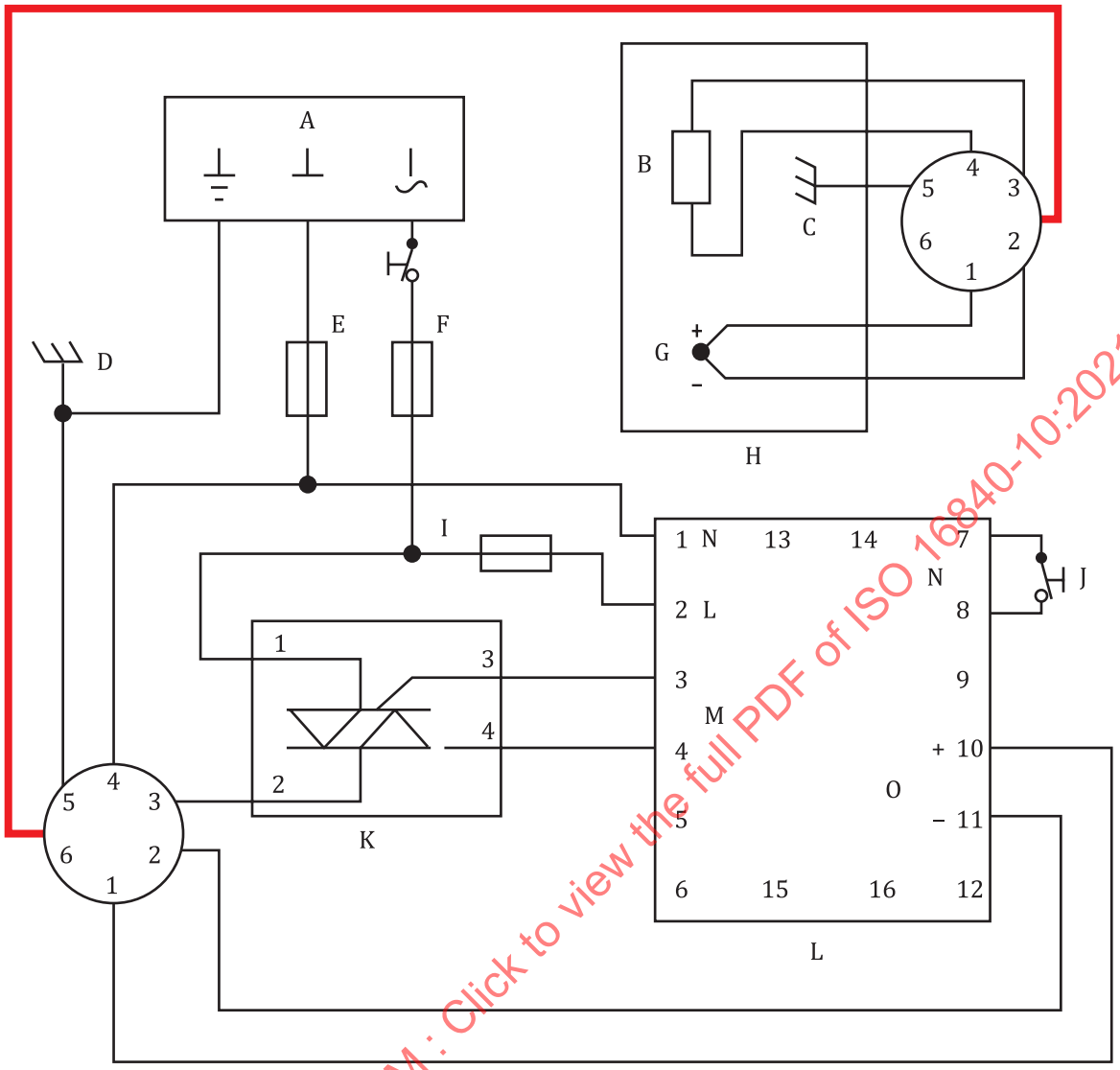
Design of a heat source as a surrogate cigarette device

Annex A provides details of a heat source that meets the specifications in this document. The heat source consists of two main parts. The heat source is realized by a heating cartridge with glass silk isolated wires and a 90° pipe adapter to be fastened at the fixture. The digital temperature controller triggers the solid state relay and provides a button to start the test cycle. Table A.1 provides a parts list where accessories are included. Figure A.1 shows the connection diagram for 230 VAC mains voltage. While the temperature controller works with 115 VAC to 230 VAC, the heat source can easily be changed for use with another mains voltage. For that purpose, a different heating cartridge is needed that provides the requested 200 W ± 20 W power consumption at the specified mains voltage. Table A.2 shows the parameters for programming the HotControl C248 from the HotSet company. Note that some parameters are identified automatically during the identification of the control area. The sample apparatus is shown in Figure A.2.

Table A.1 — Parts list

Item No	Element	Description
1	Temperature controller	HotSet Hotcontrol® [a] C248
2	Heating cartridge with thermo sensor	HotSet Hotrod® [a] HHP 8 mm × 80 mm 250 V 200 W K-type thermo- couple
3	Box base	2 Fischer Elektronik KOH6 [a]
4	Cover	2 Fischer Elektronik H6 [a]
5	Solid state relay	Crydom D2425 [a] 250 V 16 A
6	Protective cover for relay	Crydom D2425 [a]
7	Connector	Hirschmann Ca-6 GD [a]
8	Connector	Hirschmann Ca-6 LS [a]
9	Power entry module including fuse holder and main switch	Schurter KM [a]
10	Fuse holder for power entry module	Schurter KM [a]
11	Power cable	1,8 m
12	3 Fuse holders	
13	3 Fuses	2 250 V 0,63A F 1 250 V 0,2A T (delayed)
14	Start button	Push button
15	Consumables	Cables, eyelets, screws, etc.

[a] This is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.



Key

A 230 VAC Mains supply
B heating wire
C ground
D box ground
E F630 ma fuse
F F630 ma fuse
G K-type (NiCrNi) Thermocouple
H HotSet HotRod 8x80 200 W Heating Cartridge
I 200 mA fuse
J start switch
K crydom D2425 Solid state relay
L HotSet HotControl C248 Temperature Controller
M doul2
N din
O thermoln

Figure A.1 — Connection diagram

Table A.2 — Parameters for HotSet HotControl C248 temperature controller

Parameter	Value	Default	Parameter	Value	Default	Parameter	Value	Default
sp	150		sp.cb	0	✓	sen.s	off	✓
manu	Off	✓	gp.rt	0	✓	off.a	0	✓
out	0	✓	gp.nr	0	✓	off.b	0–10	✓
cur.s	0	✓	gp.fu	0	✓	off.c	0–20	✓
cur.t	20	✓	li.1d	0	✓	aib.l	0	✓
zone	On	✓	li.2d	0	✓	aib.h	999	✓
li.1	5	✓	li.3d	0	✓	aic.l	4	✓
li.2	–5	✓	li.4d	0	✓	aAic.h	999	✓
li.3	0	✓	out.h	100	✓	a1.d1	4	✓
li.4	0	✓	out.c	–100	✓	a1.d2	0	✓
sp.2	575		out.m	100	✓	a2.d1	8	✓
sp.3	575		Cool	Off	✓	a2.d2	0	✓
Sp.4	150		rel.h	Off	✓	a3.d1	2	✓
rap.t	425		rel.c	On	✓	a3.d2	0	✓
rap.a	Off	✓	sp.lo	0	✓	a4.d1	1	✓
rap.g	5	✓	sp.hi	600		a4.d2	0	✓
t1	60		cur.d	0		t1.d1	sp2.a	
t2	60		cur.e	100	✓	t1.d2	t2	
t3	300		Cels	C	✓	t2.d1	sp3.a	
t4	0	✓	Decp	0,1		t2.d2	t3	
aman	Off	✓	Dman	out	✓	t3.d1	sp4.a	
tc.al	On		Do 0,1	heat	✓	t3.d2	off	✓
tc.ti	8		Do 0,2	off		t4.d1	off	✓
appl	0	✓	Do 0,3	off	✓	t4.d2	off	✓
h.pb	11,9		Do 0,4	Off	✓	t.res	run	✓
h.td	4		Din.1	t1		edit	on	✓
h.ti	15		Din.2	off	✓	iloc	on	
h.ct	0,2		opt.a	off	✓	s,adr	0	✓
c.pb	16,6		opt.b	off	✓	s.pro	P562	✓
c.td	4		do.a	off	✓	s.bd	19,2	✓
c.ti	15		do.b	off	✓	s.par	no	✓
c.ct	10		din.a	off	✓	s.sto	1	✓
Ide.h	Off		din.b	off	✓	c.bas	32	✓
Ide.c	Off	✓	ao.a	off	✓	c.bd	250	✓
Ide.i	Off	✓	ao.b	off	✓	c.op	auto	✓
c.com	Off	✓	Sen	nicr		m.adr	1	✓

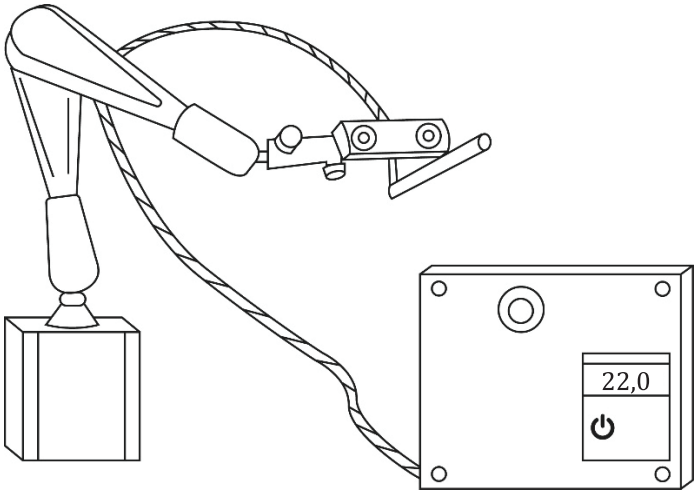


Figure A.2 — Example Apparatus